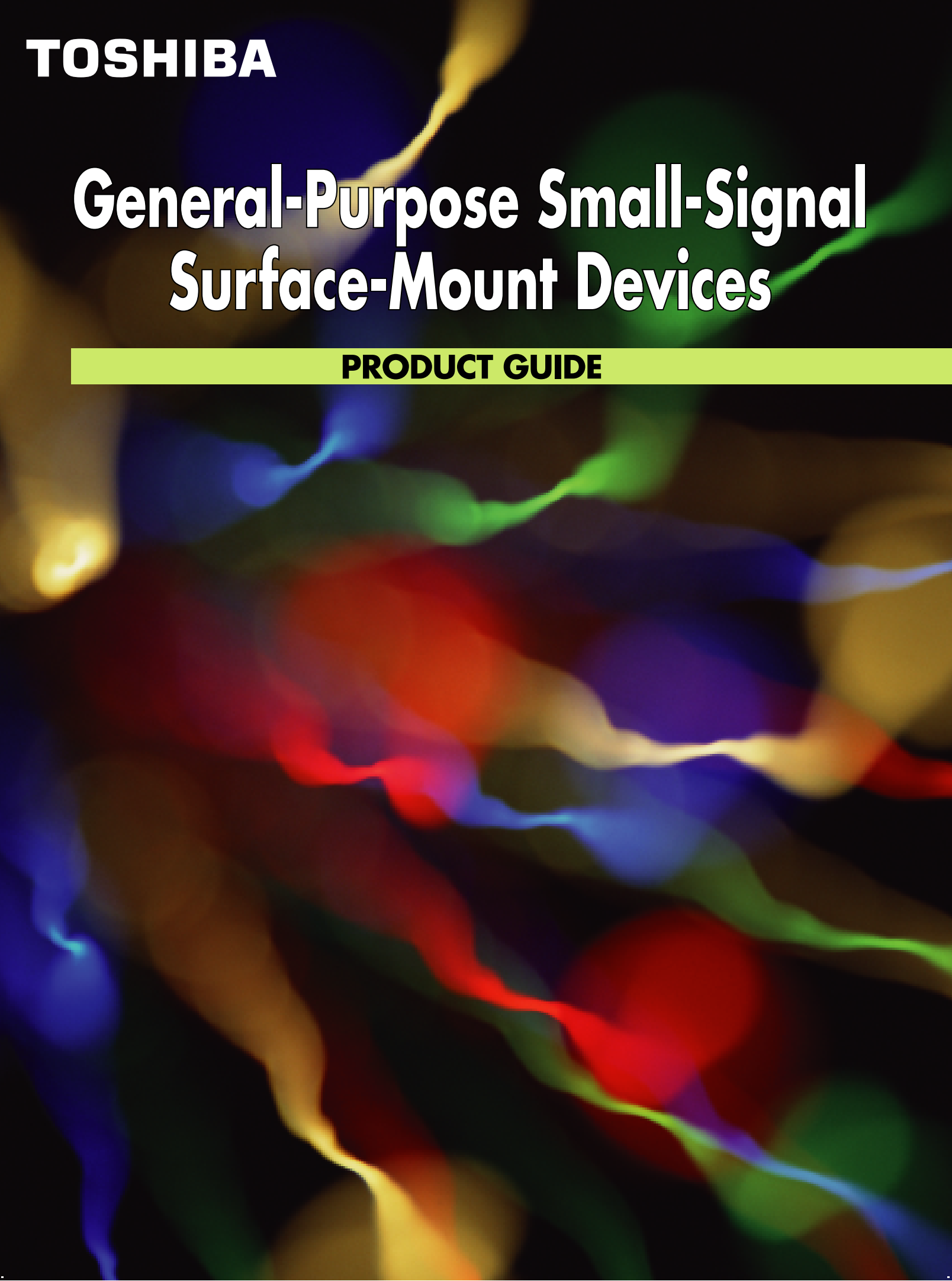




**TOSHIBA**

# **General-Purpose Small-Signal Surface-Mount Devices**

**PRODUCT GUIDE**

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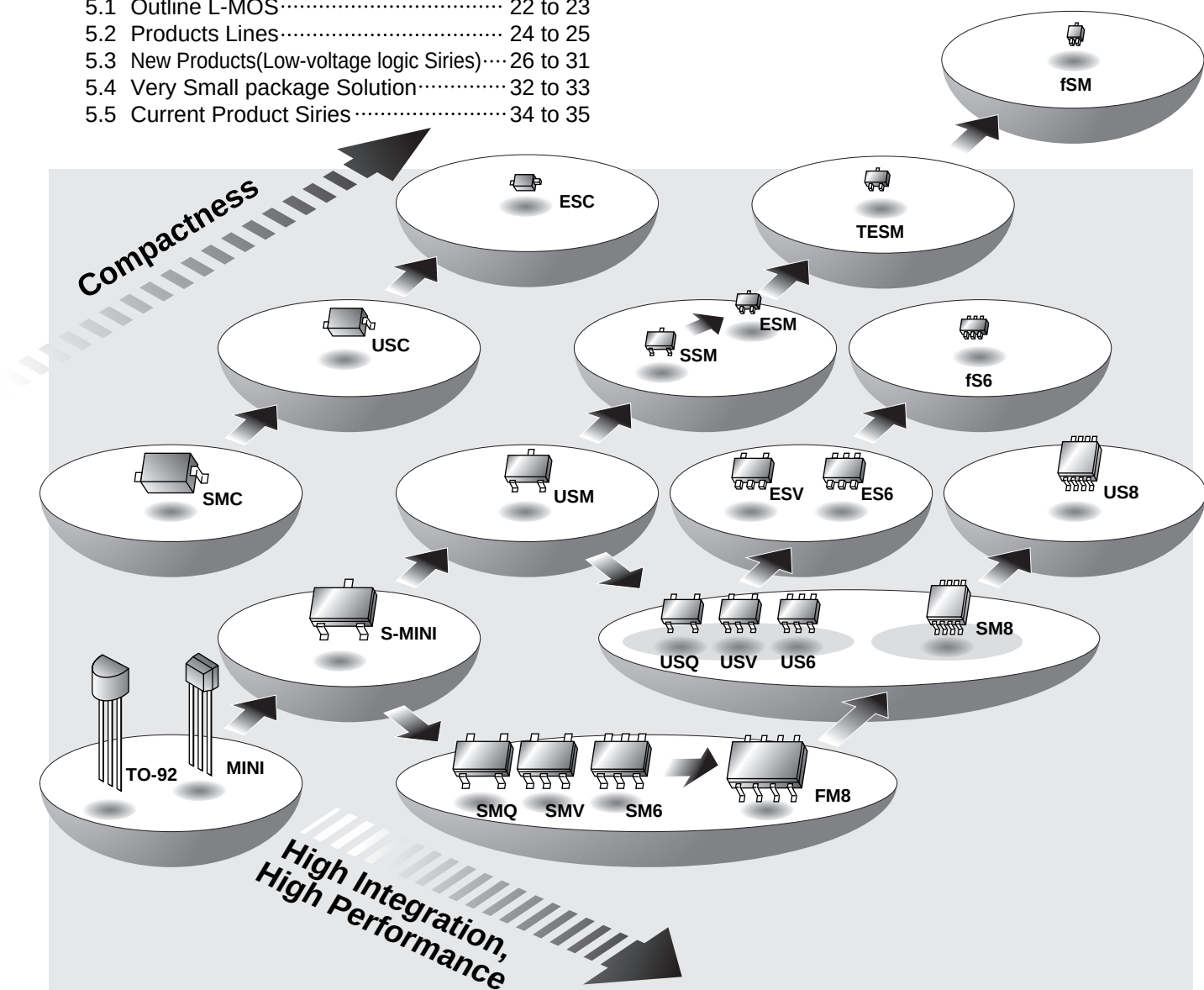
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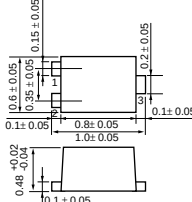
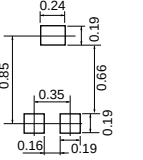
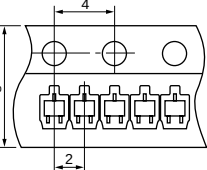
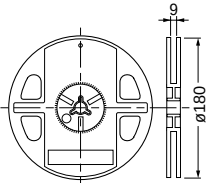
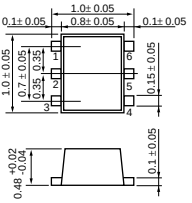
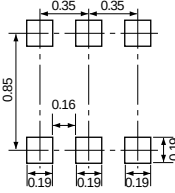
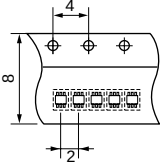
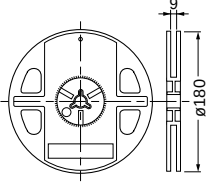
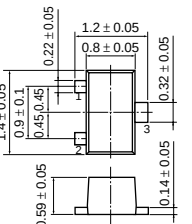
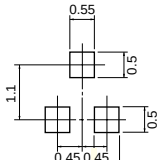
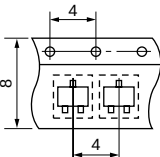
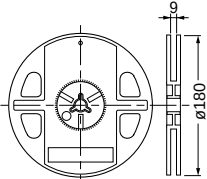
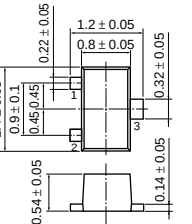
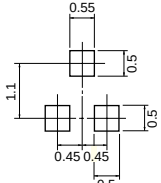
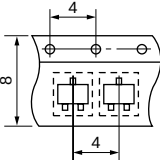
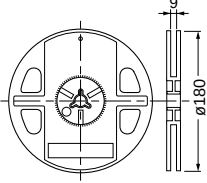
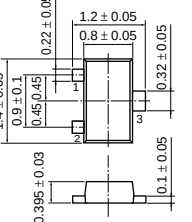
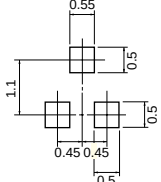
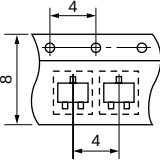
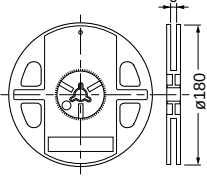
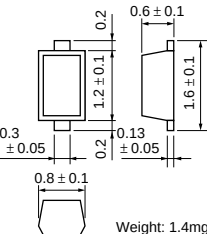
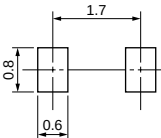
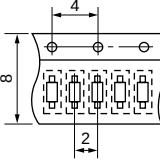
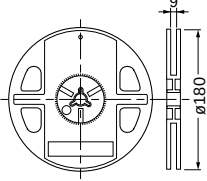
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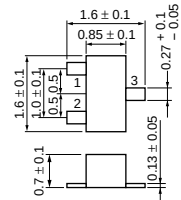
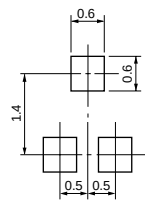
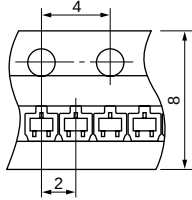
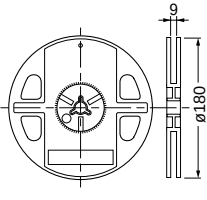
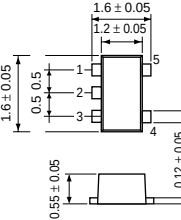
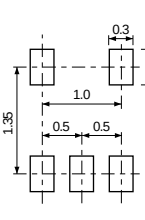
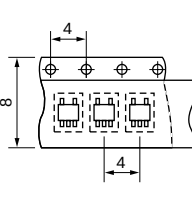
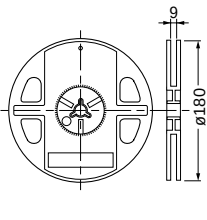
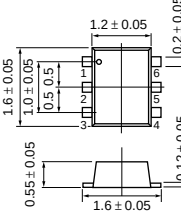
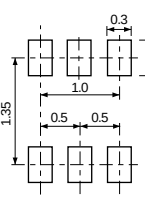
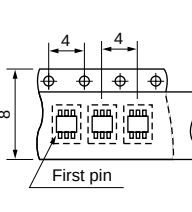
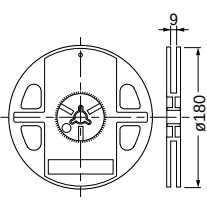
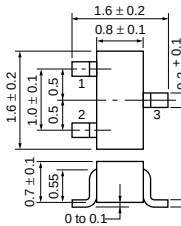
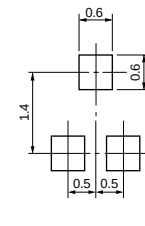
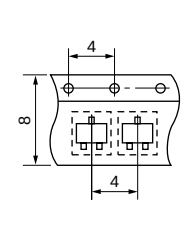
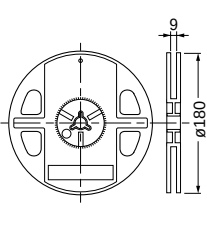
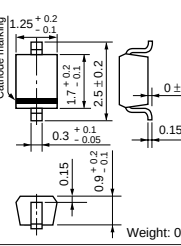
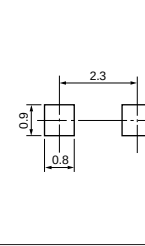
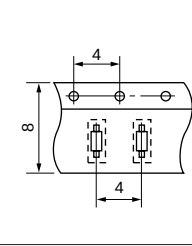
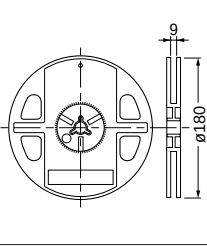
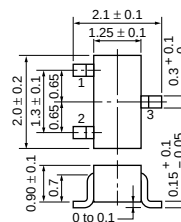
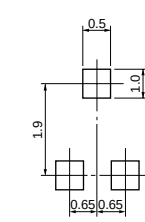
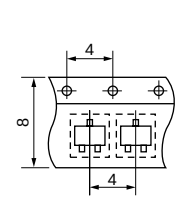
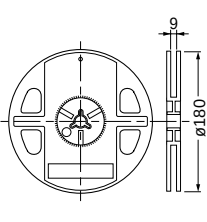
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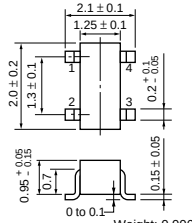
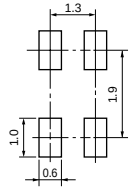
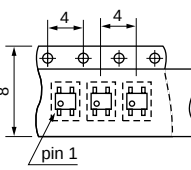
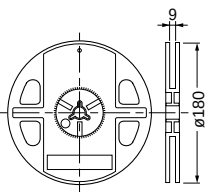
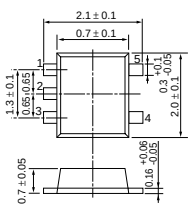
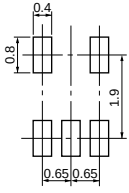
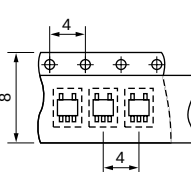
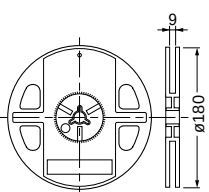
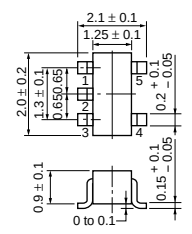
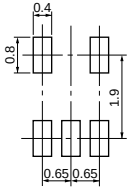
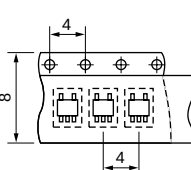
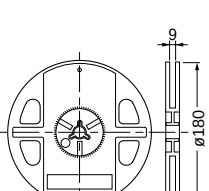
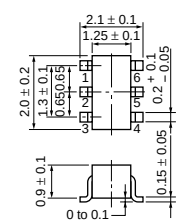
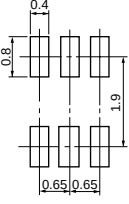
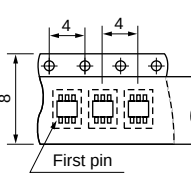
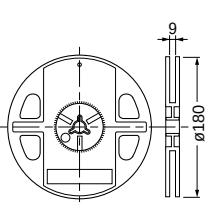
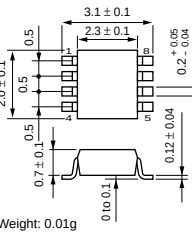
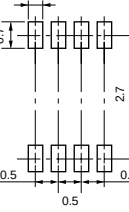
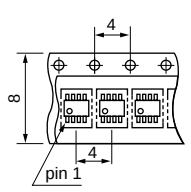
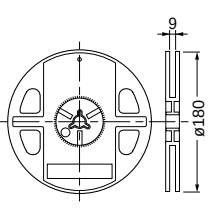
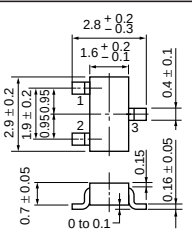
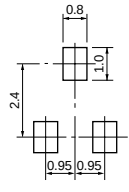
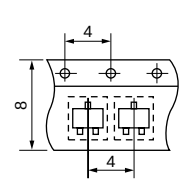
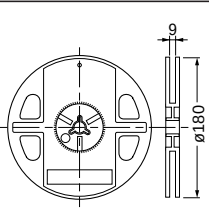


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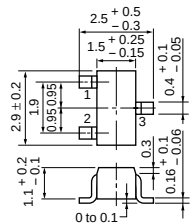
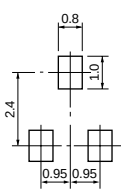
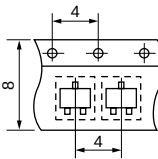
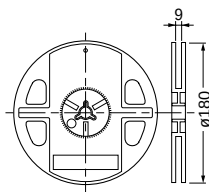
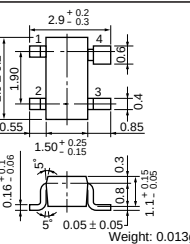
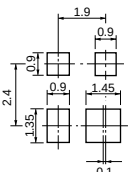
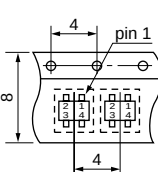
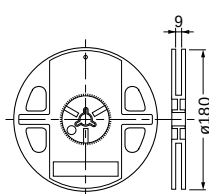
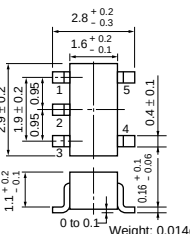
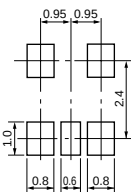
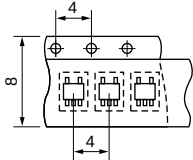
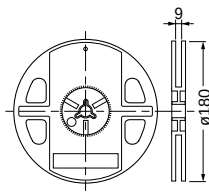
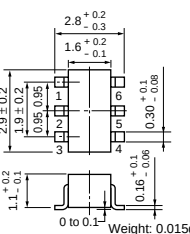
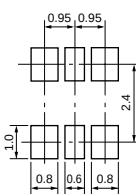
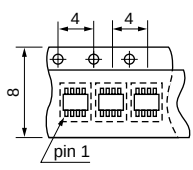
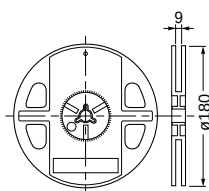
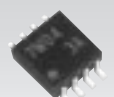
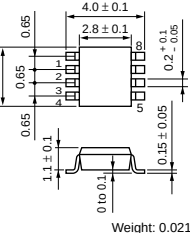
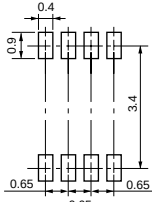
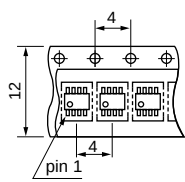
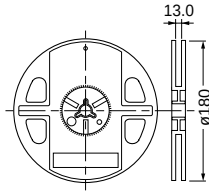
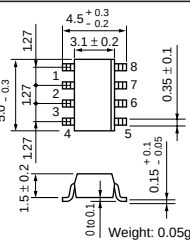
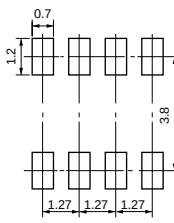
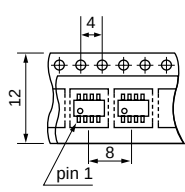
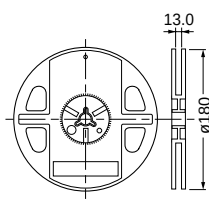
| Toshiba package name | Package Type                                                                        |                                                                                                      | Reference pad dimensions                                                            | Standard Tape Packing Specifications |                                                                                       |                                                                                       |
|----------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                      | Appearance                                                                          | Dimensions                                                                                           |                                                                                     | Tape type                            | Tape dimensions                                                                       | Reel dimensions                                                                       |
| fSM                  |    |                     |    | TPL3                                 |    |    |
|                      | Packing quantity                                                                    |                                                                                                      | 10000/reel                                                                          |                                      |                                                                                       |                                                                                       |
| fS6                  |    |                     |    | TPL3                                 |    |    |
|                      | Packing quantity                                                                    |                                                                                                      | 10000/reel                                                                          |                                      |                                                                                       |                                                                                       |
| TESM                 |  |                    |   | TE85L                                |   |   |
|                      | Packing quantity                                                                    |                                                                                                      | 4000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| TESM2                |  |                   |  | TE85L                                |  |  |
|                      | Packing quantity                                                                    |                                                                                                      | 4000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| TESM3                |  |                   |  | TE85L                                |  |  |
|                      | Packing quantity                                                                    |                                                                                                      | 5000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| ESC<br>(SOD-523)     |  | <br>Weight: 1.4mg |  | TPL3                                 |  |  |
|                      | Packing quantity                                                                    |                                                                                                      | 4000/reel                                                                           |                                      |                                                                                       |                                                                                       |

# 1. Package Information

| Toshiba package name        | Package Type                                                                        |                                                                                                                          | Reference pad dimensions                                                            | Standard Tape Packing Specifications |                                                                                                   |                                                                                       |
|-----------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                             | Appearance                                                                          | Dimensions                                                                                                               |                                                                                     | Tape type                            | Tape dimensions                                                                                   | Reel dimensions                                                                       |
| ESM<br>(SOT-490)<br>(SC-81) |    |                                         |    | TPL3                                 |                |    |
|                             | Packing quantity                                                                    |                                                                                                                          | 8000/reel                                                                           |                                      |                                                                                                   |                                                                                       |
| ESV                         |    |                                         |    | TE85L                                |                |    |
|                             | Packing quantity                                                                    |                                                                                                                          | 4000/reel                                                                           |                                      |                                                                                                   |                                                                                       |
| ES6                         |  |                                        |   | TE85L                                | <br>First pin |   |
|                             | Packing quantity                                                                    |                                                                                                                          | 4000/reel                                                                           |                                      |                                                                                                   |                                                                                       |
| SSM<br>(SOT-416)<br>(SC-75) |  |                                       |  | TE85L                                |              |  |
|                             | Packing quantity                                                                    |                                                                                                                          | 3000/reel                                                                           |                                      |                                                                                                   |                                                                                       |
| USC<br>(SOD-323)            |  | <br>Cathode marking<br>Weight: 0.004g |  | TPH3                                 |              |  |
|                             | Packing quantity                                                                    |                                                                                                                          | 3000/reel                                                                           |                                      |                                                                                                   |                                                                                       |
| USM<br>(SOT-323)<br>(SC-70) |  |                                       |  | TE85L                                |              |  |
|                             | Packing quantity                                                                    |                                                                                                                          | 3000/reel                                                                           |                                      |                                                                                                   |                                                                                       |

| Toshiba package name         | Package Type                                                                        |                                                                                                      | Reference pad dimensions                                                            | Standard Tape Packing Specifications |                                                                                                    |                                                                                       |
|------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                              | Appearance                                                                          | Dimensions                                                                                           |                                                                                     | Tape type                            | Tape dimensions                                                                                    | Reel dimensions                                                                       |
| USQ<br>(SOT-343)             |    | <br>Weight: 0.006g  |    | TE85L                                | <br>pin 1       |    |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |
| UFV                          |    |                     |    | TE85L                                |                 |    |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |
| USV<br>(SOT-353)<br>(SC-88A) |   |                    |   | TE85L                                |                |   |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |
| US6<br>(SOT-363)<br>(SC-88)  |  |                   |  | TE85L                                | <br>First pin |  |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |
| US8                          |  | <br>Weight: 0.01g |  | TE85L                                | <br>pin 1     |  |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |
| TSM                          |  |                   |  | TE85L                                |               |  |
|                              | Packing quantity                                                                    |                                                                                                      |                                                                                     |                                      |                                                                                                    |                                                                                       |

# 1. Package Information

| Toshiba package name                  | Package Type                                                                        |                                                                                                       | Reference pad dimensions                                                            | Standard Tape Packing Specifications |                                                                                       |                                                                                       |
|---------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                       | Appearance                                                                          | Dimensions                                                                                            |                                                                                     | Tape type                            | Tape dimensions                                                                       | Reel dimensions                                                                       |
| <b>S-MINI</b><br>(SOT-346)<br>(SC-59) |    |                      |    | <b>TE85L</b>                         |    |    |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 3000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| <b>SMQ</b><br>(SOT-24)<br>(SC-61)     |    | <br>Weight: 0.013g   |    | <b>TE85L</b>                         |    |    |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 3000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| <b>SMV</b><br>(SOT-25)<br>(SC-74A)    |   | <br>Weight: 0.014g  |   | <b>TE85L</b>                         |   |   |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 3000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| <b>SM6</b><br>(SOT-26)<br>(SC-74)     |  | <br>Weight: 0.015g |  | <b>TE85L</b>                         |  |  |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 3000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| <b>SM8</b>                            |  | <br>Weight: 0.021g |  | <b>TE12L</b>                         |  |  |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 3000/reel                                                                           |                                      |                                                                                       |                                                                                       |
| <b>FM8</b>                            |  | <br>Weight: 0.05g  |  | <b>TE12L</b>                         |  |  |
|                                       | <b>Packing quantity</b>                                                             |                                                                                                       | 1000/reel                                                                           |                                      |                                                                                       |                                                                                       |

# 2. Small Signal Transistors and Diodes

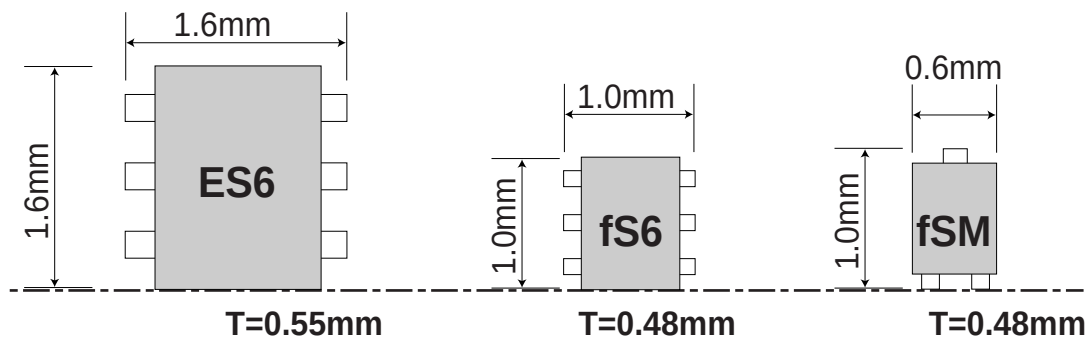
## 2.1 New Products

Very Small Package Solution for BRTs. fSM, fS6 package

### Features

- Very Small Package fSM = 1.0 x 0.6mm\* fS6 = 1.0 x 1.0mm\* (\* : Include Outer Lead)
- Very thin Package fSM/fS6 Height = 0.50mm max

### Comparison of Package Size



### Product Line-up

| Rating       | V <sub>CEO</sub> (V) |  | 50                                                                                  |                                                                                     |                                                                                     |                                                                                      |                                                                                       |                                                                                       |
|--------------|----------------------|--|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|              | I <sub>c</sub> (mA)  |  | 100                                                                                 |                                                                                     |                                                                                     |                                                                                      |                                                                                       |                                                                                       |
| Package Name |                      |  | fSM                                                                                 |                                                                                     | fS6                                                                                 |                                                                                      |                                                                                       |                                                                                       |
| Polarity     |                      |  | NPN                                                                                 | PNP                                                                                 | NPN × 2                                                                             | PNP × 2                                                                              | NPN × 2                                                                               | PNP × 2                                                                               |
| Resistor(kΩ) |                      |  |  |  |  |  |  |  |
| R1           | R2                   |  |                                                                                     |                                                                                     |                                                                                     |                                                                                      |                                                                                       |                                                                                       |
| 4.7          | 4.4                  |  | RN1101FS                                                                            | RN2101FS                                                                            | RN1961FS                                                                            | RN2961FS                                                                             | RN1901FS                                                                              | RN2901FS                                                                              |
| 10           | 10                   |  | RN1102FS                                                                            | RN2102FS                                                                            | RN1962FS                                                                            | RN2962FS                                                                             | RN1902FS                                                                              | RN2902FS                                                                              |
| 22           | 22                   |  | RN1103FS                                                                            | RN2103FS                                                                            | RN1963FS                                                                            | RN2963FS                                                                             | RN1903FS                                                                              | RN2903FS                                                                              |
| 47           | 47                   |  | RN1104FS                                                                            | RN2104FS                                                                            | RN1964FS                                                                            | RN2964FS                                                                             | RN1904FS                                                                              | RN2904FS                                                                              |
| 2.2          | 47                   |  | RN1105FS                                                                            | RN2105FS                                                                            | RN1965FS                                                                            | RN2965FS                                                                             | RN1905FS                                                                              | RN2905FS                                                                              |
| 4.7          | 47                   |  | RN1106FS                                                                            | RN2106FS                                                                            | RN1966FS                                                                            | RN2966FS                                                                             | RN1906FS                                                                              | RN2906FS                                                                              |
| 10           | 47                   |  | RN1107FS                                                                            | RN2107FS                                                                            | RN1967FS                                                                            | RN2967FS                                                                             | RN1907FS                                                                              | RN2907FS                                                                              |
| 22           | 47                   |  | RN1108FS                                                                            | RN2108FS                                                                            | RN1968FS                                                                            | RN2968FS                                                                             | RN1908FS                                                                              | RN2908FS                                                                              |
| 47           | 22                   |  | RN1109FS                                                                            | RN2109FS                                                                            | RN1969FS                                                                            | RN2969FS                                                                             | RN1909FS                                                                              | RN2909FS                                                                              |
| 4.7          | ∞                    |  | RN1110FS                                                                            | RN2110FS                                                                            | RN1970FS                                                                            | RN2970FS                                                                             | RN1910FS                                                                              | RN2910FS                                                                              |
| 10           | ∞                    |  | RN1111FS                                                                            | RN2111FS                                                                            | RN1971FS                                                                            | RN2971FS                                                                             | RN1911FS                                                                              | RN2911FS                                                                              |
| 22           | ∞                    |  | RN1112FS                                                                            | RN2112FS                                                                            | RN1972FS                                                                            | RN2972FS                                                                             | RN1912FS                                                                              | RN2912FS                                                                              |
| 47           | ∞                    |  | RN1113FS                                                                            | RN2113FS                                                                            | RN1973FS                                                                            | RN2973FS                                                                             | RN1913FS                                                                              | RN2913FS                                                                              |

Underdevelopment

# 2. Small Signal Transistors and Diodes

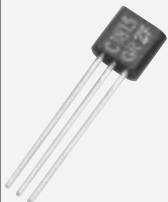
## 2.2 Small-Signal Transistors

### Transistors

| Transistors                       |                         |                        |  |  |  |  |  |  |  |  |  |                       |                            |         |                                    |                  |
|-----------------------------------|-------------------------|------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------|----------------------------|---------|------------------------------------|------------------|
| Classification                    | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | TESM2                                                                             | TESM                                                                              |                                                                                   | ESM<br>(SOT-490, SC-81)                                                           |                                                                                     | SSM<br>(SOT-416, SC-75)                                                             |                                                                                     | USM<br>(SOT-323, SC-70)                                                             |                                                                                     | TSM                   | S-MINI<br>(SOT-346, SC-59) |         | ESV                                | USV<br>(SOT-353) |
|                                   |                         |                        | NPN                                                                               | NPN                                                                               | PNP                                                                               | NPN                                                                               | PNP                                                                                 | NPN                                                                                 | PNP                                                                                 | NPN                                                                                 | PNP                                                                                 | NPN                   | NPN                        | PNP     | PNP + NPN                          | NPN              |
| General-purpose                   | 50                      | 150                    | 2SC4738TT                                                                         | 2SC4738FT                                                                         | 2SA1832FT                                                                         | 2SC4738F                                                                          | 2SA1832F                                                                            | 2SC4738                                                                             | 2SA1832                                                                             | 2SC4116                                                                             | 2SA1586                                                                             | —                     | 2SC2712                    | 2SA1162 | HN4B01JE                           | 2SC4944          |
| Low-noise                         | 120                     | 100                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC4117                                                                             | 2SA1587                                                                             | —                     | 2SC2713                    | 2SA1163 | —                                  | —                |
|                                   |                         |                        | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC3324                    | 2SA1312 | —                                  | —                |
| General-purpose                   | 30                      | 500                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC4118                                                                             | 2SA1588                                                                             | —                     | 2SC2859                    | 2SA1182 | —                                  | —                |
|                                   | 50                      | 500                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC3325                    | 2SA1313 | —                                  | —                |
| Low saturation                    | 12                      | 400                    | —                                                                                 | —                                                                                 | —                                                                                 | 2SC5376F                                                                          | —                                                                                   | 2SC5376                                                                             | 2SA1955                                                                             | —                                                                                   | —                                                                                   | —                     | —                          | —       | —                                  | HN4C05JU         |
|                                   | 12                      | 500                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC5233                                                                             | 2SA1954                                                                             | —                     | 2SC5232                    | 2SA1953 | —                                  | —                |
|                                   | 15                      | 800                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | —                          | 2SA1362 | —                                  | —                |
| High current                      | 25                      | 800                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC3265                    | 2SA1298 | —                                  | —                |
|                                   | 30                      | 800                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC4210                    | 2SA1621 | —                                  | —                |
| High withstand voltage capability | 80                      | 300                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC4209                    | 2SA1620 | —                                  | —                |
| High h <sub>FE</sub>              | 50                      | 150                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC4666                                                                             | —                                                                                   | —                     | 2SC3295                    | —       | —                                  | —                |
| Muting                            | 20                      | 300                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC4213                                                                             | —                                                                                   | —                     | 2SC3326                    | —       | —                                  | —                |
| High-speed switching              | 15                      | 200                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | 2SC4667                                                                             | —                                                                                   | —                     | 2SC3437                    | —       | —                                  | —                |
| High-speed switching              | 200                     | 50                     | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC3138                    | 2SA1255 | —                                  | —                |
| High withstand voltage capability | 300                     | 100                    | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                     | 2SC4497                    | 2SA1721 | —                                  | —                |
| Strobe                            | 10                      | 5000<br>(3000)         | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | —                                                                                   | (2SC5766)             | —                          | —       | —                                  | —                |
| Package Size                      |                         |                        | 1.4 × 0.8<br>(3 pins)<br>Flat lead                                                | 1.4 × 0.8(3 pins)<br>Flat lead                                                    |                                                                                   | 1.6 × 0.8(3 pins)<br>Flat lead                                                    |                                                                                     | 1.6 × 0.8(3 pins)                                                                   |                                                                                     | 2.0 × 1.25(3 pins)                                                                  |                                                                                     | 2.9 × 1.6<br>(3 pins) | 2.9 × 1.5(3 pins)          |         | 1.6 × 1.2<br>(5 pins)<br>Flat lead | 2.0 × 1.25       |

 New products



|          |                                                                                   |         |           |                                                                                   |                       |           |                                                                                   |                       |                                                |                                                                                    |                       |                       |                                                                                     |         |                                                                                     |          |
|----------|-----------------------------------------------------------------------------------|---------|-----------|-----------------------------------------------------------------------------------|-----------------------|-----------|-----------------------------------------------------------------------------------|-----------------------|------------------------------------------------|------------------------------------------------------------------------------------|-----------------------|-----------------------|-------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------|----------|
|          |  |         |           |  |                       |           |  |                       |                                                |  |                       |                       |  |         |  |          |
| SC-88A)  | SMV<br>(SOT-25, SC-74A)                                                           |         |           | ES6                                                                               |                       |           | US6<br>(SOT-363, SC-88)                                                           |                       |                                                | SM6<br>(SOT-26, SC-74)                                                             |                       |                       | MINI                                                                                |         | TO-92                                                                               |          |
| PNP      | NPN                                                                               | PNP     | PNP + NPN | NPN                                                                               | PNP                   | PNP + NPN | NPN                                                                               | PNP                   | PNP + NPN                                      | NPN                                                                                | PNP                   | PNP + NPN             | NPN                                                                                 | PNP     | NPN                                                                                 | PNP      |
| 2SA1873  | 2SC4207                                                                           | 2SA1618 | —         | HN1C01FE <sup>★</sup>                                                             | HN1A01FE <sup>★</sup> | —         | HN1C01FU                                                                          | HN1A01FU              | HN1B01FU                                       | HN1C01F                                                                            | HN1A01F               | HN1B01F               | 2SC2458                                                                             | 2SA1048 | 2SC1815                                                                             | 2SA1015  |
| HN4A56JU |                                                                                   |         |           | HN2C01FE <sup>★</sup>                                                             | HN2A01FE <sup>★</sup> | HN1B04FE  | HN2C01FU <sup>★</sup><br>HN3C56FU <sup>★</sup>                                    | HN2A01FU <sup>★</sup> | HN1B04FU <sup>★</sup><br>HN3B02FU <sup>★</sup> | —                                                                                  | HN3A56F <sup>**</sup> | HN3B01F <sup>**</sup> |                                                                                     |         |                                                                                     |          |
| —        | HN4C06J                                                                           | HN4A06J | HN1B06J   | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | HN3C51F <sup>**</sup>                                                              | HN3A51F <sup>**</sup> | —                     | 2SC2459                                                                             | 2SA1049 | 2SC2240                                                                             | 2SA970   |
| —        | HN4C51J                                                                           | HN4A51J | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | HN4B04J   | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | 2SC1959                                                                             | 2SA562TM |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | HN1C07F                                                                            | HN1A07F               | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | HN4C08J                                                                           | HN4A08J | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | 2SC2710                                                                             | 2SA1150 | 2SC2120                                                                             | 2SA950   |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | 2SC1627                                                                             | 2SA817   |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | 2SC3113                                                                             | —       | 2SC3112                                                                             | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | HN1C03FU                                                                          | —                     | —                                              | HN1C03F                                                                            | —                     | —                     | 2SC3327                                                                             | —       | 2SC2878                                                                             | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | HN3C61FU <sup>**</sup>                                                            | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | 2SC752 <sup>Ⓒ</sup> TM                                                              | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | —                                                                                   | —        |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | —                                                                                   | —       | 2SC2551                                                                             | 2SA1091  |
| —        | —                                                                                 | —       | —         | —                                                                                 | —                     | —         | —                                                                                 | —                     | —                                              | —                                                                                  | —                     | —                     | 2SC5720<br>2SC5765                                                                  | —       | 2SC5853<br>2SC5854                                                                  | —        |

|          |                   |                   |                    |                   |
|----------|-------------------|-------------------|--------------------|-------------------|
| (5 pins) | 2.9 × 1.5(5 pins) | 1.6 × 1.2(6 pins) | 2.0 × 1.25(6 pins) | 2.9 × 1.6(6 pins) |
|----------|-------------------|-------------------|--------------------|-------------------|

<sup>★</sup>: Mirror-image connections    <sup>★</sup>: Point-symmetrical array  
<sup>\*\*</sup>: Cascade connection

# 2. Small Signal Transistors and Diodes

## 2.3 Bias Resistor Built-in Transistors (BRTs)

|                            |                      | General-Purpose Type |          |                         |         |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
|----------------------------|----------------------|----------------------|----------|-------------------------|---------|-------------------------|--------|-------------------------|--------|----------------------------|--------|----------|----------|--------------------------|--------|-------------------------|--------|--------------------------------|--|--|--|--|--|
| Ratings                    | V <sub>CE0</sub> (V) | 50                   |          |                         |         |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
|                            | I <sub>c</sub> (mA)  | 100                  |          |                         |         |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| Package                    |                      | TESM                 |          | ESM<br>(SOT-490, SC-81) |         | SSM<br>(SOT-416, SC-75) |        | USM<br>(SOT-323, SC-70) |        | S-MINI<br>(SOT-346, SC-59) |        | ESV      |          | USV<br>(SOT-353, SC-88A) |        | SMV<br>(SOT-25, SC-74A) |        |                                |  |  |  |  |  |
| Polarity                   |                      | NPN                  | PNP      | NPN                     | PNP     | NPN                     | PNP    | NPN                     | PNP    | NPN                        | PNP    | NPN      | PNP      | NPN                      | PNP    | NPN                     | PNP    | PNP × 2                        |  |  |  |  |  |
| Internal resistors<br>(kΩ) |                      |                      |          |                         |         |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
|                            |                      | (Emitter-common)     |          |                         |         |                         |        |                         |        |                            |        |          |          |                          |        |                         |        | (Point-symmetrical array type) |  |  |  |  |  |
| R1                         | R2                   | RN1101FT             | RN2101FT | RN1101F                 | RN2101F | RN1101                  | RN2101 | RN1301                  | RN2301 | RN1401                     | RN2401 | RN1701JE | RN2701JE | RN1701                   | RN2701 | RN1501                  | RN2501 | RN1901FE                       |  |  |  |  |  |
| 4.7                        | 4.7                  | RN1102FT             | RN2102FT | RN1102F                 | RN2102F | RN1102                  | RN2102 | RN1302                  | RN2302 | RN1402                     | RN2402 | RN1702JE | RN2702JE | RN1702                   | RN2702 | RN1502                  | RN2502 | RN1902FE                       |  |  |  |  |  |
| 22                         | 22                   | RN1103FT             | RN2103FT | RN1103F                 | RN2103F | RN1103                  | RN2103 | RN1303                  | RN2303 | RN1403                     | RN2403 | RN1703JE | RN2703JE | RN1703                   | RN2703 | RN1503                  | RN2503 | RN1903FE                       |  |  |  |  |  |
| 47                         | 47                   | RN1104FT             | RN2104FT | RN1104F                 | RN2104F | RN1104                  | RN2104 | RN1304                  | RN2304 | RN1404                     | RN2404 | RN1704JE | RN2704JE | RN1704                   | RN2704 | RN1504                  | RN2504 | RN1904FE                       |  |  |  |  |  |
| 2.2                        | 47                   | RN1105FT             | RN2105FT | RN1105F                 | RN2105F | RN1105                  | RN2105 | RN1305                  | RN2305 | RN1405                     | RN2405 | RN1705JE | RN2705JE | RN1705                   | RN2705 | RN1505                  | RN2505 | RN1905FE                       |  |  |  |  |  |
| 4.7                        | 47                   | RN1106FT             | RN2106FT | RN1106F                 | RN2106F | RN1106                  | RN2106 | RN1306                  | RN2306 | RN1406                     | RN2406 | RN1706JE | RN2706JE | RN1706                   | RN2706 | RN1506                  | RN2506 | RN1906FE                       |  |  |  |  |  |
| 10                         | 47                   | RN1107FT             | RN2107FT | RN1107F                 | RN2107F | RN1107                  | RN2107 | RN1307                  | RN2307 | RN1407                     | RN2407 | RN1707JE | RN2707JE | RN1707                   | RN2707 | RN1507                  | RN2507 | RN1907FE                       |  |  |  |  |  |
| 22                         | 47                   | RN1108FT             | RN2108FT | RN1108F                 | RN2108F | RN1108                  | RN2108 | RN1308                  | RN2308 | RN1408                     | RN2408 | RN1708JE | RN2708JE | RN1708                   | RN2708 | RN1508                  | RN2508 | RN1908FE                       |  |  |  |  |  |
| 47                         | 22                   | RN1109FT             | RN2109FT | RN1109F                 | RN2109F | RN1109                  | RN2109 | RN1309                  | RN2309 | RN1409                     | RN2409 | RN1709JE | RN2709JE | RN1709                   | RN2709 | RN1509                  | RN2509 | RN1909FE                       |  |  |  |  |  |
| 4.7                        | ∞                    | RN1110FT             | RN2110FT | RN1110F                 | RN2110F | RN1110                  | RN2110 | RN1310                  | RN2310 | RN1410                     | RN2410 | RN1710JE | RN2710JE | RN1710                   | RN2710 | RN1510                  | RN2510 | RN1910FE                       |  |  |  |  |  |
| 10                         | ∞                    | RN1111FT             | RN2111FT | RN1111F                 | RN2111F | RN1111                  | RN2111 | RN1311                  | RN2311 | RN1411                     | RN2411 | RN1711JE | RN2711JE | RN1711                   | RN2711 | RN1511                  | RN2511 | RN1911FE                       |  |  |  |  |  |
| 22                         | ∞                    | RN1112FT             | RN2112FT | RN1112F                 | RN2112F | RN1112                  | RN2112 | RN1312                  | RN2312 | RN1412                     | RN2412 |          | RN2712JE |                          |        |                         |        |                                |  |  |  |  |  |
| 47                         | ∞                    | RN1113FT             | RN2113FT | RN1113F                 | RN2113F | RN1113                  | RN2113 | RN1313                  | RN2313 | RN1413                     | RN2413 |          | RN2713JE |                          |        |                         |        |                                |  |  |  |  |  |
| 1                          | 10                   | RN1114FT             | RN2114FT | RN1114F                 | RN2114F | RN1114                  | RN2114 | RN1314                  | RN2314 | RN1414                     | RN2414 |          |          |                          | RN2714 |                         |        |                                |  |  |  |  |  |
| 2.2                        | 10                   | RN1115FT             | RN2115FT | RN1115F                 | RN2115F | RN1115                  | RN2115 | RN1315                  | RN2315 | RN1415                     | RN2415 |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 4.7                        | 10                   | RN1116FT             | RN2116FT | RN1116F                 | RN2116F | RN1116                  | RN2116 | RN1316                  | RN2316 | RN1416                     | RN2416 |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 10                         | 4.7                  | RN1117FT             | RN2117FT | RN1117F                 | RN2117F | RN1117                  | RN2117 | RN1317                  | RN2317 | RN1417                     | RN2417 |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 47                         | 10                   | RN1118FT             | RN2118FT | RN1118F                 | RN2118F | RN1118                  | RN2118 | RN1318                  | RN2318 | RN1418                     | RN2418 |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 100                        | 100                  | RN1130FT             | RN2130FT | RN1130F                 | RN2130F |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 100                        | ∞                    | RN1131FT             | RN2131FT | RN1131F                 | RN2131F |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |
| 200                        | ∞                    | RN1132FT             | RN2132FT | RN1132F                 | RN2132F |                         |        |                         |        |                            |        |          |          |                          |        |                         |        |                                |  |  |  |  |  |

New products

(NPN/PNP)

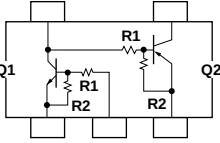
|                            |                      | High Current                                |         |        |        |                         |        | Muting |                         |
|----------------------------|----------------------|---------------------------------------------|---------|--------|--------|-------------------------|--------|--------|-------------------------|
| Ratings                    | V <sub>CE0</sub> (V) | 12                                          |         | 50     |        |                         |        | 20     |                         |
|                            | I <sub>C</sub> (mA)  | 500                                         |         | 800    |        |                         |        | 300    |                         |
| Package                    |                      | USM (SOT-323, SC-70)                        |         | MINI   |        | S-MINI (SOT-346, SC-59) |        | MINI   | S-MINI (SOT-346, SC-59) |
| Polarity                   |                      | NPN                                         | PNP     | NPN    | PNP    | NPN                     | PNP    | NPN    | NPN                     |
| Internal resistors<br>(KΩ) |                      | <div><div>(NPN)</div><div>(PNP)</div></div> |         |        |        |                         |        |        |                         |
|                            |                      | R1                                          | R2      |        |        |                         |        |        |                         |
| 1                          | 1                    | RN1321A                                     | RN2321A | RN1221 | RN2221 | RN1421                  | RN2421 |        |                         |
| 2.2                        | 2.2                  | RN1322A                                     | RN2322A | RN1222 | RN2222 | RN1422                  | RN2422 |        |                         |
| 4.7                        | 4.7                  | RN1323A                                     | RN2323A | RN1223 | RN2223 | RN1423                  | RN2423 |        |                         |
| 10                         | 10                   | RN1324A                                     | RN2324A | RN1224 | RN2224 | RN1424                  | RN2424 |        |                         |
| 0.47                       | 10                   | RN1325A                                     | RN2325A | RN1225 | RN2225 | RN1425                  | RN2425 |        |                         |
| 1                          | 10                   | RN1326A                                     | RN2326A | RN1226 | RN2226 | RN1426                  | RN2426 |        |                         |
| 2.2                        | 10                   | RN1327A                                     | RN2327A | RN1227 | RN2227 | RN1427                  | RN2427 |        |                         |
| 5.6                        | ∞                    |                                             |         |        |        |                         |        | RN1241 | RN1441                  |
| 10                         | ∞                    |                                             |         |        |        |                         |        | RN1242 | RN1442                  |
| 22                         | ∞                    |                                             |         |        |        |                         |        | RN1243 | RN1443                  |
| 2.2                        | ∞                    |                                             |         |        |        |                         |        | RN1244 | RN1444                  |

New products

(NPN/PNP)

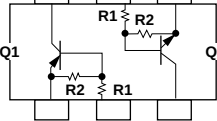
[illegible]

### Multi-chip 5-pin packages(C-B Connecting type)

|                    |                       | Multi-Chip Type |                      |                   |         |                                                                                       |
|--------------------|-----------------------|-----------------|----------------------|-------------------|---------|---------------------------------------------------------------------------------------|
| Ratings            | V <sub>CEO</sub> (V)  | 50 / -50        |                      | Component devices |         | Internal resistor                                                                     |
|                    | I <sub>CEO</sub> (mA) | 100 / -100      |                      |                   |         |                                                                                       |
| Package            |                       | ESV             | USV(SOT-353, SC-88A) |                   |         |                                                                                       |
| Internal resistors |                       |                 |                      |                   |         |                                                                                       |
| R1 (kΩ)            | R2 (kΩ)               |                 |                      |                   |         |  |
| 4.7                | —                     | RN47A1JE        | RN47A1               | Q1                | RN1310  |                                                                                       |
| 4.7                | —                     |                 |                      | Q2                | RN2310  |                                                                                       |
| 22                 | 22                    | RN47A2JE        | RN47A2               | Q1                | RN1303  |                                                                                       |
| 22                 | 22                    |                 |                      | Q2                | RN2303  |                                                                                       |
| 10                 | 10                    | RN47A3JE        | RN47A3               | Q1                | RN1302  |                                                                                       |
| 10                 | 10                    |                 |                      | Q2                | RN2302  |                                                                                       |
| 47                 | 47                    | RN47A4JE        | RN47A4               | Q1                | RN1304  |                                                                                       |
| 10                 | 47                    |                 |                      | Q2                | RN2307  |                                                                                       |
| 47                 | 47                    | RN47A5JE        | RN47A5               | Q1                | RN1304  |                                                                                       |
| 4.7                | 10                    |                 |                      | Q2                | RN2316  |                                                                                       |
| 100                | 100                   |                 | RN47A6 <sup>*</sup>  | Q1                | RN1130F |                                                                                       |
| 100                | 100                   |                 |                      | Q2                | RN2130F |                                                                                       |

 New products      \* Under development

### Multi-chip 6-pin packages(Special Combination type)

|                    |                       | Multi-Chip Type |                         |                        |                   |        |                                                                                       |
|--------------------|-----------------------|-----------------|-------------------------|------------------------|-------------------|--------|---------------------------------------------------------------------------------------|
| Ratings            | V <sub>CEO</sub> (V)  | -50 / 50        |                         |                        | Component devices |        | Internal resistor                                                                     |
|                    | I <sub>CEO</sub> (mA) | -100 / 100      |                         |                        |                   |        |                                                                                       |
| Package            |                       | ES6             | US6<br>(SOT-363, SC-88) | SM6<br>(SOT-26, SC-74) |                   |        |                                                                                       |
| Internal resistors |                       |                 |                         |                        |                   |        |                                                                                       |
| R1 (kΩ)            | R2 (kΩ)               |                 |                         |                        |                   |        |  |
| 2.2                | 47                    | RN49A1FE        | RN49A1                  |                        | Q1                | RN2305 |                                                                                       |
| 22                 | 47                    |                 |                         |                        | Q2                | RN1308 |                                                                                       |
| 22                 | 22                    |                 |                         | RN46A1                 | Q1                | RN2303 |                                                                                       |
| 10                 | 10                    |                 |                         |                        | Q2                | RN1302 |                                                                                       |
| 2.2                | 47                    |                 |                         |                        | Q1                | RN2305 |                                                                                       |
| 47                 | 47                    | RN49A2          |                         |                        | Q2                | RN1304 |                                                                                       |

☐ New products

# 3.Small-Signal MOSFETs(S-MOS)

## 3.1 Standard Family 1-in-1 Type

| Polarity | Maximum Ratings         |                         |                        | Packages                   |                         |                         |                         |                  | V <sub>th</sub><br>(V) | R <sub>DS(on)</sub><br>(Ω) | Typ.(Max)            |  |
|----------|-------------------------|-------------------------|------------------------|----------------------------|-------------------------|-------------------------|-------------------------|------------------|------------------------|----------------------------|----------------------|--|
|          | V <sub>DSS</sub><br>(V) | V <sub>GSS</sub><br>(V) | I <sub>D</sub><br>(mA) | S-MINI<br>(SOT-346, SC-59) | USM<br>(SOT-323, SC-70) | SSM<br>(SOT-416, SC-75) | ESM<br>(SOT-490, SC-81) | TESM<br>(140806) |                        |                            | @V <sub>GS</sub> (V) |  |
| Nch      | 50                      | 10                      | 50                     | 2SK1826                    | 2SK1827                 | —                       | —                       | —                | 0.8 ~ 2.5              | 20 (50)                    | 4                    |  |
|          | 20                      | 10                      | 50                     | 2SK1828                    | 2SK1829                 | 2SK1830                 | —                       | —                | 0.5 ~ 1.5              | 20 (40)                    | 2.5                  |  |
|          | 20                      | 10                      | 100                    | 2SK2823                    | 2SK2824                 | 2SK2825                 | —                       | —                | 0.5 ~ 1.0              | 10 (40)                    | 1.5                  |  |
|          | 20                      | 10                      | 100                    | 2SK2033                    | 2SK2034                 | 2SK2035                 | —                       | —                | 0.5 ~ 1.5              | 8 (12)                     | 2.5                  |  |
|          | 20                      | 10                      | 100                    | 2SK2036                    | 2SK2037                 | —                       | —                       | —                | 0.5 ~ 1.5              | 3.5 (6)                    | 2.5                  |  |
|          | 20                      | 10                      | 100                    | —                          | —                       | —                       | SSM3K03FE               | SSM3K03TE        | 0.7 ~ 1.3              | 4 (12)                     | 2.5                  |  |
|          | 20                      | 10                      | 100                    | —                          | *SSM3K04FU              | *SSM3K04FS              | *SSM3K04FE              | —                | 0.7 ~ 1.3              | 4 (12)                     | 2.5                  |  |
|          | 20                      | ± 10                    | 100                    | —                          | SSM3K16FU               | SSM3K16FS               | —                       | SSM3K16TE        | 0.6 ~ 1.1              | 2.2 (5)                    | 2.5                  |  |
|          | 30                      | ± 20                    | 100                    | SSM3K15F                   | SSM3K15FU               | SSM3K15FS               | —                       | SSM3K15TE        | 0.8 ~ 1.5              | 4 (7)                      | 2.5                  |  |
|          | 50                      | ± 7                     | 100                    | —                          | SSM3K17FU               | —                       | —                       | —                | 0.9 ~ 1.5              | 22 (40)                    | 2.5                  |  |
|          | 60                      | ± 20                    | 200                    | 2SK1062                    | —                       | —                       | —                       | —                | 2.0 ~ 3.5              | 0.6 (1.0)                  | 10                   |  |
|          | 30                      | ± 20                    | 200                    | 2SK2009                    | —                       | —                       | —                       | —                | 0.5 ~ 1.5              | 1.2 (2.0)                  | 2.5                  |  |
|          | 20                      | ± 12                    | 400                    | —                          | SSM3K05FU               | —                       | —                       | —                | 0.6 ~ 1.1              | 0.85 (1.2)                 | 2.5                  |  |
|          | 30                      | ± 20                    | 400                    | —                          | SSM3K09FU               | —                       | —                       | —                | 1.1 ~ 1.8              | 0.8 (1.2)                  | 4                    |  |
| Pch      | - 50                    | - 7                     | - 50                   | 2SJ343                     | 2SJ344                  | —                       | —                       | —                | - 0.8 ~ - 2.5          | 20 (50)                    | - 4                  |  |
|          | - 20                    | - 7                     | - 50                   | 2SJ345                     | 2SJ346                  | 2SJ347                  | —                       | —                | - 0.5 ~ - 1.5          | 20 (40)                    | - 2.5                |  |
|          | - 20                    | 10                      | - 100                  | —                          | —                       | —                       | SSM3J03FE               | —                | - 0.7 ~ - 1.3          | 12 (25)                    | - 2.5                |  |
|          | - 20                    | ± 10                    | - 100                  | —                          | SSM3J16FU               | SSM3J16FS               | —                       | SSM3J16TE        | - 0.6 ~ - 1.1          | 8 (12)                     | - 2.5                |  |
|          | - 30                    | ± 20                    | - 100                  | SSM3J15F                   | SSM3J15FU               | SSM3J15FS               | —                       | SSM3J15TE        | - 1.1 ~ - 1.7          | 18 (36)                    | - 2.5                |  |
|          | - 60                    | ± 20                    | - 200                  | 2SJ168                     | —                       | —                       | —                       | —                | - 2.0 ~ - 3.5          | 1.3 (2)                    | - 10                 |  |
|          | - 30                    | ± 20                    | - 200                  | 2SJ305                     | —                       | —                       | —                       | —                | - 0.5 ~ - 1.5          | 2.4 (4)                    | - 2.5                |  |
|          | - 20                    | ± 12                    | - 200                  | —                          | SSM3J05FU               | —                       | —                       | —                | - 0.6 ~ - 1.1          | 3.2 (4.0)                  | - 2.5                |  |
|          | - 30                    | ± 20                    | - 200                  | —                          | SSM3J09FU               | —                       | —                       | —                | - 1.1 ~ - 1.8          | 3.3 (4.2)                  | - 4                  |  |
|          | —                       | —                       | —                      | —                          | —                       | —                       | —                       | —                | —                      | —                          | —                    |  |

New products ★ Pull-down resistance built-in type R<sub>GS</sub> = 1MΩ

## 3.2 Standard Family 2-in-1 Type

| Polarity  | Maximum Ratings         |                         |                        | Packages                |                          |                       |                                      | V <sub>th</sub><br>(V) | R <sub>DS(on)</sub><br>(Ω) | Typ.(Max)            |                       | Combination |
|-----------|-------------------------|-------------------------|------------------------|-------------------------|--------------------------|-----------------------|--------------------------------------|------------------------|----------------------------|----------------------|-----------------------|-------------|
|           | V <sub>DSS</sub><br>(V) | V <sub>GSS</sub><br>(V) | I <sub>D</sub><br>(mA) | US6<br>(SOT-363, SC-88) | USV<br>(SOT-353, SC-88A) | ES6<br>(1612055 6pin) | ESV<br>(1612055 5pin)<br>Source-com. |                        |                            | @V <sub>GS</sub> (V) |                       |             |
| Nch × 2   | 20                      | 10                      | 50                     | HN1K02FU                | —                        | —                     | —                                    | 0.5 ~ 1.5              | 20 (40)                    | 2.5                  | 2SK1829 × 2           |             |
|           | 20                      | 10                      | 100                    | HN1K03FU                | HN4K03JU                 | —                     | —                                    | 0.5 ~ 1.5              | 8 (12)                     | 2.5                  | 2SK2034 × 2           |             |
|           | 50                      | 10                      | 50                     | HN1K04FU                | —                        | —                     | —                                    | 0.8 ~ 2.5              | 20 (50)                    | 4                    | 2SK1827 × 2           |             |
|           | 20                      | 10                      | 100                    | —                       | —                        | SSM6N03FE             | SSM5N03FE                            | 0.7 ~ 1.3              | 4 (12)                     | 2.5                  | SSM3K03FE × 2         |             |
|           | 20                      | 10                      | 100                    | *SSM6N04FU              | —                        | —                     | —                                    | 0.7 ~ 1.3              | 4 (12)                     | 2.5                  | SSM3K04FU × 2         |             |
|           | 20                      | 10                      | 100                    | HN1K05FU                | —                        | —                     | —                                    | 0.5 ~ 1.0              | 15 (50)                    | 1.2                  | 2SK2825 × 2           |             |
|           | 20                      | 10                      | 100                    | HN1K06FU                | —                        | —                     | —                                    | 0.5 ~ 1.5              | 10 (40)                    | 1.5                  | 2SK2825 × 2           |             |
|           | 20                      | ± 10                    | 100                    | SSM6N16FU               | SSM5N16FU                | SSM6N16FE             | SSM5N16FE                            | 0.6 ~ 1.1              | 7 (28)                     | 2.5                  | SSM3K16FU × 2         |             |
|           | 30                      | ± 20                    | 100                    | SSM6N15FU               | SSM5N15FU                | SSM6N15FE             | SSM5N15FE                            | 0.8 ~ 1.5              | 3.5 (6.0)                  | 2.5                  | SSM3K15FU × 2         |             |
|           | 50                      | ± 7                     | 100                    | SSM6N17FU               | —                        | —                     | —                                    | 0.9 ~ 1.5              | 2.2 (5)                    | 2.5                  | SSM3K17FU × 2         |             |
|           | 20                      | ± 12                    | 400                    | SSM6N05FU               | SSM5N05FU                | —                     | —                                    | 0.6 ~ 1.1              | 4 (7)                      | 2.5                  | SSM3K05FU × 2         |             |
|           | 30                      | ± 20                    | 400                    | SSM6N09FU               | —                        | —                     | —                                    | 1.1 ~ 1.8              | 22 (40)                    | 2.5                  | SSM3K09FU × 2         |             |
|           | - 20                    | - 7                     | - 50                   | HN1J02FU                | —                        | —                     | —                                    | - 0.5 ~ - 1.5          | 0.85 (1.2)                 | 4                    | SSM3K09FU × 2         |             |
|           | - 20                    | ± 10                    | - 100                  | SSM6P16FU               | SSM5P16FU                | SSM6P16FE             | SSM5P16FE                            | - 0.6 ~ - 1.1          | 0.8 (1.2)                  | - 2.5                | SSM3J16FU × 2         |             |
| Pch × 2   | - 30                    | ± 20                    | - 100                  | SSM6P15FU               | SSM5P15FU                | SSM6P15FE             | SSM5P15FE                            | - 1.1 ~ - 1.7          | 8 (12)                     | - 2.5                | SSM3J15FU × 2         |             |
|           | - 20                    | ± 12                    | - 200                  | SSM6P05FU               | SSM5N05FU                | —                     | —                                    | - 0.6 ~ - 1.1          | 18 (36)                    | - 2.5                | SSM3J05FU × 2         |             |
|           | - 30                    | ± 20                    | - 200                  | SSM6P09FU               | —                        | —                     | —                                    | - 1.1 ~ - 1.8          | 3.2 (4.0)                  | - 2.5                | SSM3J09FU × 2         |             |
|           | - 30                    | ± 20                    | - 200                  | SSM6P09FU               | —                        | —                     | —                                    | - 1.1 ~ - 1.8          | 3.3 (4.2)                  | - 4                  | SSM3J09FU × 2         |             |
| Nch + Pch | 20                      | 10                      | 50                     | HN1L02FU                | —                        | —                     | —                                    | 0.5 ~ 1.5              | 20 (40)                    | 2.5                  | 2SK1829 + 2SJ346      |             |
|           | - 20                    | - 7                     | - 50                   | HN1L03FU                | —                        | —                     | —                                    | - 0.5 ~ - 1.5          | 20 (40)                    | - 2.5                | 2SK1827 + 2SJ346      |             |
|           | 50                      | 10                      | 50                     | HN1L03FU                | —                        | —                     | —                                    | 0.8 ~ 2.5              | 20 (50)                    | 4                    | 2SK1827 + 2SJ346      |             |
|           | - 20                    | ± 12                    | 400                    | SSM6L05FU               | —                        | —                     | —                                    | - 0.5 ~ - 1.5          | 20 (40)                    | - 2.5                | SSM3K05FU + SSM3J05FU |             |
|           | - 20                    | ± 12                    | - 200                  | SSM6L05FU               | —                        | —                     | —                                    | 0.6 ~ 1.1              | 0.85 (1.2)                 | 2.5                  | SSM3K05FU + SSM3J05FU |             |
|           | 30                      | ± 20                    | 400                    | SSM6L09FU               | —                        | —                     | —                                    | - 0.6 ~ - 1.1          | 3.2 (4.0)                  | - 2.5                | SSM3K09FU + SSM3J09FU |             |
|           | - 30                    | ± 20                    | - 200                  | SSM6L09FU               | —                        | —                     | —                                    | 1.1 ~ 1.8              | 0.8 (1.2)                  | 4                    | SSM3K09FU + SSM3J09FU |             |
|           | - 30                    | ± 20                    | - 200                  | SSM6L09FU               | —                        | —                     | —                                    | - 1.1 ~ - 1.8          | 3.3 (4.2)                  | - 4                  | SSM3K09FU + SSM3J09FU |             |

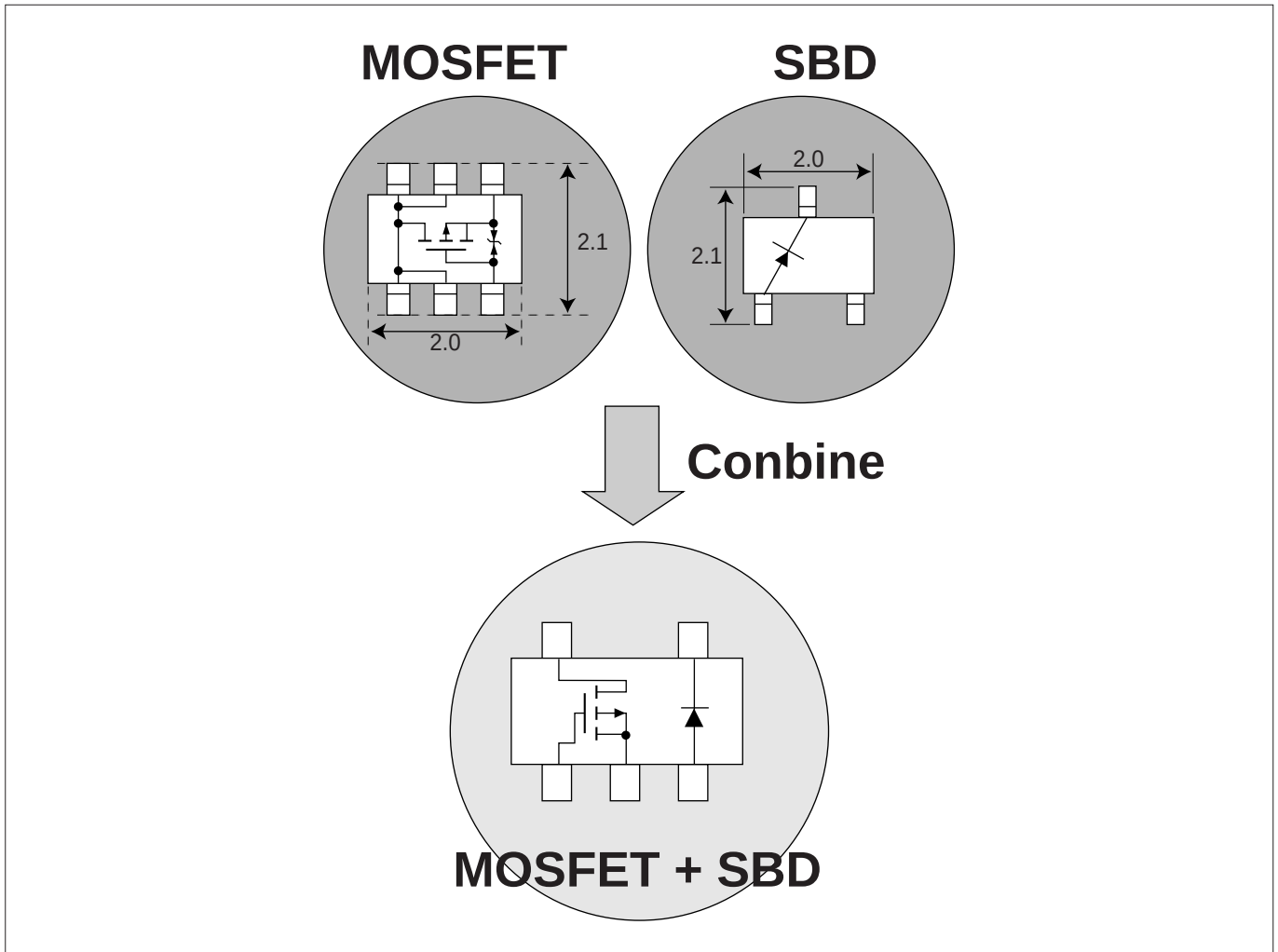
New products ★ Pull-down resistance built-in type R<sub>GS</sub> = 1MΩ

### 3.3 High Current Family

#### New Products

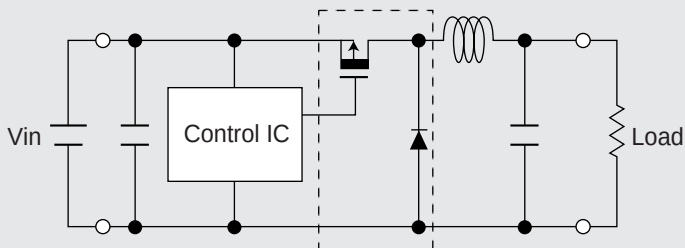
High Current S-MOS + SBD for DC/DC Converter Application

#### Concept



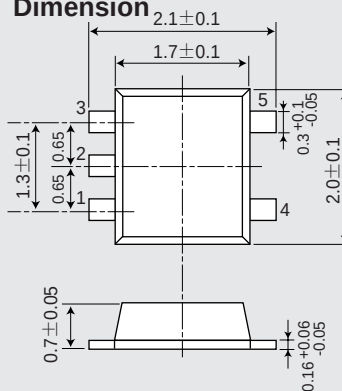
#### Application Example

##### DC-DC Converter

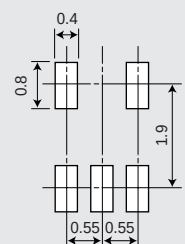


#### Package Information

##### Dimension



##### Land Pattern



# 3.Small-Signal MOSFETs(S-MOS)

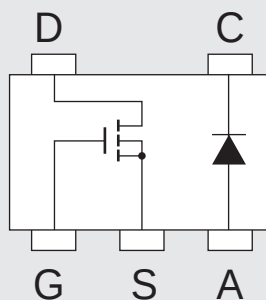


## Line-up

| Name             | Typ | V(V) | I(A) | V <sub>th</sub> (V) | characteristic              |                       |
|------------------|-----|------|------|---------------------|-----------------------------|-----------------------|
|                  |     |      |      |                     | R <sub>DS(on)</sub> max(mΩ) | V <sub>F</sub> max(V) |
| <b>SSM5H01TU</b> | Nch | 30   | 1.4  | 1.0 ~ 2.4           | 0.45@4.0V                   | 0.45@0.3A             |
|                  | SBD | 12   | 0.5  |                     |                             |                       |
| <b>SSM5H03TU</b> | Nch | 12   | 1.4  | 1.0 ~ 2.3           | 0.3@4.0V                    | 0.43@0.5A             |
|                  | SBD | 12   | 0.5  |                     |                             |                       |
| <b>SSM5G01TU</b> | Pch | -30  | -1.0 | -0.8 ~ -1.8         | 0.80@-4.0V                  | 0.45@0.3A             |
|                  | SBD | 20   | 0.5  |                     |                             |                       |
| <b>SSM5G02TU</b> | Pch | -12  | -1.0 | -0.4 ~ -1.1         | 0.48@-1.8V                  | 0.43@0.5A             |
|                  | SBD | 12   | 0.5  |                     |                             |                       |
| <b>SSM5G04TU</b> | Pch | -12  | -1.0 | -0.4 ~ -1.1         | 0.42@-2.5V                  | 0.43@0.5A             |
|                  | SBD | 12   | 0.5  |                     |                             |                       |

 New Products

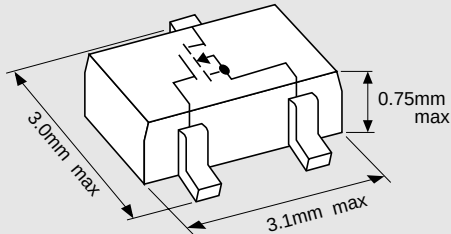
## Internal Connection



## New Products

### TSM Package Series

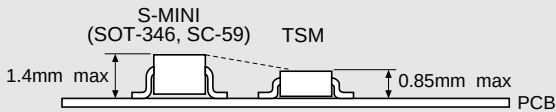
#### Feature of TSM Package



#### Feature

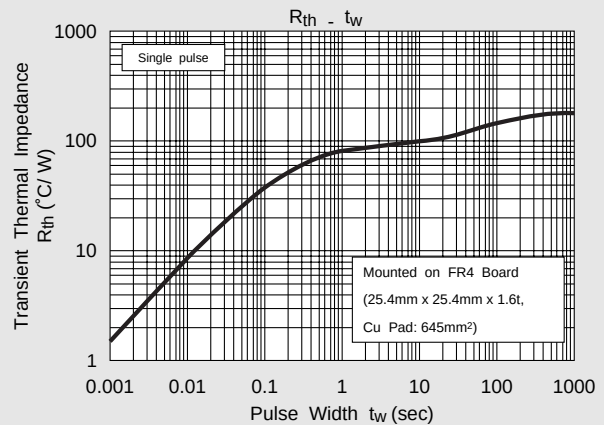
Compact package: 3.1 mm(max) x 3.0 mm(max)  
Mold thickness: 0.75 mm(max)  
 $P_D = 1.25$  W (when mounted on a PCB,  $t = 10$  s)

To meet the demand for S-MOS devices which can be incorporated into thin equipment, Toshiba have reduced the package thickness from 1.4 mm max. to 0.85 mm max. (for the TSM package).



#### Thermal resistance

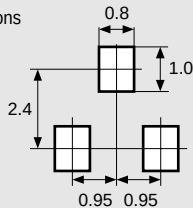
Ratings of  $R_{th} = 100^\circ\text{C/W}$  and  $P_D = 1.25$  W can be achieved when this package is mounted on an FR4-type PCB. ( $t_w = 10$  s)



\* Actual thermal resistance and permissible power dissipation values will be affected by the following factors: the PCB material, the PCB thickness, the pad area and the nature of the environment in which the devices are used. When using a device, please take both these factors and the thermal characteristics of the individual device into account.

Mounting area is the same as that of the S-MINI(SOT-346, SC-59) package.

Minimum pad dimensions  
(for reference)



Unit: mm

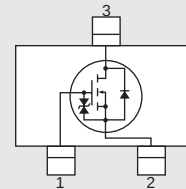
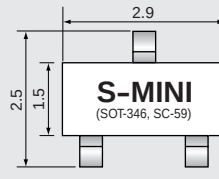
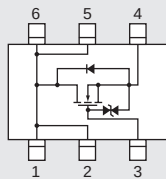
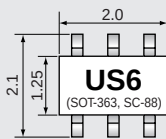
#### Line-up

| Type | Name     | $V_{DSS}(V)$ | $I_D(A)$ | $V_{th}(V)$  | $R_{DS(ON)}$ max (m $\Omega$ ) |              |
|------|----------|--------------|----------|--------------|--------------------------------|--------------|
|      |          |              |          |              | $V_{GS(1)}$                    | $V_{GS(2)}$  |
| Nch  | SSM3K01T | 30           | 3.2      | 0.6 ~ 1.1    | 150 @ 2.5 V                    | 120 @ 4 V    |
|      | SSM3K02T |              | 2.5      | 0.6 ~ 1.1    | 250 @ 2.5 V                    | 200 @ 4 V    |
|      | SSM3K12T |              | 3.0      | 1.1 ~ 1.8    | —                              | 145 @ 4.5 V  |
|      | SSM3K14T |              | 4.0      | 1.0 ~ 2.5    | —                              | 60 @ 4.5 V   |
| Pch  | SSM3J13T | -12          | -3       | -0.45 ~ -1.1 | 95 @ -2.5 V                    | 70 @ -4 V    |
|      | SSM3J01T | -30          | -1.7     | -0.6 ~ -1.1  | 600 @ -2.5 V                   | 400 @ -4 V   |
|      | SSM3J02T |              | -1.5     | -0.6 ~ -1.1  | 700 @ -2.5 V                   | 500 @ -4 V   |
|      | SSM3J14T |              | -2.6     | -0.8 ~ -2.0  | —                              | 145 @ -4.5 V |

# 3.Small-Signal MOSFETs(S-MOS)

## High-Current Family

| Drive Voltage | Polarity | Packages             |                         | Maximum Ratings     |                      |                    | R <sub>DS(ON)</sub> (mΩ) |      |                      | V <sub>th</sub> (V) |      |                      |                      | ton (ns) | toff (ns) |                      |                     |
|---------------|----------|----------------------|-------------------------|---------------------|----------------------|--------------------|--------------------------|------|----------------------|---------------------|------|----------------------|----------------------|----------|-----------|----------------------|---------------------|
|               |          | US6 (SOT-363, SC-88) | S-MINI (SOT-346, SC-59) | V <sub>DS</sub> (V) | V <sub>GSS</sub> (V) | I <sub>D</sub> (A) | Typ.                     | Max. | @V <sub>GS</sub> (V) | Min.                | Max. | @V <sub>DS</sub> (V) | @I <sub>D</sub> (mA) | Typ.     | Typ.      | @V <sub>GS</sub> (V) | @I <sub>D</sub> (A) |
|               |          |                      |                         |                     |                      |                    |                          |      |                      |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Nch      | —                    | <b>SSM3K01F</b>         | 30                  | ± 10                 | 1.3                | 115                      | 150  | 2.5                  | 0.6                 | 1.1  | 3                    | 0.1                  | 45       | 69        | 2.5                  | 0.5                 |
|               |          |                      |                         |                     |                      |                    | 85                       | 120  | 4                    |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Nch      | —                    | <b>SSM3K02F</b>         | 30                  | ± 10                 | 1                  | 180                      | 250  | 2.5                  | 0.6                 | 1.1  | 3                    | 0.1                  | 52       | 80        | 2.5                  | 0.5                 |
|               |          |                      |                         |                     |                      |                    | 140                      | 200  | 4                    |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Nch      | <b>SSM6K06FU</b>     | —                       | 20                  | ± 12                 | 1.1                | 160                      | 210  | 2.5                  | 0.6                 | 1.1  | 3                    | 0.1                  | 42       | 100       | 2.5                  | 0.5                 |
|               |          |                      |                         |                     |                      |                    | 120                      | 160  | 4                    |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Nch      | <b>SSM6K08FU</b>     | —                       | 20                  | ± 12                 | 1.6                | 100                      | 140  | 2.5                  | 0.5                 | 1.2  | 3                    | 0.1                  | 16       | 15        | 2.5                  | 0.8                 |
|               |          |                      |                         |                     |                      |                    | 77                       | 105  | 4                    |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Pch      | <b>SSM6J08FU</b>     | —                       | −20                 | ± 12                 | −1.3               | 200                      | 260  | −2.5                 | −0.5                | −1.1 | −3                   | −0.1                 | 33       | 47        | −2.5                 | −0.65               |
|               |          |                      |                         |                     |                      |                    | 140                      | 180  | −4                   |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Pch      | —                    | <b>SSM3J01F</b>         | −30                 | ± 10                 | −0.7               | 400                      | 600  | −2.5                 | −0.6                | −1.1 | −3                   | −0.1                 | 36       | 37        | −2.5                 | −0.3                |
|               |          |                      |                         |                     |                      |                    | 300                      | 400  | −4                   |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Pch      | —                    | <b>SSM3J02F</b>         | −30                 | ± 10                 | −0.6               | 550                      | 700  | −2.5                 | −0.6                | −1.1 | −3                   | −0.1                 | 55       | 52        | −2.5                 | −0.3                |
|               |          |                      |                         |                     |                      |                    | 400                      | 500  | −4                   |                     |      |                      |                      |          |           |                      |                     |
| 2.5 V         | Pch      | <b>SSM6J06FU</b>     | —                       | −20                 | ± 12                 | −0.65              | 550                      | 700  | −2.5                 | −0.6                | −1.1 | −3                   | −0.1                 | 27       | 43        | −2.5                 | −0.3                |
|               |          |                      |                         |                     |                      |                    | 400                      | 500  | −4                   |                     |      |                      |                      |          |           |                      |                     |
| 4 V           | Nch      | <b>SSM6K07FU</b>     | —                       | 30                  | ± 20                 | 1.5                | 170                      | 220  | 4                    | 1.1                 | 1.8  | 5                    | 0.1                  | 46       | 65        | 4                    | 0.75                |
|               |          |                      |                         |                     |                      |                    | 105                      | 130  | 10                   |                     |      |                      |                      |          |           |                      |                     |
| 4 V           | Pch      | <b>SSM6J07FU</b>     | —                       | −30                 | ± 20                 | −0.8               | 570                      | 800  | −4                   | −1.1                | −1.8 | −5                   | −0.1                 | 28       | 38        | −4                   | −0.4                |
|               |          |                      |                         |                     |                      |                    | 350                      | 450  | −10                  |                     |      |                      |                      |          |           |                      |                     |



Unit: mm

New products

## Junction FETs (J-FETs)

| Polarity | S-MINI (SOT-346) (SC-59) | USM (SOT-323) (SC-70) | SMV (SOT-25) (SC-74A) | USV (SOT-353) (SC-88A) | V <sub>GDS</sub> (V) | I <sub>G</sub> (mA) | P <sub>D</sub> (mW) | I <sub>DSS</sub> (mA) | V <sub>DS</sub> (V) | V <sub>GS</sub> (V) | Y <sub>fs</sub>   (mS) | V <sub>DS</sub> (V) | V <sub>GS</sub> (V) | C <sub>rss</sub> (pF) (Typ.) | V <sub>DS</sub> (V) | f (MHz) | Marking |
|----------|--------------------------|-----------------------|-----------------------|------------------------|----------------------|---------------------|---------------------|-----------------------|---------------------|---------------------|------------------------|---------------------|---------------------|------------------------------|---------------------|---------|---------|
| Nch      | <b>2SK208</b>            | <b>2SK879</b>         | —                     | —                      | −50                  | 10                  | 100                 | 0.3 ~ 6.5             | 10                  | 0                   | 1.2 (min)              | 10                  | 0                   | 2.6                          | 10                  | 1       | J□      |
| Pch      | <b>2SJ106</b>            | <b>2SJ144</b>         | —                     | —                      | 50                   | −10                 | 100                 | −1.2 ~ −14            | −10                 | 0                   | 1 (min)                | −10                 | 0                   | 3.6                          | −10                 | 1       | V□      |
| Nch      | <b>2SK209</b>            | <b>2SK880</b>         | <b>2SK2145</b>        | <b>2SK3320</b>         | −50                  | 10                  | 100                 | 1.2 ~ 14              | 10                  | 0                   | 15 (typ.)              | 10                  | 0                   | 3                            | 10                  | 1       | X□      |
| Nch      | <b>2SK368</b>            | —                     | —                     | —                      | −100                 | 10                  | 100                 | 0.6 ~ 6.5             | 10                  | 0                   | 4.6 (typ.)             | 10                  | 0                   | 3                            | 10                  | 1       | KA□     |

Alphabetic characters of marking prefix indicates loss rank.



# 4. Small Signal Diodes

## 4.1 Switching Diodes

| Electrical Characteristics<br>(Ta=25°C) |                        |                         |              |             |                |              |              |                |                  |              |              |            |                 |            |                |               |
|-----------------------------------------|------------------------|-------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| V <sub>R</sub><br>(V)                   | I <sub>o</sub><br>(mA) | t <sub>rr</sub><br>(ns) | ESC<br>(SOD-523)                                                                              | ESM<br>(SOT-490,<br>SC-81)                                                                   | SSM<br>(SOT-416,<br>SC-75)                                                                      | USC<br>(SOD-323)                                                                              | USM<br>(SOT-323,<br>SC-70)                                                                    | USQ<br>(SOT-343)                                                                                | US6<br>(SOT-363,<br>SC-88)                                                                        | S-MINI<br>(SOT-346,<br>SC-59)                                                                 | SMQ<br>(SOT-24,<br>SC-61)                                                                      | SMV<br>(SOT-25,<br>SC-74A)                                                                    | SM6<br>(SOT-26,<br>SC-74)                                                                          | MINI                                                                                          | ESV                                                                                               | ES6                                                                                              |
| 30                                      | 100                    | —                       |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               |                                                                                                 |                                                                                                   | 1SS307<br>   |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 100                    | —                       |                                                                                               |                                                                                              |                                                                                                 |                                                                                               | 1SS412*<br>  |                                                                                                 |                                                                                                   | 1SS379<br>   |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 100                    | 1.6<br>typ.             |                                                                                               | 1SS360F<br> | 1SS360<br>     |                                                                                               | 1SS300<br>   |                                                                                                 | HN1D01FU<br>     | 1SS181<br>   |                                                                                                | 1SS308<br> | HN1D01F<br>     | 1SS200<br> |                                                                                                   | HN1D01FE<br>  |
| 80                                      | 100                    | 1.6<br>typ.             |                                                                                               | 1SS361F<br> | 1SS361<br>     |                                                                                               | 1SS301<br>   |                                                                                                 | HN1D02FU<br>     | 1SS184<br>   |                                                                                                | 1SS309<br> | HN1D02F<br>     | 1SS201<br> |                                                                                                   | HN1D02 FE<br> |
| 80                                      | 100<br>(80)            | 1.6<br>typ.             |                                                                                               |                                                                                              | (1SS362)<br> |                                                                                               | 1SS302<br> |                                                                                                 |                                                                                                   | 1SS226<br> |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 100<br>(80)            | 1.6<br>typ.             | 1SS387<br> |                                                                                              |                                                                                                 | 1SS352<br> |                                                                                               |                                                                                                 | (HN2D01FU)<br> | 1SS193<br> |                                                                                                |                                                                                               | (HN2D01F)<br> |                                                                                               | HN2D01JE<br> |                                                                                                  |
| 80                                      | 100                    | 1.6<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               | 1SS382<br>   |                                                                                                   | 1SS196<br> | 1SS272<br> |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 100                    | 1.6<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               | HN1D03FU<br> |                                                                                                   |                                                                                               |                                                                                                |                                                                                               | HN1D03F<br>   |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 200                    | 7.0<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               |                                                                                                 |                                                                                                   | 1SS336<br> |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 80                                      | 200                    | 6.0<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               |                                                                                                 |                                                                                                   | 1SS337<br> |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 200                                     | 100                    | 30<br>typ.              |                                                                                               |                                                                                              |                                                                                                 | 1SS403<br> | 1SS370<br> |                                                                                                 |                                                                                                   | 1SS250<br> | 1SS306<br> |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |
| 400                                     | 100                    | 500<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               | 1SS397<br> |                                                                                                 |                                                                                                   | 1SS311<br> | 1SS399<br> |                                                                                               | HN2D03F*<br>  |                                                                                               |                                                                                                   |                                                                                                  |
| 400                                     | 100                    | 500<br>typ.             |                                                                                               |                                                                                              |                                                                                                 |                                                                                               |                                                                                               |                                                                                                 |                                                                                                   | 1SS398<br> |                                                                                                |                                                                                               |                                                                                                    |                                                                                               |                                                                                                   |                                                                                                  |

 New products  Under development

# 4. Small Signal Diodes

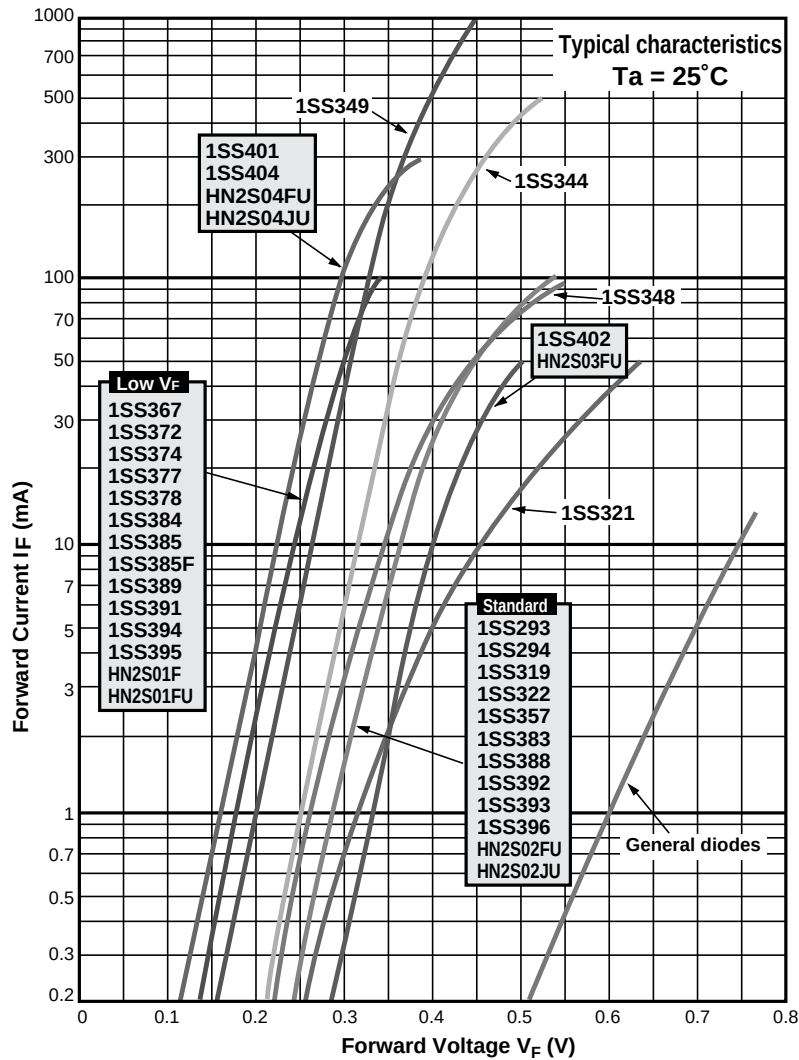
## 4.2 Schottky Barrier Diodes (SBDs)

| Features                                 | Maximum Ratings     |                    |                      |                     | Electrical Characteristics (Ta=25°C) |      |      |    |  |  |    |    |    |      |    |    |  |    |    |    |
|------------------------------------------|---------------------|--------------------|----------------------|---------------------|--------------------------------------|------|------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                          | V <sub>RM</sub> (V) | V <sub>R</sub> (V) | I <sub>FM</sub> (mA) | I <sub>O</sub> (mA) | V <sub>F</sub> (V)                   |      |      | ESC (SOD-523)                                                                       | ESM (SOT-490, SC-81)                                                              | SSM (SOT-416, SC-75)                                                              | USC (SOD-323)                                                                       | USM (SOT-323, SC-70)                                                                | USQ (SOT-343)                                                                       | US6 (SOT-363, SC-88)                                                                  | S-MINI (SOT-346, SC-59)                                                               | SMQ (SOT-24, SC-61)                                                                   | SM6 (SOT-26, SC-74)                                                                 | MINI                                                                                  | ESV                                                                                   | USV (SOT-353, SC-88A)                                                                 |
|                                          | Typ.                | Max                | @I <sub>F</sub> (mA) |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| Low-V <sub>F</sub>                       | 15                  | 10                 | 200                  | 100                 | 0.23                                 | 0.3  | 5    | 1SS389                                                                              |                                                                                   |                                                                                   | 1SS367                                                                              | 1SS395                                                                              | 1SS384                                                                              | HN2S01FU                                                                              | 1SS394                                                                                | 1SS391                                                                                | HN2S01F                                                                             |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     | 0.35                                 | 0.5  | 100  |    |                                                                                   |                                                                                   |    |    |    |     |    |    |  |                                                                                       |                                                                                       |                                                                                       |
|                                          | 15                  | 10                 | 200                  | 100                 | 0.23                                 | 0.3  | 5    |                                                                                     | 1SS385F                                                                           | 1SS385                                                                            |                                                                                     | 1SS378                                                                              |                                                                                     |                                                                                       | 1SS377                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     | 0.35                                 | 0.5  | 100  |                                                                                     |  |  |                                                                                     |    |                                                                                     |                                                                                       |    |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          | 15                  | 10                 | 200                  | 100                 | 0.23                                 | 0.3  | 5    |                                                                                     |                                                                                   |                                                                                   |                                                                                     | 1SS372                                                                              |                                                                                     |                                                                                       | 1SS374                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     | 0.35                                 | 0.5  | 100  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |    |                                                                                     |                                                                                       |    |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| Low-I <sub>R</sub> , High-speed          | 25                  | 20                 | 100                  | 50                  | 0.33                                 | —    | 1    | 1SS405                                                                              |                                                                                   |                                                                                   | 1SS406                                                                              |                                                                                     | 1SS402                                                                              | HN2S03FU                                                                              |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     | 0.38                                 | —    | 5    |    |                                                                                   |                                                                                   |    |                                                                                     |    |     |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     | 0.50                                 | 0.55 | 50   |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| Low-I <sub>R</sub>                       | 12                  | 10                 | 150                  | 50                  | 0.63                                 | 1.0  | 100  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       | 1SS321                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |  |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| Standard                                 | 45                  | 40                 | 300                  | 100                 | 0.54                                 | 0.6  | 100  | 1SS388                                                                              |                                                                                   |                                                                                   | 1SS357                                                                              | 1SS322                                                                              | 1SS383                                                                              | HN2S02FU                                                                              | 1SS294                                                                                | 1SS319                                                                                |                                                                                     | 1SS293                                                                                | HN2S02JE                                                                              |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |  |                                                                                   |                                                                                   |  |  |  |   |  |  |                                                                                     |  |  |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     | 1SS393                                                                              |                                                                                     |                                                                                       | 1SS392                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          | 45                  | 40                 | 300                  | 100                 | 0.54                                 | 0.6  | 100  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       | 1SS396                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          | 45                  | 40                 | 300                  | 100                 | 0.54                                 | 0.6  | 100  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |  |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| High-V <sub>R</sub>                      | 85                  | 80                 | 300                  | 100                 | 0.56                                 | 0.7  | 100  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       | 1SS348                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |  |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| High-I <sub>O</sub> , Low-V <sub>F</sub> | 25                  | 20                 | 700                  | 300                 | 0.16                                 | —    | 1    |                                                                                     |                                                                                   |                                                                                   | 1SS404                                                                              | 1SS401                                                                              |                                                                                     | HN2S04FU                                                                              |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       | HN2S04JU                                                                              |
|                                          |                     |                    |                      |                     | 0.22                                 | —    | 10   |                                                                                     |                                                                                   |                                                                                   |  |  |                                                                                     |   |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |  |
|                                          |                     |                    |                      |                     | 0.38                                 | 0.45 | 300  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
| High-I <sub>O</sub>                      | 25                  | 20                 | 1500                 | 500                 | 0.50                                 | 0.55 | 500  |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       | 1SS344                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |  |                                                                                       |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          | 25                  | 20                 | 3000                 | 1000                | 0.46                                 | 0.55 | 1000 |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       | 1SS349                                                                                |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |
|                                          |                     |                    |                      |                     |                                      |      |      |                                                                                     |                                                                                   |                                                                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                       |  |                                                                                       |                                                                                     |                                                                                       |                                                                                       |                                                                                       |

■ New products ★ Under development

## Schottky Barrier Diodes

### ● I<sub>F</sub>-V<sub>F</sub> Characteristics (typ.)

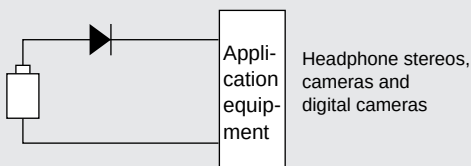


### Functions and Applications

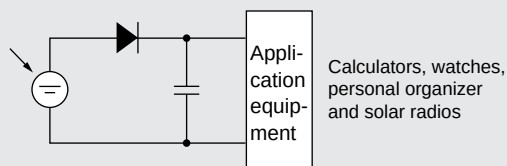
| Functional Use                        | Applications                                                    |
|---------------------------------------|-----------------------------------------------------------------|
| Battery reverse-connection prevention | Headphone stereos, cameras and digital cameras                  |
| Memory back-up circuits               | Notebook computers, word processors, cellular phones and pagers |
| Speed-up circuits                     | Measuring instruments                                           |
| Low-voltage operation circuits        | Calculators and watches                                         |
| Others                                | DC-DC converters                                                |

### Application Examples of Schottky Barrier Diodes

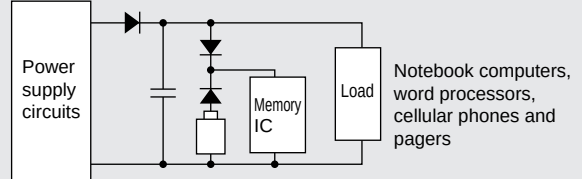
#### ● Battery reverse-connection prevention



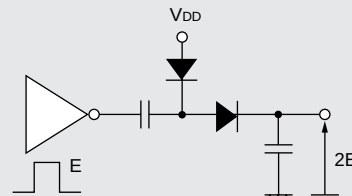
#### ● Solar cell battery



#### ● Memory back-up circuits

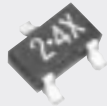
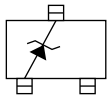
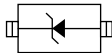
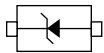


#### ● DC-DC converters



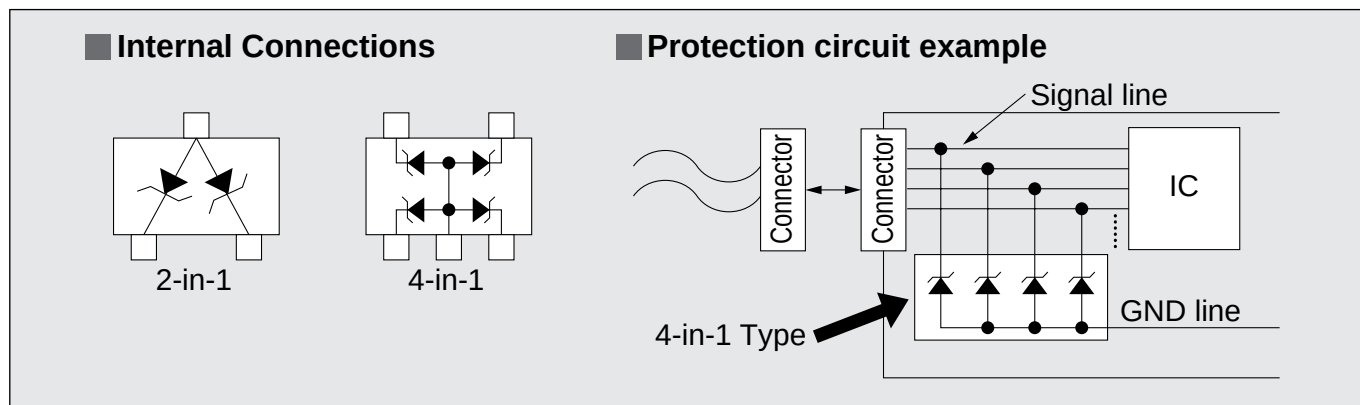
# 4. Small Signal Diodes

## 4.3 Zener Diodes

| Package<br><br>Zener Voltage<br>V <sub>Z</sub> (V) |    |    |    |
|----------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                                    | S-MINI<br>(SOT-346, SC-59)                                                          | USC<br>(SOD-323)                                                                    | ESC<br>(SOD-523)                                                                      |
| 2.0                                                | 02CZ2.0                                                                             | 02DZ2.0                                                                             | 015AZ2.0                                                                              |
| 2.2                                                | 02CZ2.2                                                                             | 02DZ2.2                                                                             | 015AZ2.2                                                                              |
| 2.4                                                | 02CZ2.4                                                                             | 02DZ2.4                                                                             | 015AZ2.4                                                                              |
| 2.7                                                | 02CZ2.7                                                                             | 02DZ2.7                                                                             | 015AZ2.7                                                                              |
| 3.0                                                | 02CZ3.0                                                                             | 02DZ3.0                                                                             | 015AZ3.0                                                                              |
| 3.3                                                | 02CZ3.3                                                                             | 02DZ3.3                                                                             | 015AZ3.3                                                                              |
| 3.6                                                | 02CZ3.6                                                                             | 02DZ3.6                                                                             | 015AZ3.6                                                                              |
| 3.9                                                | 02CZ3.9                                                                             | 02DZ3.9                                                                             | 015AZ3.9                                                                              |
| 4.3                                                | 02CZ4.3                                                                             | 02DZ4.3                                                                             | 015AZ4.3                                                                              |
| 4.7                                                | 02CZ4.7                                                                             | 02DZ4.7                                                                             | 015AZ4.7                                                                              |
| 5.1                                                | 02CZ5.1                                                                             | 02DZ5.1                                                                             | 015AZ5.1                                                                              |
| 5.6                                                | 02CZ5.6                                                                             | 02DZ5.6                                                                             | 015AZ5.6                                                                              |
| 6.2                                                | 02CZ6.2                                                                             | 02DZ6.2                                                                             | 015AZ6.2                                                                              |
| 6.8                                                | 02CZ6.8                                                                             | 02DZ6.8                                                                             | 015AZ6.8                                                                              |
| 7.5                                                | 02CZ7.5                                                                             | 02DZ7.5                                                                             | 015AZ7.5                                                                              |
| 8.2                                                | 02CZ8.2                                                                             | 02DZ8.2                                                                             | 015AZ8.2                                                                              |
| 9.1                                                | 02CZ9.1                                                                             | 02DZ9.1                                                                             | 015AZ9.1                                                                              |
| 10                                                 | 02CZ10                                                                              | 02DZ10                                                                              | 015AZ10                                                                               |
| 11                                                 | 02CZ11                                                                              | 02DZ11                                                                              | 015AZ11                                                                               |
| 12                                                 | 02CZ12                                                                              | 02DZ12                                                                              | 015AZ12                                                                               |
| 13                                                 | 02CZ13                                                                              | 02DZ13                                                                              |                                                                                       |
| 15                                                 | 02CZ15                                                                              | 02DZ15                                                                              |                                                                                       |
| 16                                                 | 02CZ16                                                                              | 02DZ16                                                                              |                                                                                       |
| 18                                                 | 02CZ18                                                                              | 02DZ18                                                                              |                                                                                       |
| 20                                                 | 02CZ20                                                                              | 02DZ20                                                                              |                                                                                       |
| 22                                                 | 02CZ22                                                                              | 02DZ22                                                                              |                                                                                       |
| 24                                                 | 02CZ24                                                                              | 02DZ24                                                                              |                                                                                       |
| 27                                                 | 02CZ27                                                                              |                                                                                     |                                                                                       |
| 30                                                 | 02CZ30                                                                              |                                                                                     |                                                                                       |
| 33                                                 | 02CZ33                                                                              |                                                                                     |                                                                                       |
| 36                                                 | 02CZ36                                                                              |                                                                                     |                                                                                       |
| 39                                                 | 02CZ39                                                                              |                                                                                     |                                                                                       |
| 43                                                 | 02CZ43                                                                              |                                                                                     |                                                                                       |
| 47                                                 | 02CZ47                                                                              |                                                                                     |                                                                                       |
| Pin assignent                                      |  |  |  |
| P (mW)                                             | 200                                                                                 | 200                                                                                 | 150                                                                                   |

## 4.4 Diodes for Protection against ESD

Small-signal zener diodes are suitable for protecting electronic circuits against ESD from external pins. (Since multiple devices are incorporated into a single package, the product is ideal for interface protection.)



### Single Type

| Product No. | V <sub>Z</sub> (V) |      |      | @I <sub>Z</sub> (mA) | I <sub>R</sub> (μA) | @V <sub>R</sub> (V) | C <sub>T</sub> (μF) | @V <sub>R</sub> (V) | Package USC |
|-------------|--------------------|------|------|----------------------|---------------------|---------------------|---------------------|---------------------|-------------|
|             | Min                | Typ. | Max  |                      |                     |                     |                     |                     |             |
| DF2S12FU    | 11.4               | 12.0 | 12.6 | 5                    | 0.05                | 9                   | 15                  | 0                   |             |

New product

### Standard Type

| 2-in-1    |           | 4-in-1     |           |          |            | V <sub>Z</sub> (V) |                      | I <sub>R</sub> (μA) |                     |
|-----------|-----------|------------|-----------|----------|------------|--------------------|----------------------|---------------------|---------------------|
| ESM       | USM       | ESV        | USV       | SMV      | US8        |                    |                      |                     |                     |
|           |           |            |           |          |            | Typ.               | @I <sub>Z</sub> (mA) | Max                 | @V <sub>Z</sub> (V) |
| DF3A3.3FE | DF3A3.3FU | DF5A3.3JE* | DF5A3.3FU | DF5A3.3F |            | 3.3                | 5                    | 20                  | 1.0                 |
| DF3A5.6FE | DF3A5.6FU | DF5A5.6JE* | DF5A5.6FU | DF5A5.6F | DF8A5.6FK* | 3.6                | 5                    | 10                  | 1.0                 |
| DF3A6.2FE | DF3A6.2FU | DF5A6.2JE* | DF5A6.2FU | DF5A6.2F | DF8A6.2FK* | 6.2                | 5                    | 1                   | 3.0                 |
| DF3A6.8FE | DF3A6.8FU | DF5A6.8JE  | DF5A6.8FU | DF5A6.8F | DF8A6.8FK  | 6.8                | 5                    | 0.5                 | 5.0                 |
| DF3A8.2FE | DF3A8.2FU | DF5A8.2JE  | DF5A8.2FU | DF5A8.2F |            | 8.2                | 5                    | 0.5                 | 6.5                 |

New products    \* Under development

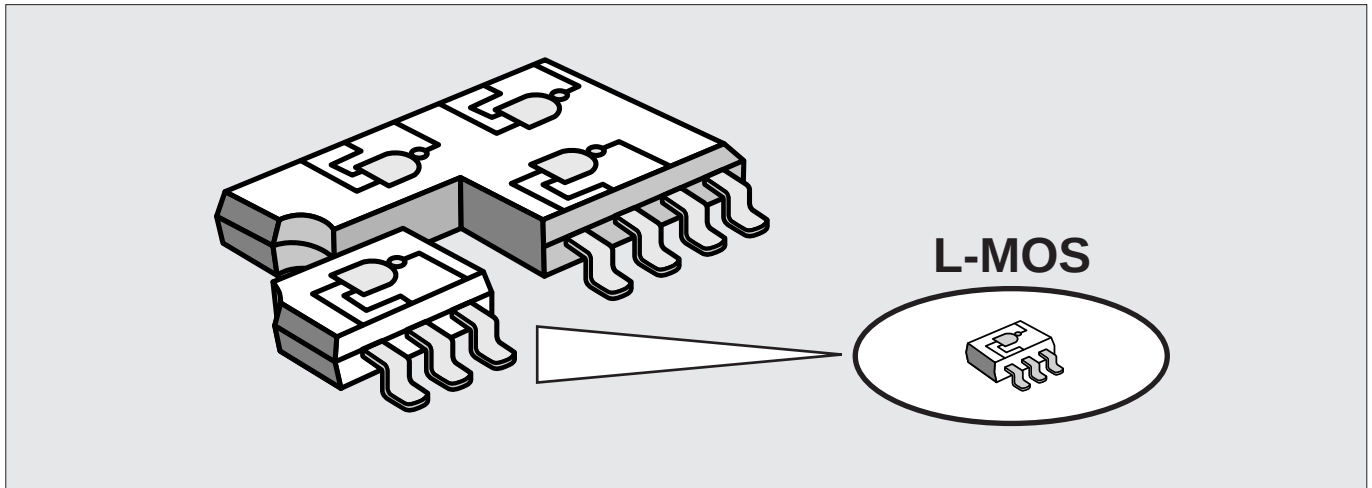
### High-Speed Signal Type

| 2-in-1      |             | 4-in-1      |             |            | V <sub>Z</sub> (V) |                      | C <sub>T</sub> (pF) |                     |  |
|-------------|-------------|-------------|-------------|------------|--------------------|----------------------|---------------------|---------------------|--|
| ESM         | USM         | ESV         | USV         | SMV        |                    |                      |                     |                     |  |
|             |             |             |             |            | Typ.               | @I <sub>Z</sub> (mA) | Typ.                | @V <sub>Z</sub> (V) |  |
| DF3A6.2LFE* | DF3A6.2LFU* | DF5A6.2LJE* | DF5A6.2LFU* | DF5A6.2LF* | 6.2                | 5                    | 6.5                 | 0                   |  |
| DF3A6.8LFE  | DF3A6.8LFU  | DF5A6.8LJE  | DF5A6.8LFU  | DF5A6.8LF  | 6.8                | 5                    | 6                   | 0                   |  |
| DF3A8.2LFE  | DF3A8.2LFU  | DF5A8.2LJE  | DF5A8.2LFU  | DF5A8.2LF  | 8.2                | 5                    | 6                   | 0                   |  |

New products    \* Under development

# 5. L-MOS

## 5.1 Outline of L-MOS



### Features

#### 1. Very Small

The smallest package USV's area is only 5% of CMOS SOP package.  
It is very good for high density mount set.  
And it is suitable for circuit minor change.

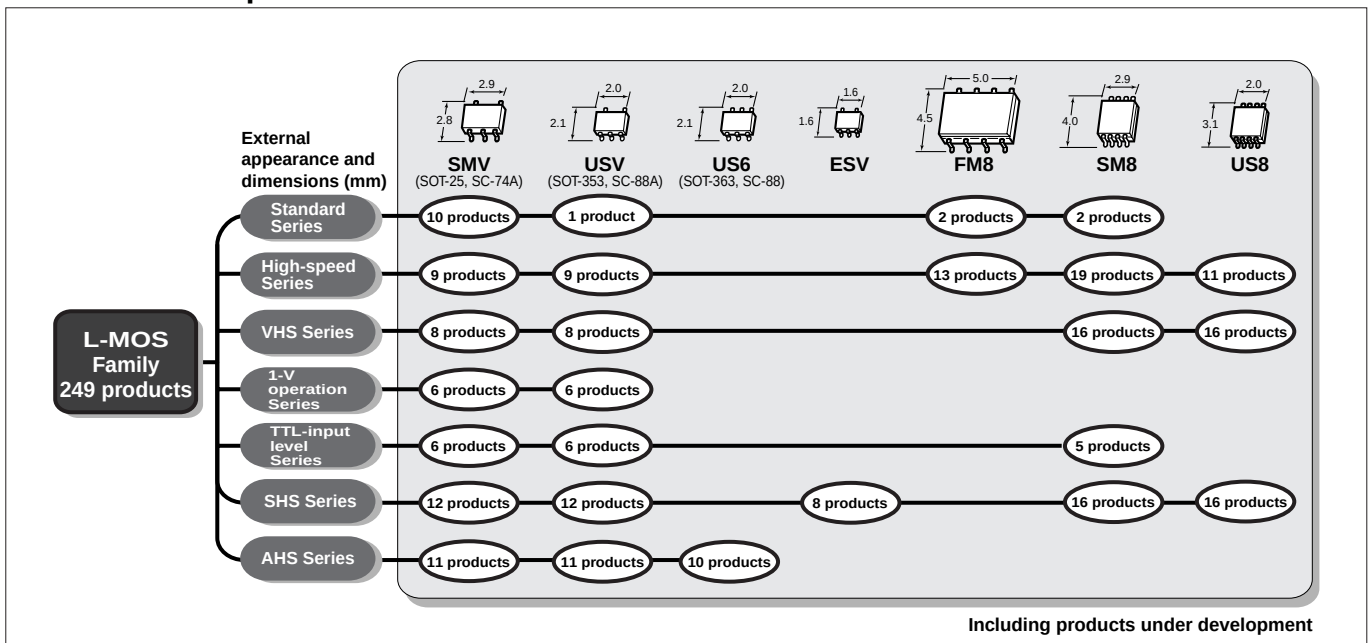
#### 2. Easy Layout Arrangement

L-MOS contain only 1 or 2 circuit in package, so it is very convenience for separate arrangement.  
This increase the ease of layout and pattern design.

#### 3. Thin Thickness

The thinnest package ESV is only 0.6mm height.  
It is convenience for portable set like PDA.

### Products Line-up



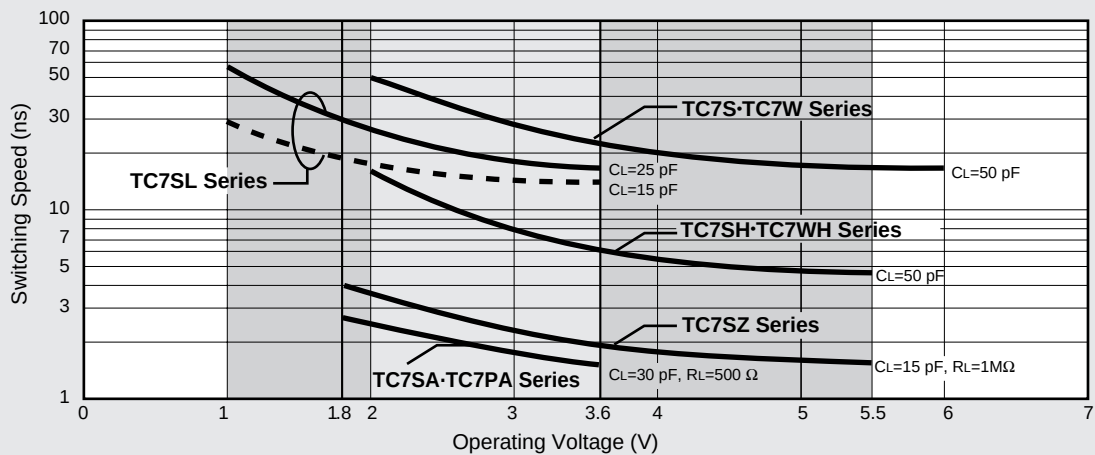
## ● L-MOS Performance Summary

| Parameter                                                                    |                 | Standard Series                                                          | High-Speed Series * <sub>1</sub>                                        |                                                                         | Very-High-Speed Series                                                    | 1-V Operation Series * <sub>1</sub>                                       | TTL-Level Input Series                                                                                                                                             |                                                                                           | Super-High-Speed Series * <sub>2</sub>                                                              | AHS Series                                                                                                |
|------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|                                                                              |                 | TC4S <sub>xx</sub> F<br>TC4W <sub>xx</sub> F/FU                          | TC7S <sub>xx</sub> F/FU                                                 | TC7W <sub>xx</sub> F/FU/FK<br>TC3W <sub>xx</sub> F/FU                   | TC7SH <sub>xx</sub> F/FU<br>TC7WH <sub>xx</sub> FU/FK                     | TC7SL <sub>xx</sub> F/FU                                                  | TC7SET <sub>xx</sub> F/FU                                                                                                                                          | TC7WT <sub>xx</sub> FU                                                                    | *TC7SZ <sub>xx</sub> F/FU<br>*TC7SZ <sub>xx</sub> AFE<br>*TC7WZ <sub>xx</sub> FU/FK                 | *TC7SA <sub>xx</sub> F/FU<br>*TC7PA <sub>xx</sub> F/FU                                                    |
| Propagation delay time (NAND gate)                                           |                 | 65 ns typ.<br>@V <sub>CC</sub> = 5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 7 ns typ.<br>@V <sub>CC</sub> = 5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 6 ns typ.<br>@V <sub>CC</sub> = 5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 3.7 ns typ.<br>@V <sub>CC</sub> = 5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 7.5 ns typ.<br>@V <sub>CC</sub> = 3 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 4.2 ns typ.<br>@V <sub>CC</sub> = 5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C                                                                                          | 10 ns typ.<br>(3state Bu)<br>@V <sub>CC</sub> = 5.5 V<br>C <sub>L</sub> = 15pF<br>Ta=25°C | 2.4 ns typ.<br>@V <sub>CC</sub> = 3.3 V<br>C <sub>L</sub> = 15pF<br>R <sub>L</sub> = 1MΩ<br>Ta=25°C | 2.8 ns max<br>@V <sub>CC</sub> = 3.3 V<br>C <sub>L</sub> = 30pF<br>R <sub>L</sub> = 500Ω<br>Ta=-40 ~ 85°C |
| Operating voltage range                                                      |                 | 3 ~ 18 V                                                                 | 2 ~ 6 V                                                                 | 2 ~ 6 V                                                                 | 2 ~ 5.5 V                                                                 | 1 ~ 3.6 V                                                                 | 4.5 ~ 5.5 V                                                                                                                                                        | 4.5 ~ 5.5 V                                                                               | 1.8 ~ 5.5 V                                                                                         | 1.8 ~ 3.6 V                                                                                               |
| Operating temperature range                                                  |                 | -40 ~ 85°C                                                               | -40 ~ 85°C                                                              | -40 ~ 85°C                                                              | -40 ~ 85°C                                                                | -40 ~ 85°C                                                                | -40 ~ 85°C                                                                                                                                                         | -40 ~ 85°C                                                                                | -40 ~ 85°C                                                                                          | -40 ~ 85°C                                                                                                |
| Output current                                                               | I <sub>OH</sub> | 0.42mA min<br>(@V <sub>CC</sub> = 5V)                                    | 2mA min<br>(@V <sub>CC</sub> = 4.5V)                                    | 4mA min<br>(@V <sub>CC</sub> = 4.5V)                                    | 8mA min<br>(@V <sub>CC</sub> = 4.5V)                                      | 1mA min<br>(@V <sub>CC</sub> = 1.5V)                                      | 8mA min<br>(@V <sub>CC</sub> = 4.5V)                                                                                                                               | 4mA min<br>(@V <sub>CC</sub> = 4.5V)                                                      | 24mA min<br>(@V <sub>CC</sub> = 3V)                                                                 | 24mA min<br>(@V <sub>CC</sub> = 3V)                                                                       |
|                                                                              | I <sub>OL</sub> | 0.42mA min<br>(@V <sub>CC</sub> = 5V)                                    | 2mA min<br>(@V <sub>CC</sub> = 4.5V)                                    | 4mA min<br>(@V <sub>CC</sub> = 4.5V)                                    | 8mA min<br>(@V <sub>CC</sub> = 4.5V)                                      | 1mA min<br>(@V <sub>CC</sub> = 1.5V)                                      | 8mA min<br>(@V <sub>CC</sub> = 4.5V)                                                                                                                               | 4mA min<br>(@V <sub>CC</sub> = 4.5V)                                                      | 24mA min<br>(@V <sub>CC</sub> = 3V)                                                                 | 24mA min<br>(@V <sub>CC</sub> = 3V)                                                                       |
| Electrical characteristics (except for permissible power dissipation rating) |                 | Same as those of the TC4 <sub>xxx</sub> B series                         | Output current is 1/2 that of the TC74HC <sub>xx</sub> A series         | Same as those of the TC74HC <sub>xx</sub> A series                      | Same as those of the TC74VHC <sub>xxx</sub> series                        | -                                                                         | Input voltage specification is TTL level.<br>V <sub>IL</sub> = 0.8 V (max)<br>V <sub>IH</sub> = 2.0 V (min)<br>The output voltage level is subject to full swings. |                                                                                           | Same as those of the TC74LC <sub>xx</sub> series when operating V <sub>CC</sub> = 3.3V              | Same as those of the TC74VC <sub>xx</sub> series                                                          |

\*: Some products are in under development stage.

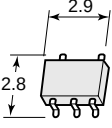
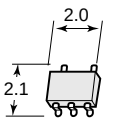
\*1: TC3WxxF/FU and TC7SLxxF/FU are original L-MOS devices and it is not a C<sup>2</sup>MOS logic IC.

\*2: TC7SZxxF/FU Series have 5-V tolerant function for input and output same as those of the TC74LCxx Series. TC7SZxxAFE Series only have 5-V tolerant function for input.



# 5. L-MOS

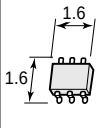
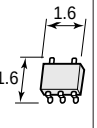
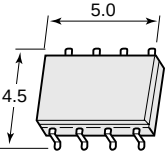
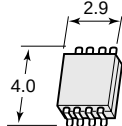
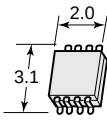
## 5.2 Products Lines

| Package Name                    | SMV<br>(SOT-25, SC-74A)                                                           |                   |                      |            |                        |            |            | USV<br>(SOT-353, SC-88A)                                                            |                      |            |                        |            |
|---------------------------------|-----------------------------------------------------------------------------------|-------------------|----------------------|------------|------------------------|------------|------------|-------------------------------------------------------------------------------------|----------------------|------------|------------------------|------------|
| Appearance Image (mm)           |  |                   |                      |            |                        |            |            |  |                      |            |                        |            |
| Function                        | Standard Series                                                                   | High-Speed Series | 1-V Operation Series | VHS Series |                        | SHS Series | AHS Series | High-Speed Series                                                                   | 1-V Operation Series | VHS Series |                        | SHS Series |
|                                 |                                                                                   |                   |                      |            | TTL level input Series |            |            |                                                                                     |                      |            | TTL level input Series |            |
| NAND                            | TC4S11F                                                                           | TC7S00F           | TC7SL00F             | TC7SH00F   | TC7SET00F              | TC7SZ00F   | TC7SA00F   | TC7S00FU                                                                            | TC7SL00FU            | TC7SH00FU  | TC7SET00FU             | TC7SZ00FU  |
| NAND (unbuffer)                 | TC4SU11F                                                                          |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| NAND (Open Drain)               |                                                                                   |                   |                      |            |                        | *TC7SZ38F  |            |                                                                                     |                      |            |                        | *TC7SZ38FU |
| AND                             | TC4S81F                                                                           | TC7S08F           | TC7SL08F             | TC7SH08F   | TC7SET08F              | TC7SZ08F   | TC7SA08F   | TC7S08FU                                                                            | TC7SL08FU            | TC7SH08FU  | TC7SET08FU             | TC7SZ08FU  |
| NOR                             | TC4S01F                                                                           | TC7S02F           | TC7SL02F             | TC7SH02F   | TC7SET02F              | TC7SZ02F   | *TC7SA02F  | TC7S02FU                                                                            | TC7SL02FU            | TC7SH02FU  | TC7SET02FU             | TC7SZ02FU  |
| OR                              | TC4S71F                                                                           | TC7S32F           | TC7SL32F             | TC7SH32F   | TC7SET32F              | TC7SZ32F   | *TC7SA32F  | TC7S32FU                                                                            | TC7SL32FU            | TC7SH32FU  | TC7SET32FU             | TC7SZ32FU  |
| Exclusive-OR                    | TC4S30F                                                                           | TC7S86F           |                      | TC7SH86F   | TC7SET86F              | TC7SZ86F   |            | TC7S86FU                                                                            |                      | TC7SH86FU  | TC7SET86FU             | TC7SZ86FU  |
| Inverter                        | TC4S69F                                                                           | TC7S04F           | TC7SL04F             | TC7SH04F   | TC7SET04F              | TC7SZ04F   | TC7SA04F   | TC7S04FU                                                                            | TC7SL04FU            | TC7SH04FU  | TC7SET04FU             | TC7SZ04FU  |
| Inverter (unbuffer)             | TC4SU69F                                                                          | TC7SU04F          | TC7SLU04F            | TC7SHU04F  |                        | TC7SZU04F  | TC7SAU04F  | TC7SU04FU                                                                           | TC7SLU04FU           | TC7SHU04FU |                        | TC7SZU04FU |
| Inverter (open drain)           |                                                                                   |                   |                      |            |                        | TC7SZ05F   | TC7SA05F   |                                                                                     |                      |            |                        | TC7SZ05FU  |
| Schmitt inverter                | TC4S584F                                                                          | TC7S14F           |                      | TC7SH14F   |                        | TC7SZ14F   | *TC7SA14F  | TC7S14FU                                                                            |                      | TC7SH14FU  |                        | TC7SZ14FU  |
| Schmitt buffer                  |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Buffer                          |                                                                                   |                   |                      |            |                        |            | TC7SA34F   |                                                                                     |                      |            |                        |            |
| Analog switch                   | TC4S66F<br>TC4S66FU(USV)                                                          | TC7S66F           |                      |            |                        |            |            | TC7S66FU                                                                            |                      |            |                        |            |
| Analog multiplexer              |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| D-type flip-flop                |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| D-type flip-flop with clear     |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| 3-state buffer                  |                                                                                   |                   |                      |            |                        | TC7SZ125F  | *TC7SA125F |                                                                                     |                      |            |                        | TC7SZ125FU |
| 3-state buffer                  |                                                                                   |                   |                      |            |                        | TC7SZ126F  | *TC7SA126F |                                                                                     |                      |            |                        | TC7SZ126FU |
| 3-state inverting buffer        |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| 3-state buffer                  |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Bus transceiver                 |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Bus transceiver with open drain |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Monostable multivibrator        |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Digital multiplexer             |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| D-type latch with 3-state       |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| D-type flip flop with 3-state   |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| 2-to-4 decoder                  |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| 2-to-3 decoder with Enable      |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| 2-to-3 decoder with Enable      |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |
| Oscillator & divider            |                                                                                   |                   |                      |            |                        |            |            |                                                                                     |                      |            |                        |            |

The suffix "F" denotes SMV or FM8 package. The suffix "FU" denotes a USV or SM8 package. The suffix "FK" denotes a US8 package. The suffix "FE" denotes a ESV package.

■ New product \* : Under development



|               | US6<br>(SOT-363,<br>SC-88)                                                        | ESV                                                                               | FM8                                                                               |                      | SM8                                                                               |                   |            |               | US8                                                                                 |                      |               | Package                     |                                    |
|---------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------------|-------------------|------------|---------------|-------------------------------------------------------------------------------------|----------------------|---------------|-----------------------------|------------------------------------|
|               |  |  |  |                      |  |                   |            |               |  |                      |               | Appearance<br>Image<br>(mm) |                                    |
| AHS<br>Series | AHS<br>Series                                                                     | SHS<br>Series                                                                     | Standard<br>Series                                                                | High-Speed<br>Series | Standard<br>Series                                                                | High-Speed Series |            | VHS<br>Series | SHS<br>Series                                                                       | High-Speed<br>Series | VHS<br>Series | SHS<br>Series               | Function                           |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             |                                    |
| TC7SA00FU     |                                                                                   | TC7SZ00AFE                                                                        |                                                                                   | TC7W00F              |                                                                                   | TC7W00FU          |            | TC7WH00FU     | TC7WZ00FU                                                                           | TC7W00FK             | TC7WH00FK     | TC7WZ00FK                   | NAND                               |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             | NAND<br>(unbuffer)                 |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               | TC7WZ38FU                                                                           |                      |               | TC7WZ38FK                   | NAND<br>(Open Drain)               |
| TC7SA08FU     |                                                                                   | TC7SZ08AFE                                                                        |                                                                                   | TC7W08F              |                                                                                   | TC7W08FU          |            | TC7WH08FU     | TC7WZ08FU                                                                           | TC7W08FK             | TC7WH08FK     | TC7WZ08FK                   | AND                                |
| *TC7SA02FU    |                                                                                   | TC7SZ02AFE                                                                        |                                                                                   | TC7W02F              |                                                                                   | TC7W02FU          |            | TC7WH02FU     | TC7WZ02FU                                                                           | TC7W02FK             | TC7WH02FK     | TC7WZ02FK                   | NOR                                |
| *TC7SA32FU    |                                                                                   | TC7SZ32AFE                                                                        |                                                                                   | TC7W32F              |                                                                                   | TC7W32FU          |            | TC7WH32FU     | TC7WZ32FU                                                                           | TC7W32FK             | TC7WH32FK     | TC7WZ32FK                   | OR                                 |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               | *TC7WZ86FU                                                                          |                      |               | *TC7WZ86FK                  | Exclusive-OR                       |
| TC7SA04FU     | TC7PA04FU                                                                         | TC7SZ04AFE                                                                        |                                                                                   | TC7W04F              |                                                                                   | TC7W04FU          |            | TC7WH04FU     | TC7WZ04FU                                                                           | TC7W04FK             | TC7WH04FK     | TC7WZ04FK                   | Inverter                           |
| TC7SAU04FU    | TC7PAU04FU                                                                        | TC7SZU04AFE                                                                       |                                                                                   | TC7WU04F             |                                                                                   | TC7WU04FU         |            | TC7WHU04FU    | TC7WZU04FU                                                                          | TC7WU04FK            | TC7WHU04FK    | TC7WZU04FK                  | Inverter<br>(unbuffer)             |
| TC7SA05FU     | TC7PA05FU                                                                         |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               | TC7WZ05FU                                                                           |                      |               | TC7WZ05FK                   | Inverter<br>(open drain)           |
| *TC7SA14FU    | *TC7PA14FU                                                                        |                                                                                   |                                                                                   | TC7W14F              |                                                                                   | TC7W14FU          |            | TC7WH14FU     | *TC7WZ14FU                                                                          | TC7W14FK             | TC7WH14FK     | *TC7WZ14FK                  | Schmitt inverter                   |
|               | *TC7PA17FU                                                                        |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             | Schmitt buffer                     |
| TC7SA34FU     | TC7PA34FU                                                                         |                                                                                   |                                                                                   |                      |                                                                                   | TC7W34FU          |            | TC7WH34FU     | TC7WZ34FU                                                                           | TC7W34FK             | TC7WH34FK     | TC7WZ34FK                   | Buffer                             |
|               |                                                                                   |                                                                                   | TC4W66F                                                                           | TC7W66F              | TC4W66FU                                                                          | TC7W66FU          |            |               |                                                                                     | TC7W66FK             |               |                             | Analog switch                      |
|               | TC7PA53FU                                                                         |                                                                                   | TC4W53F                                                                           | TC7W53F              | TC4W53FU                                                                          | TC7W53FU          |            |               |                                                                                     | TC7W53FK             |               |                             | Analog<br>multiplexer              |
|               |                                                                                   |                                                                                   |                                                                                   | TC7W74F              |                                                                                   | TC7W74FU          | TC7WT74FU  | TC7WH74FU     | TC7WZ74FU                                                                           |                      | TC7WH74FK     | TC7WZ74FK                   | D-type flip-flop                   |
|               | *TC7PA175FU                                                                       |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             | D-type flip-flop<br>with clear     |
| *TC7SA125FU   |                                                                                   | TC7SZ125AFE                                                                       |                                                                                   |                      |                                                                                   | TC7W125FU         | TC7WT125FU | TC7WH125FU    | *TC7WZ125FU                                                                         |                      | TC7WH125FK    | *TC7WZ125FK                 | 3-state buffer                     |
| *TC7SA126FU   |                                                                                   | TC7SZ126AFE                                                                       |                                                                                   |                      |                                                                                   | TC7W126FU         | TC7WT126FU | TC7WH126FU    | *TC7WZ126FU                                                                         |                      | TC7WH126FK    | *TC7WZ126FK                 | 3-state buffer                     |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   | TC7W240FU         | TC7WT240FU | TC7WH240FU    |                                                                                     |                      | TC7WH240FK    |                             | 3-state inverting<br>buffer        |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   | TC7W241FU         | TC7WT241FU | TC7WH241FU    |                                                                                     |                      | TC7WH241FK    |                             | 3-state buffer                     |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            | TC7WH245FU    | *TC7WZ245FU                                                                         |                      | TC7WH245FK    | *TC7WZ245FK                 | Bus transceiver                    |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               | *TC7WZ246FU                                                                         |                      |               | *TC7WZ246FK                 | Bus transceiver<br>with open drain |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            | TC7WH123FU    |                                                                                     |                      | TC7WH123FK    |                             | Monostable<br>multivibrator        |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   |                   |            | TC7WH157FU    |                                                                                     |                      | TC7WH157FK    |                             | Digital<br>multiplexer             |
|               | *TC7PA373FU                                                                       |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             | D-type latch<br>with 3-state       |
|               | *TC7PA374FU                                                                       |                                                                                   |                                                                                   |                      |                                                                                   |                   |            |               |                                                                                     |                      |               |                             | D-type flip flop<br>with 3-state   |
|               |                                                                                   |                                                                                   |                                                                                   | TC7W139F             |                                                                                   | TC7W139FU         |            |               |                                                                                     |                      |               |                             | 2-to-4 decoder                     |
|               |                                                                                   |                                                                                   |                                                                                   | TC3W01F              |                                                                                   | TC3W01FU          |            |               |                                                                                     |                      |               |                             | 2-to-3 decoder<br>with Enable      |
|               |                                                                                   |                                                                                   |                                                                                   | TC3W02F              |                                                                                   | TC3W02FU          |            |               |                                                                                     |                      |               |                             | 2-to-3 decoder<br>with Enable      |
|               |                                                                                   |                                                                                   |                                                                                   |                      |                                                                                   | TC3W03FU          |            |               |                                                                                     |                      |               |                             | Oscillator &<br>divider            |

# 5. L-MOS

## 5.3 New Products (Low-voltage logic series)

### SHS Series Housed in 8-pin Package: TC7WZxxFU/FK

#### ● Outline

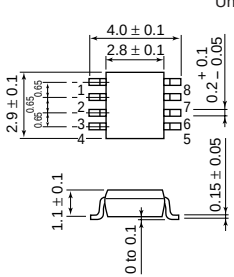
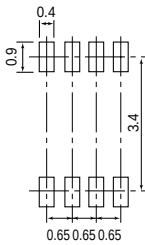
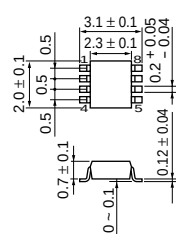
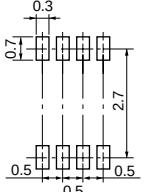
Two or three circuits of super-high-speed propagation delay time and high drive capability SHS single types are housed in 8-pin packages.

Small and thin packages; US8 and SM8 are used.

#### ● Features

- High-output drive:  $\pm 24$  mA (min) @  $V_{CC} = 3$  V
- Propagation delay time: 2.4 ns (typ.) @  $V_{CC} = 5$  V,  $C_L = 50$  pF,  $R_L = 500 \Omega$
- Operating voltage range
- 5-V input/output tolerant function and power-down protection
- Electrical characteristics when  $V_{CC} = 3.3$  V are the same those of TC74LCXxx Series.

#### ● Package dimensions

| Package SM8                                                                                    |                                                                                                | Package US8                                                                                     |                                                                                                  |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Dimensions                                                                                     | Recommended land pattern                                                                       | Dimensions                                                                                      | Recommended land pattern                                                                         |
| Unit: mm<br> | Unit: mm<br> | Unit: mm<br> | Unit: mm<br> |
| Weight: 0.021g                                                                                 |                                                                                                | Weight: 0.01g                                                                                   |                                                                                                  |

#### ● Product line-up

| Product No.     | Function                                   | Package |
|-----------------|--------------------------------------------|---------|
| TC7WZ00FU/FK    | Dual 2-input NAND gate                     | SM8/US8 |
| TC7WZ02FU/FK    | Dual 2-input NOR gate                      |         |
| TC7WZ04FU/FK    | Triple inverter                            |         |
| TC7WZU04FU/FK   | Triple inverter (unbuffer)                 |         |
| TC7WZ05FU/FK    | Triple inverter (open drain output)        |         |
| TC7WZ08FU/FK    | Dual 2-input AND gate                      |         |
| ★ TC7WZ14FU/FK  | Triple schmitt trigger inverter            |         |
| TC7WZ32FU/FK    | Dual 2-input OR gate                       |         |
| TC7WZ34FU/FK    | Triple non-inverter                        |         |
| TC7WZ38FU/FK    | Dual 2-input NAND gate (open drain output) |         |
| TC7WZ74FU/FK    | D-type flip-flop                           |         |
| ★ TC7WZ86FU/FK  | Dual 2-input exclusive OR gate             |         |
| ★ TC7WZ125FU/FK | Dual 3-state buffer                        |         |
| ★ TC7WZ126FU/FK | Dual 3-state buffer                        |         |
| ★ TC7WZ245FU/FK | Dual BUS Transceiver                       |         |
| ★ TC7WZ246FU/FK | Dual BUS Transceiver with open drain       |         |

★ : Under development

## AHS Series Housed in New 6-pin Package: TC7PAxxFU

### ● Outline

One or two circuit of AHS (Advanced High Speed) types are housed in 6-pin package.

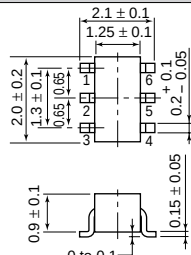
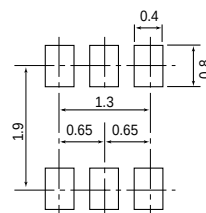
There are new function products for L-MOS family.

: 175(D-F/F), 53(Analog MPX), 373(D-F/F with 3 state output)

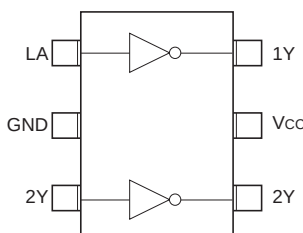
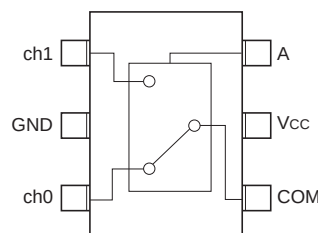
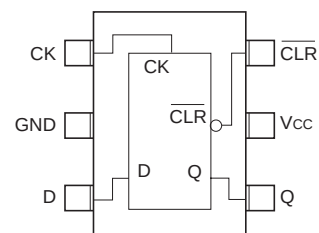
### ● Features

- High-level output drive:  $\pm 24 \text{ mA}$  @  $V_{CC} = 3 \text{ V}$
- Propagation delay time:  $2.8 \text{ ns (max)}$  @  $V_{CC} = 3.3 \text{ V}$ ,  $C_L = 30 \text{ pF}$ ,  $R_L = 500 \Omega$
- Operating voltage range:  $1.8\text{V} \sim 3.6\text{V}$
- 3.6-V output tolerant function and protection function which prevents the input power voltage from dropping for all inputs and outputs.
- 2.5 V and 3.3 V systems
- These electrical characteristics are the same those of the TC74VCXxx.

### ● Package dimensions

| Dimensions                                                                                                                                              | Recommended land pattern                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
|  <p>Unit: mm</p> <p>US6<br/>(SOT-363, SC-88)</p> <p>Weight: 0.03g</p> |  <p>Unit: mm</p> |

### ● Pin Assignment

| Inverter                                                                            | Analog MPX                                                                          | D-FLIP FLOP (Under development)                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |  |

### ● Product line-up

| Product No.  | Function                                   |
|--------------|--------------------------------------------|
| TC7PA04FU    | Dual inverter                              |
| TC7PA05FU    | Dual inverter (open drain output)          |
| ★ TC7PA14FU  | Dual schmitt trigger inverter              |
| ★ TC7PA17FU  | Dual schmitt buffer                        |
| TC7PA34FU    | Dual buffer                                |
| TC7PA53FU    | 2-channel Analog Multiplexer/Demultiplexer |
| ★ TC7PA175FU | D-type flip-flop with clear                |
| ★ TC7PA373FU | D-type latch with 3-state output           |
| ★ TC7PA374FU | D-type flip-flop with 3-state output       |

★ : Under development

# 5. L-MOS

## AHS/SHS Interface

### ● Interface performance

AHS series, SHS series and VHS series incorporate a tolerant function and a power-down protection.

■ Tolerant function: enable to interface two different power supply voltages (for a back-up circuit)

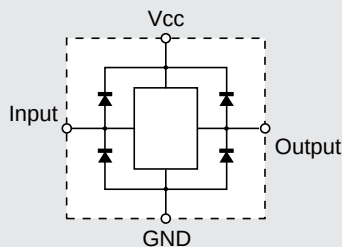
■ Power-down protection: enables to supply power to I/O when power is down (for IC protection)

### I/O permissible voltage

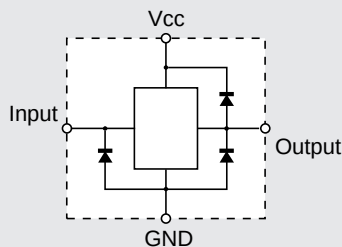
| Series               |                     | AHS       | SHS       | VHS      |
|----------------------|---------------------|-----------|-----------|----------|
| Input voltage range  | During operation    | 0 ~ 3.6 V | 0 ~ 5.5 V | 0 ~ 5.5V |
|                      | When power-down     | 0 ~ 3.6 V | 0 ~ 5.5 V | 0 ~ 5.5V |
| Output voltage range | When output enable  | 0 ~ Vcc   | 0 ~ Vcc   | 0 ~ Vcc  |
|                      | When output disable | 0 ~ 3.6 V | 0 ~ 5.5 V | 0 ~ Vcc  |
|                      | When power-down     | 0 ~ 3.6 V | 0 ~ 5.5 V | —        |

### ● I/O equivalent circuit diagrams

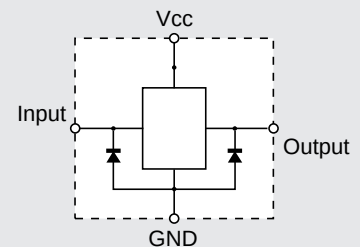
#### High-speed Series



#### VHS Series SHS(TC7SZxxAFE) Series



#### AHS Series SHS Series

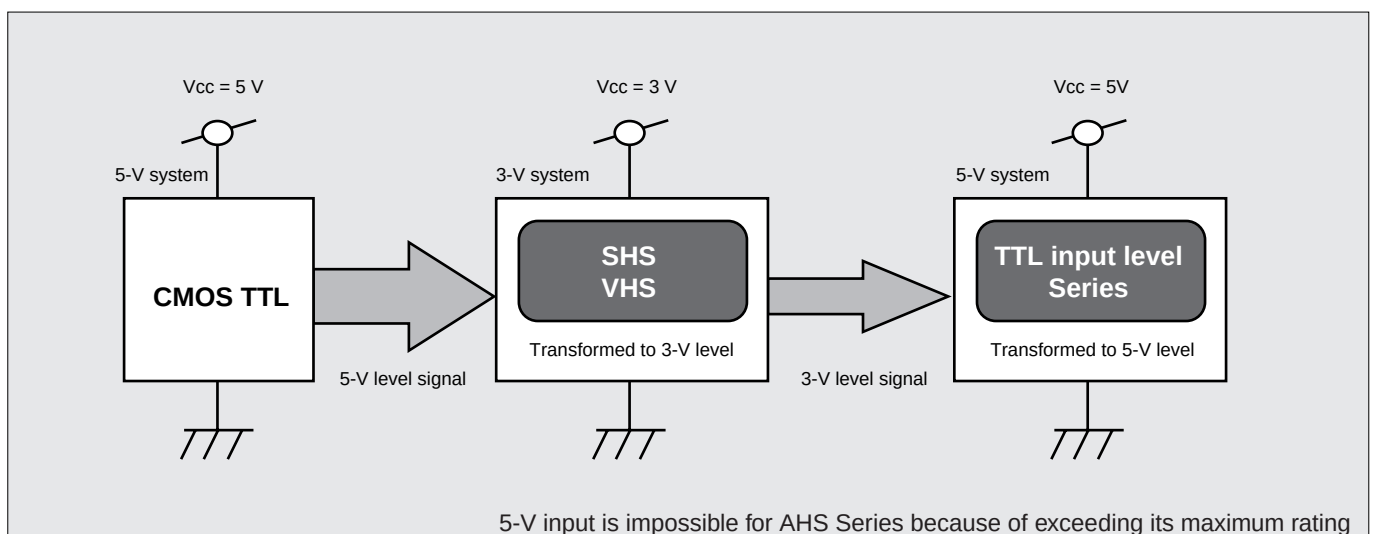


### ● Direct interfacing between 3-V and 5-V systems

The emergence of 3-V CPUs and memories has led to a transition across to 3-V mains power supply systems.

The inclusion of dual 3-V/5-V power capability in commonly-used items of office equipment continues to spread.

New L-MOS products can be used in ultra-compact dual power supply interface systems (3-V/5-V).



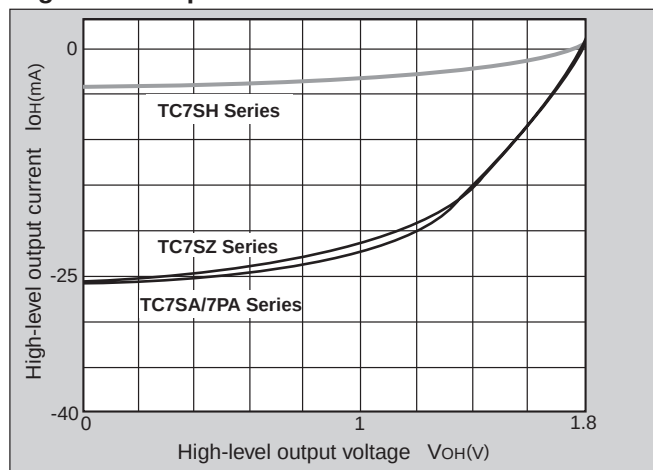
## Typical characteristics for Low Voltage logic Series

### Typical AHS Series characteristics (compared to VHS Series and SHS Series)

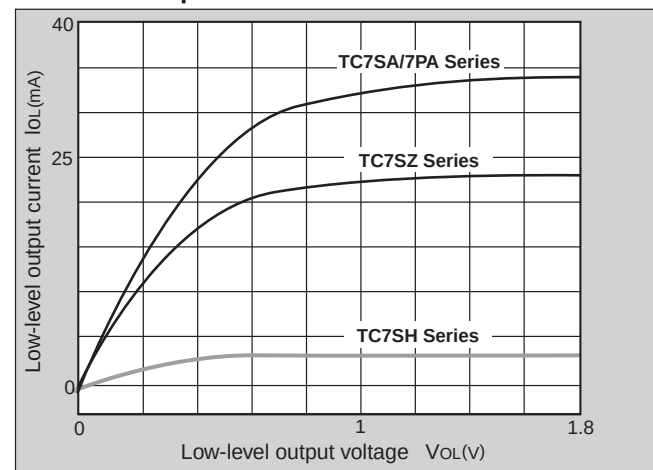
#### Drive current (typ.)

●  $V_{CC} = 1.8\text{ V}$ ,  $T_a = 25\text{ }^{\circ}\text{C}$

#### High-level output current

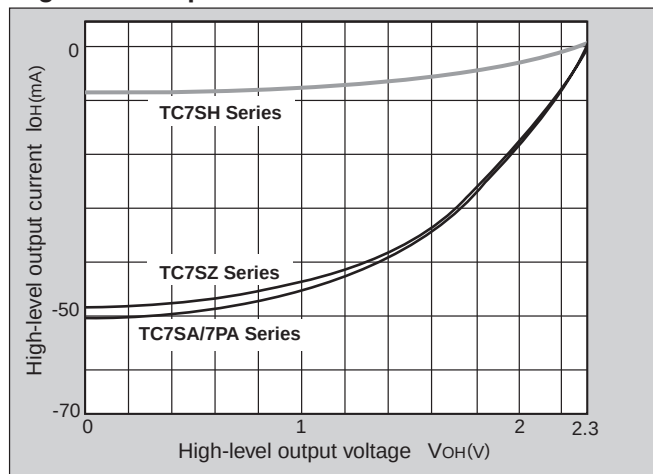


#### Low-level output current

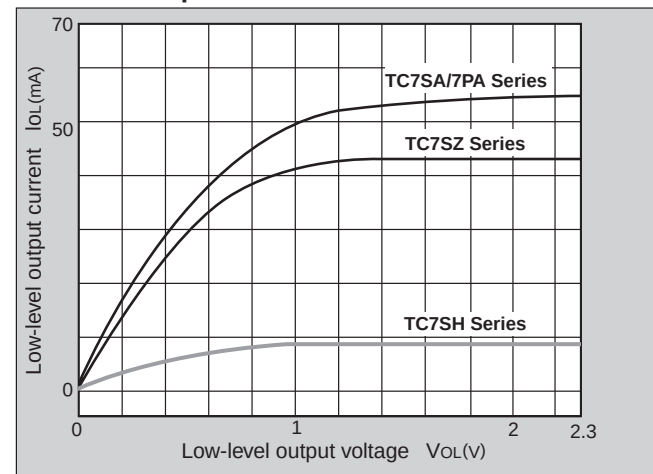


●  $V_{CC} = 2.3\text{ V}$ ,  $T_a = 25\text{ }^{\circ}\text{C}$

#### High-level output current

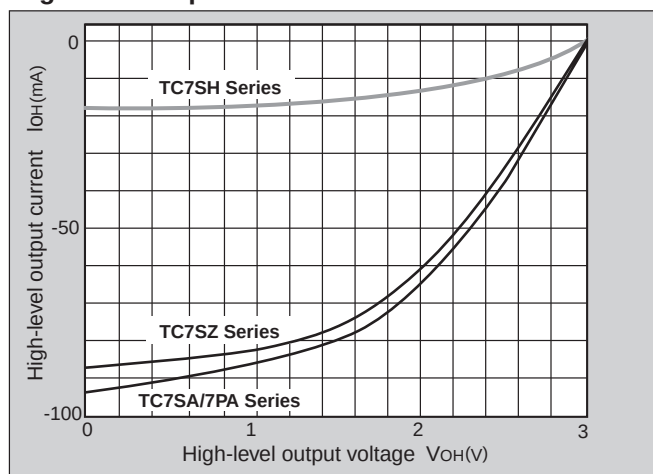


#### Low-level output current

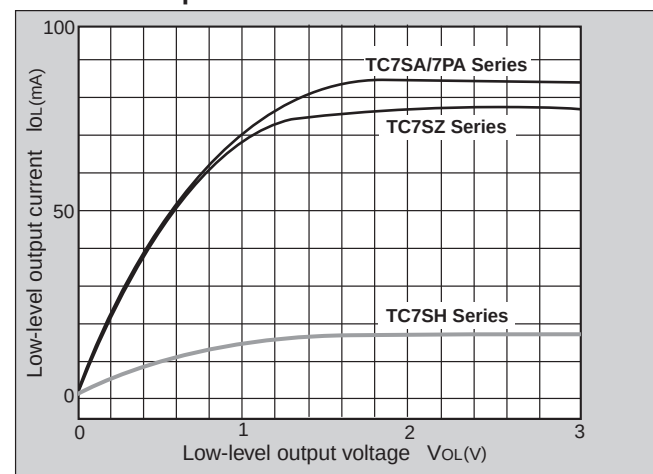


●  $V_{CC} = 3.0\text{ V}$ ,  $T_a = 25\text{ }^{\circ}\text{C}$

#### High-level output current



#### Low-level output current

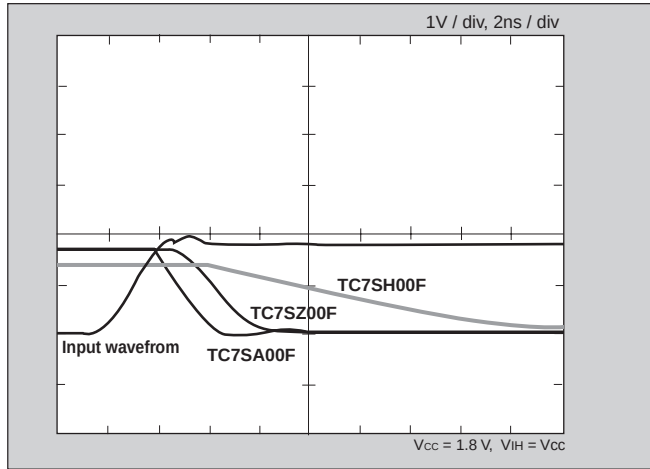


# 5. L-MOS

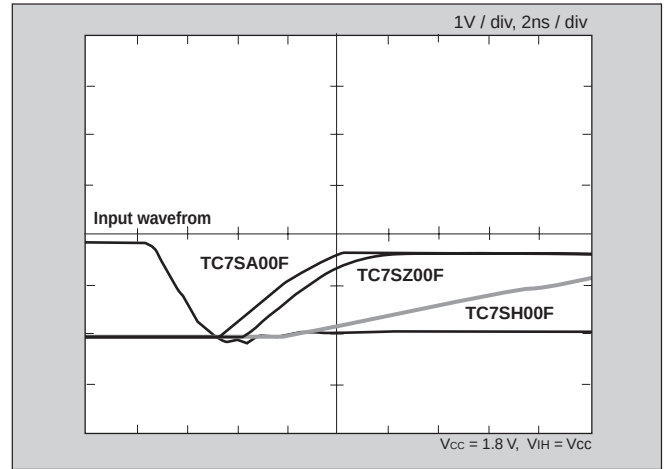
## Switching waveform (typ.)

●  $V_{CC} = 1.8\text{ V}$ ,  $C_L = 30\text{ pF}$ ,  $R_L = 500\ \Omega$

tpHL

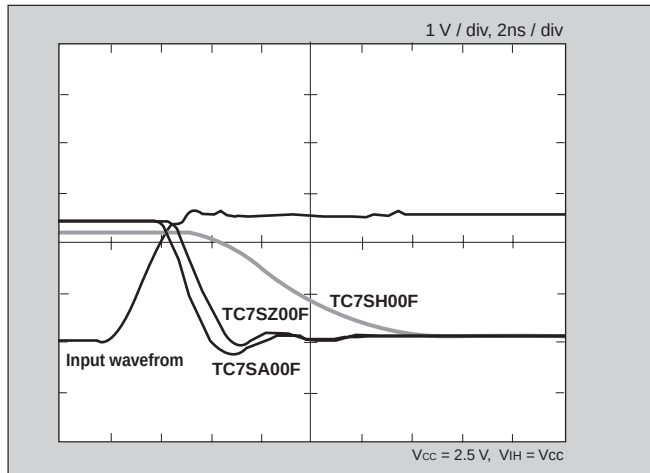


tpLH

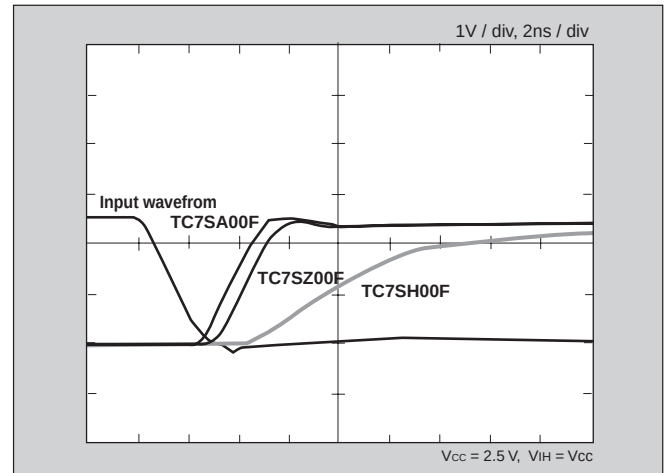


●  $V_{CC} = 2.5\text{ V}$ ,  $C_L = 30\text{ pF}$ ,  $R_L = 500\ \Omega$

tpHL

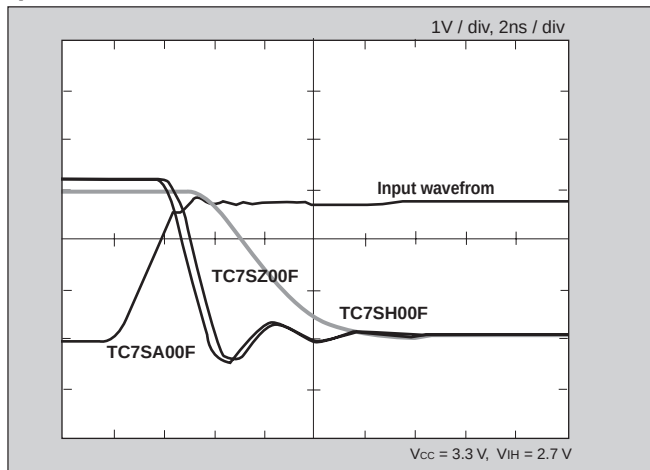


tpLH

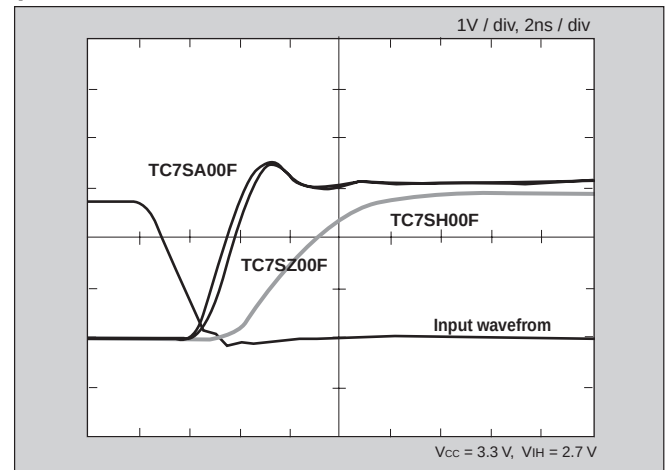


●  $V_{CC} = 3.3\text{ V}$ ,  $C_L = 30\text{ pF}$ ,  $R_L = 500\ \Omega$

tpHL

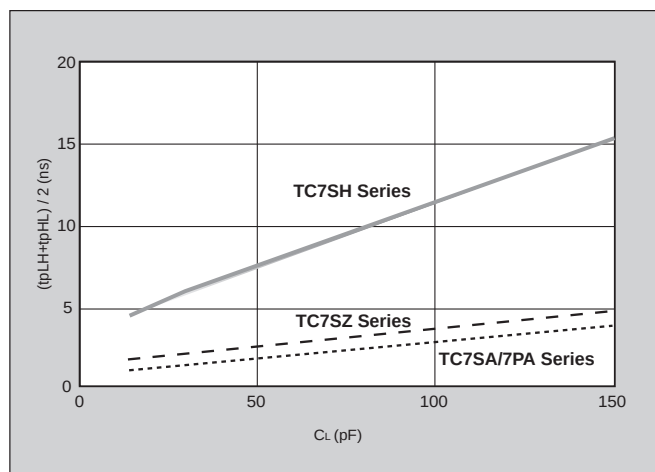


tpLH

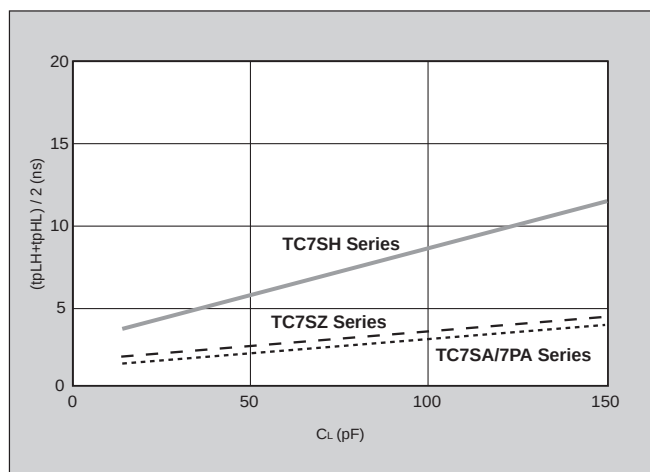


## Load capacitance dependence (typ.)

●  $V_{CC} = 2.5\text{ V}$ ,  $R_L = 500\ \Omega$ ,  $T_a = 25\ ^\circ\text{C}$

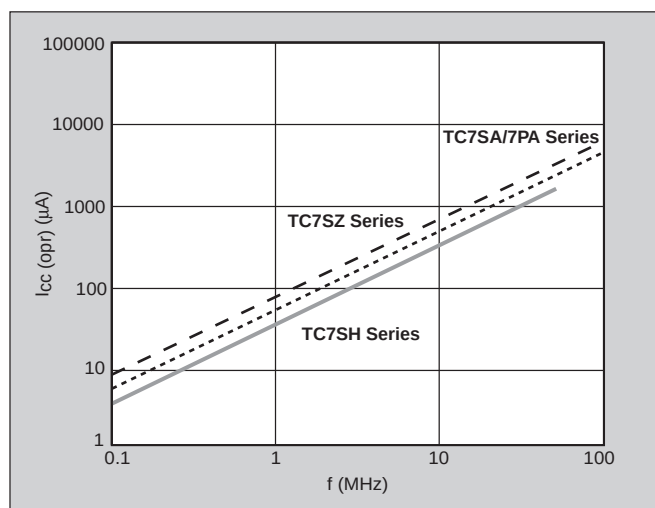


●  $V_{CC} = 3.3\text{ V}$ ,  $R_L = 500\ \Omega$ ,  $T_a = 25\ ^\circ\text{C}$



## Operating current consumption (typ.)

●  $V_{CC} = 3.3\text{ V}$ ,  $T_a = 25\ ^\circ\text{C}$



# 5. L-MOS

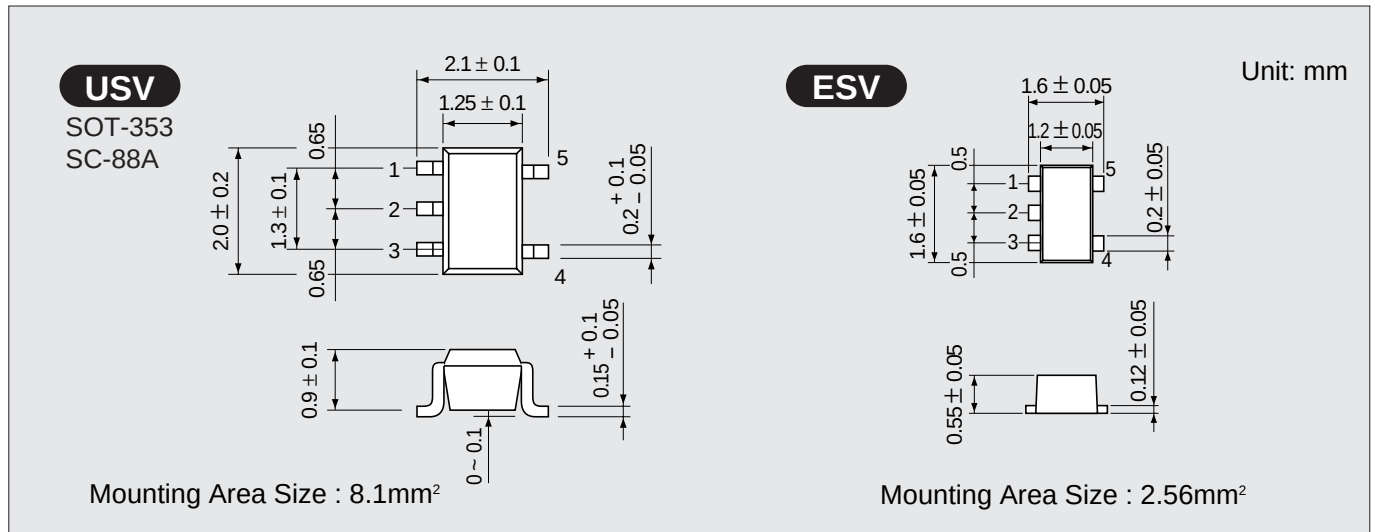
## 5.4 Very Small package Solution

### ESV Package for TC7SZxxAFE 5-pin ultra-small and thin package

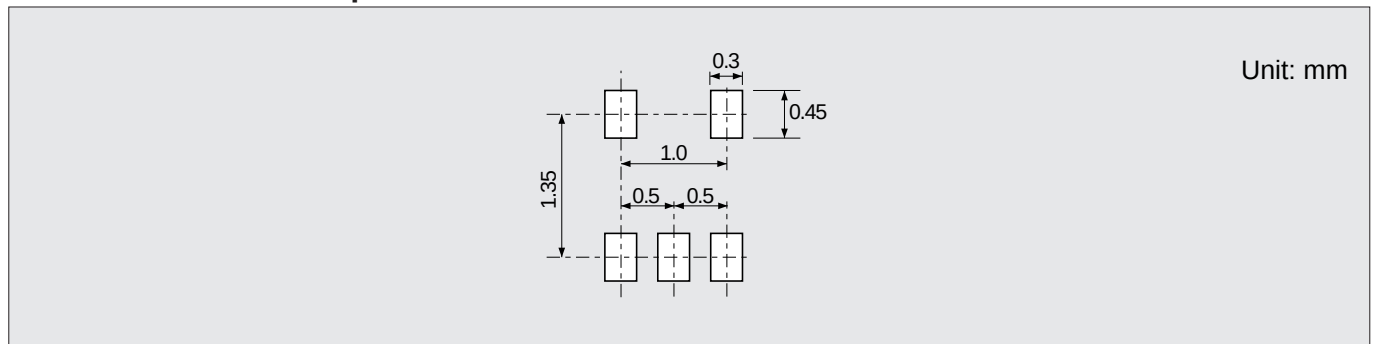
#### ● Features

- Lead pitch: 0.5 mm
- Product height: 0.55 mm (typ.), 0.6 mm (max)
- ESVs are flat-lead packages which suitable for use in high-speed and high-density mounting.

#### ● Package comparison between USV(SOT-353, SC-88A) and ESV



#### ● Recommended land pattern for ESV



#### ● Line-up

##### ■ TC7SZxxAFE Series

| Series | Product No. | Function                 |
|--------|-------------|--------------------------|
| SHS    | TC7SZ00AFE  | 2-input NAND gate        |
|        | TC7SZ02AFE  | 2-input NOR gate         |
|        | TC7SZ04AFE  | Inverter gate            |
|        | TC7SZU04AFE | Inverter gate (unbuffer) |
|        | TC7SZ08AFE  | 2-input AND gate         |
|        | TC7SZ32AFE  | 2-input OR gate          |
|        | TC7SZ125AFE | 3-state buffer           |
|        | TC7SZ126AFE | 3-state buffer           |

\*The output protection function for TC7SZxxAFE Series is different from that of TC74LCxx and TC7SZxxF/FU Series; hence, voltage greater than or equal to V<sub>CC</sub> should not be applied to TC7SZxxAFE Series.



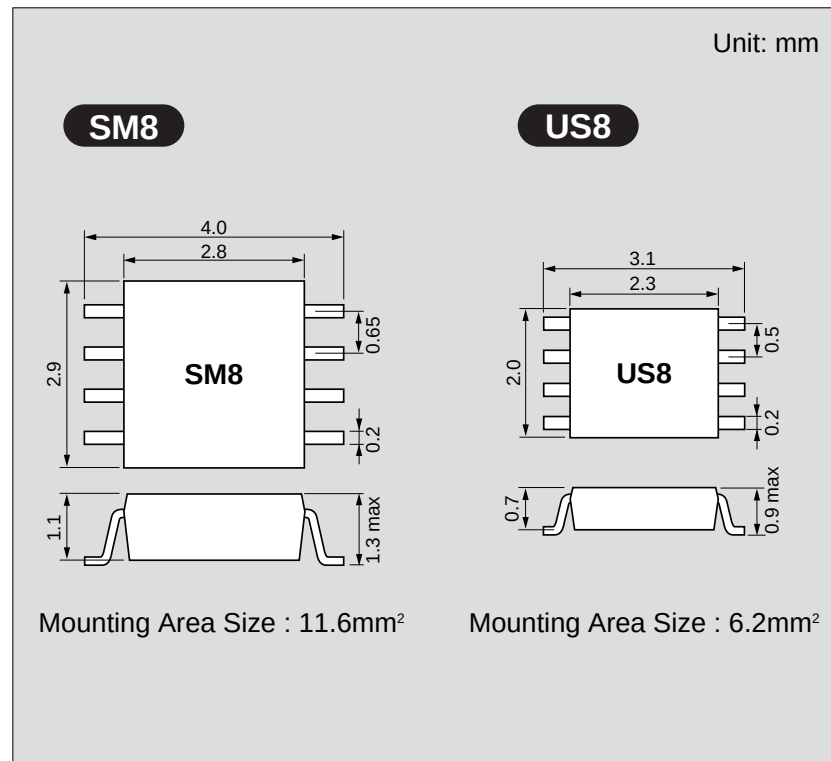
## US8 Packages for TC7WxxFK and TC7WHxxFK

### 8-pin ultra-small package

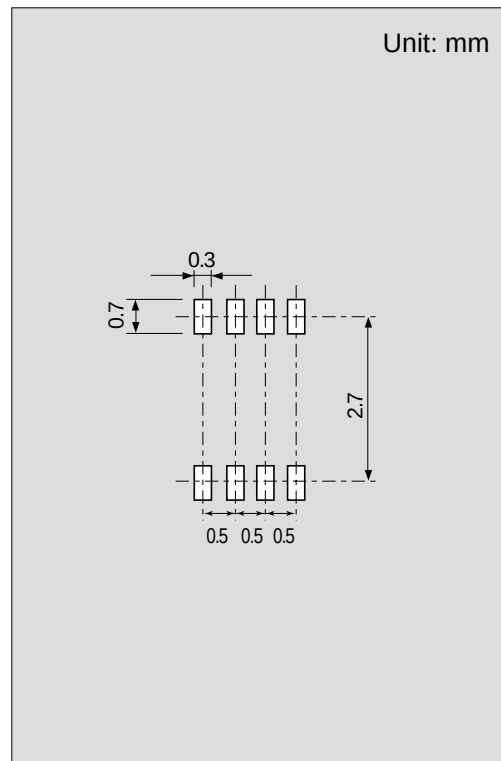
#### ● Features

- Lead pitch: 0.5 mm
- Flat area is 47% that of SM8 package.

#### ● Package comparison between SM8 and US8



#### ● Recommended land pattern for US8



#### ● Line-up

| Product No. |            | Function                        |
|-------------|------------|---------------------------------|
| High speed  | VHS        |                                 |
| TC7W00FK    | TC7WH00FK  | Dual 2-input NAND               |
| TC7W02FK    | TC7WH02FK  | Dual 2-input NOR                |
| TC7W04FK    | TC7WH04FK  | Triple inverter                 |
| TC7WU04FK   | TC7WHU04FK | Triple inverter (unbuffer)      |
| TC7W08FK    | TC7WH08FK  | Dual 2-input AND                |
| TC7W14FK    | TC7WH14FK  | Triple schmitt trigger inverter |
| TC7W32FK    | TC7WH32FK  | Dual 2-input OR                 |
| TC7W34FK    | TC7WH34FK  | Triple buffer                   |
| TC7W53FK    | —          | Analog Multiplexer              |
| TC7W66FK    | —          | Analog switch                   |
| TC7W74FK    | TC7WH74FK  | D-type flip-flop                |
| —           | TC7WH123FK | Mono-multivibrator              |
| —           | TC7WH125FK | Dual 3-state buffer             |
| —           | TC7WH126FK | Dual 3-state buffer             |
| —           | TC7WH157FK | Digital multiplexer             |
| —           | TC7WH240FK | Dual 3-state buffer             |
| —           | TC7WH241FK | Dual 3-state buffer             |
| —           | TC7WH245FK | Bus transceiver                 |

# 5. L-MOS

## 5.5 Current Product Series

### High-Speed Analog Switch Family

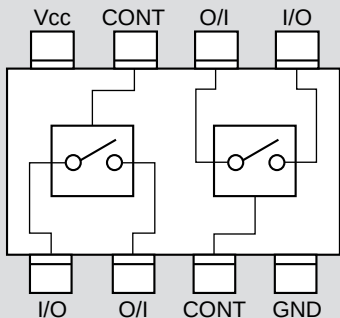
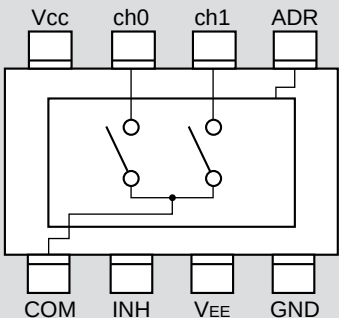
#### ● Dual analog switch TC7W66FU/FK

#### ● Analog multiplexer TC7W53FU/FK

The dual analog switch has a low ON-resistance when operated with a 3-V power supply.

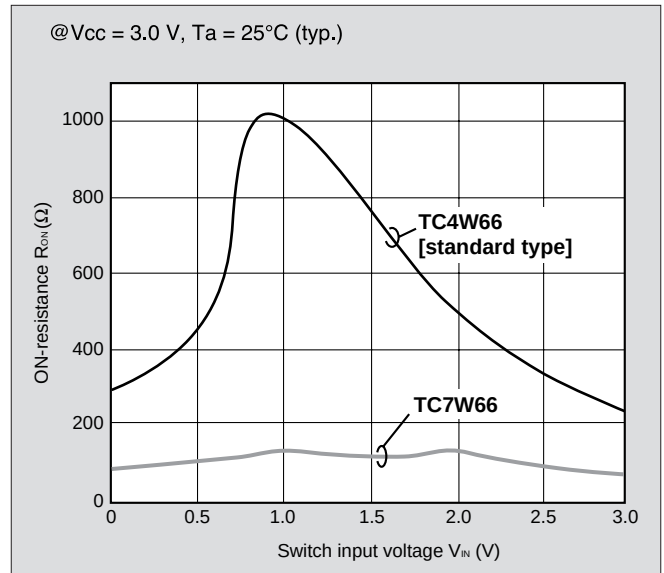
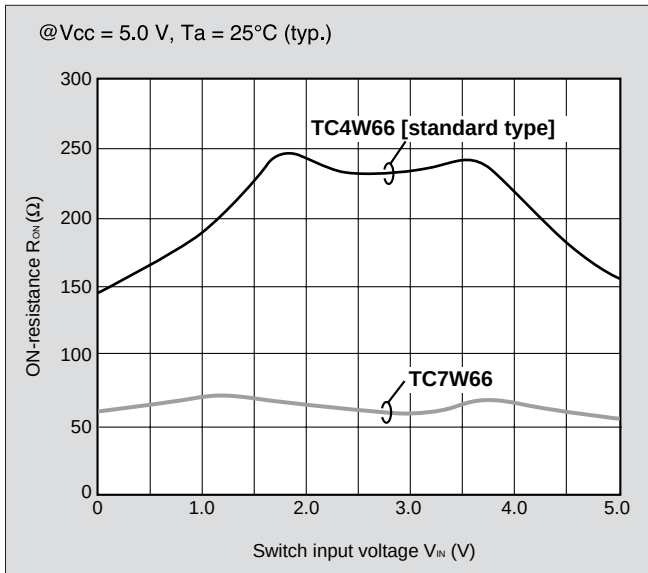
#### ● Features

- Low  $R_{ON}$  (ON-resistance):  $R_{ON} = 96\ \Omega$  (typical) at  $V_{CC} = 4.5\ V$   
 $R_{ON}$  is half that of the standard type (TC4W66).
- Wide operating voltage range:  $V_{CC} = 2\ V$  to  $12\ V$
- High operating frequency:  $f_{max} = 200\ MHz$  (typical) at  $V_{CC} = 10\ V$
- Pins and functions same as those of L-MOS Standard Series (TC4W66, TC4W53)

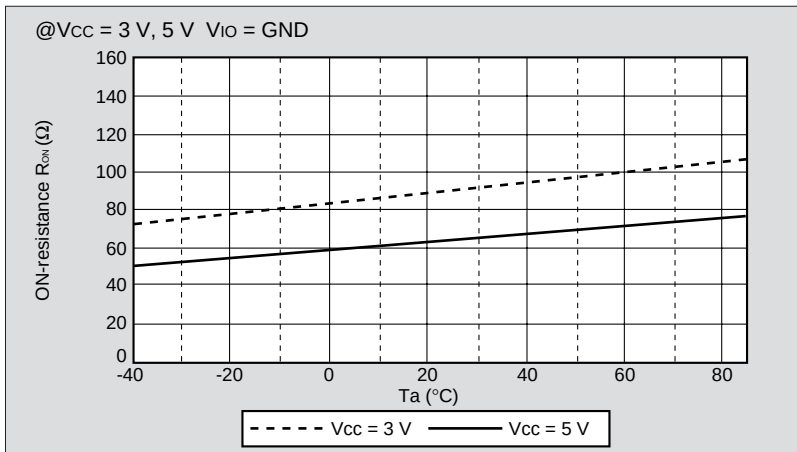
| Product No.                | TC7W66FU                                                                           | TC7W66FK | TC7W53FU                                                                             | TC7W53FK |
|----------------------------|------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------|----------|
| Package                    | SM8                                                                                | US8      | SM8                                                                                  | US8      |
| Electrical Characteristics | Same as TC74HC4066A                                                                |          | Same as TC74HC4053A                                                                  |          |
| Pin assignment             |  |          |  |          |

\*TC7W53F/FU: Analog switch characteristics are the same as those of the TC7W66.

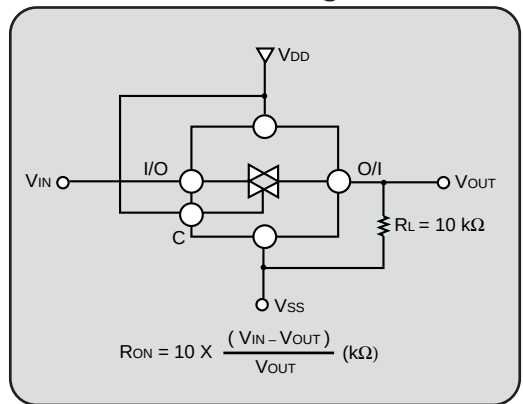
## ● ON-resistance ( $R_{ON}$ )



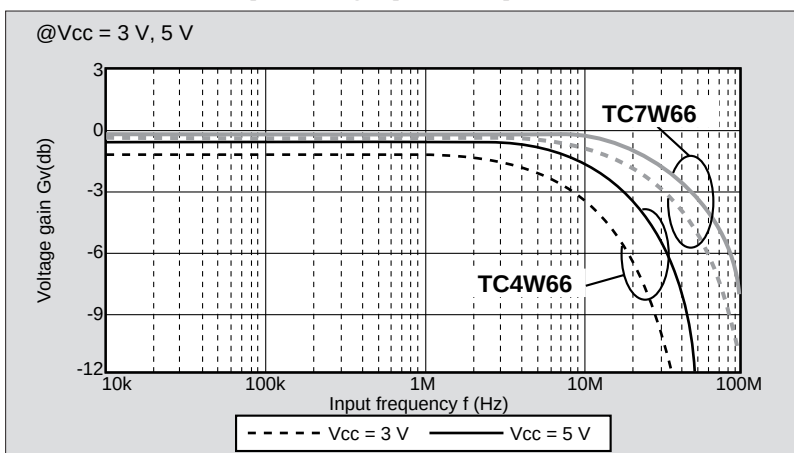
## ● ON-resistance - temperature characteristic ( $R_{ON}$ vs. Ta)



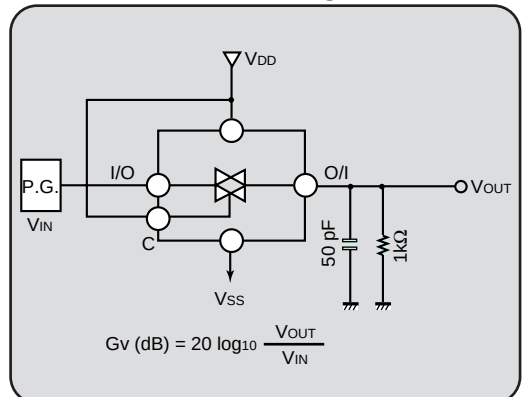
### Circuit for measuring $R_{ON}$



## ● Cut-off frequency ( $F_{max}$ )



### Circuit for measuring $f_{max}$



# 6. Point Regulator ICs (Low-Dropout Regulators)

The point regulator series features one or two regulator ICs in a small package. The devices are suitable for use as power supplies in battery-driven mobile phones and portable audio players.

## 6.1 Single Output type

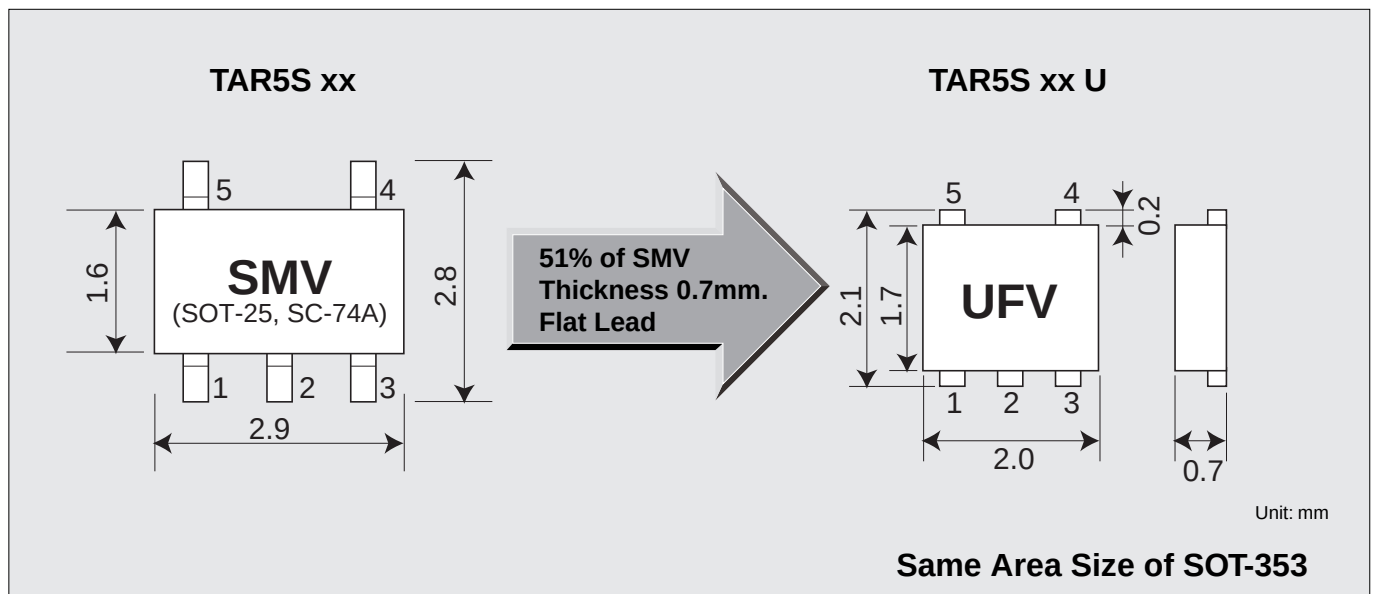
### New Products

#### TAR5S xx U Series(Very Small package Single-output type)

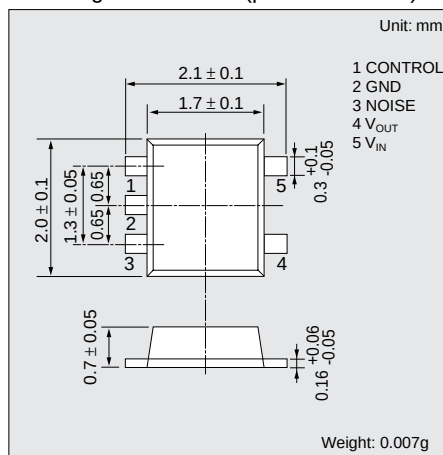
##### Features

- Very Small package (UFV)
- Dropout voltage 130 mV (typ.), 200 mV (max) @50 mA
- Connection to a noise bypass capacitor realizes low noise of 30  $\mu$ Vrms (typ.).
- High performance with ripple rejection of 70 dB (typ. @f = 1 kHz)
- ON/OFF control function (ON at 1.5 V or higher; OFF at 0.4 V or lower)
- Standby current of 0.1 $\mu$ A or less (when control OFF)
- Built-in overtemperature and overcurrent protection circuits
- Uses a ceramic capacitor

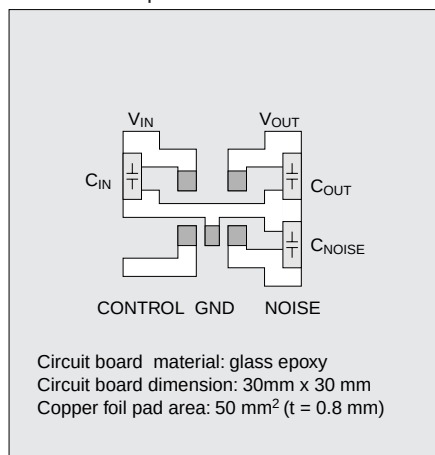
#### • Comparison between Current Standard package and New Small package



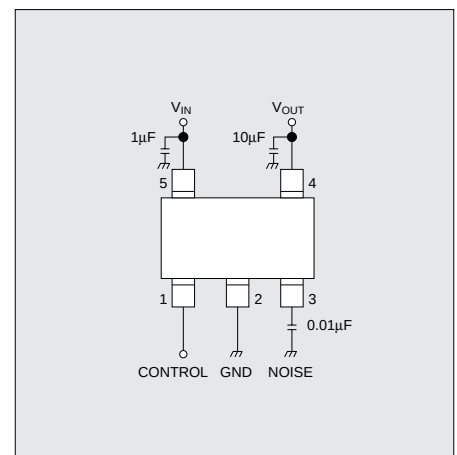
#### ■ Package dimensions (pin connections)



#### ■ Power dissipation evaluation board



#### ■ Recommend circuit



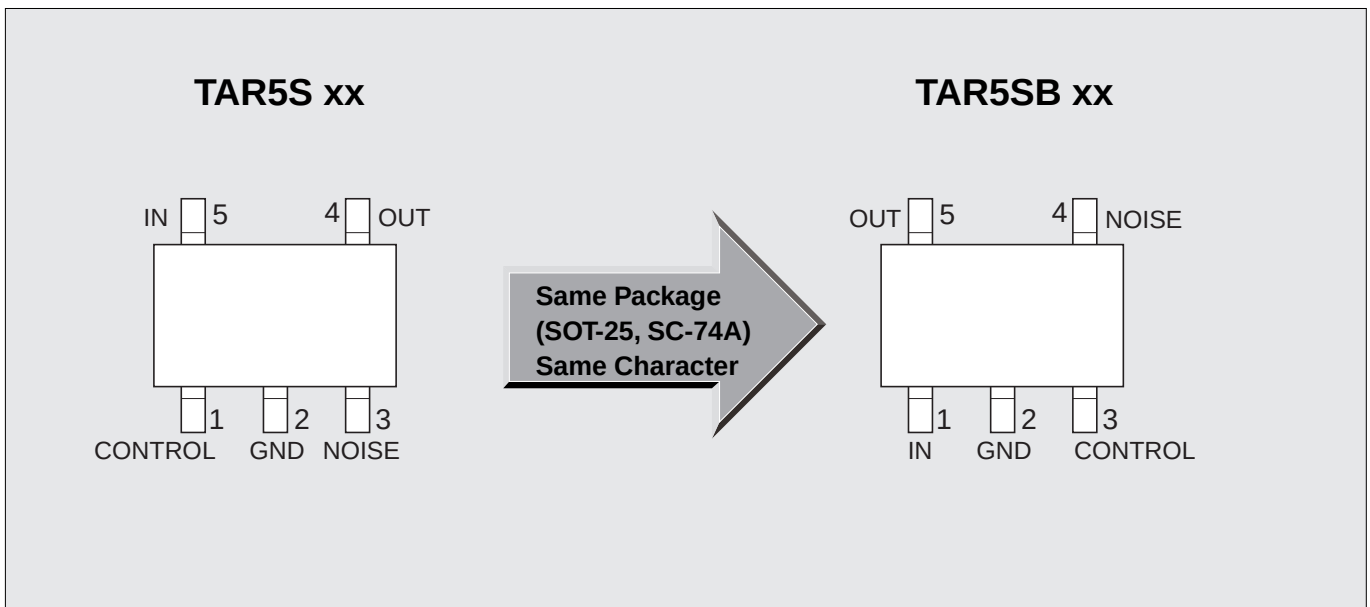
## New Products

### TAR5SB xx Series(New pin assignment Single-output type)

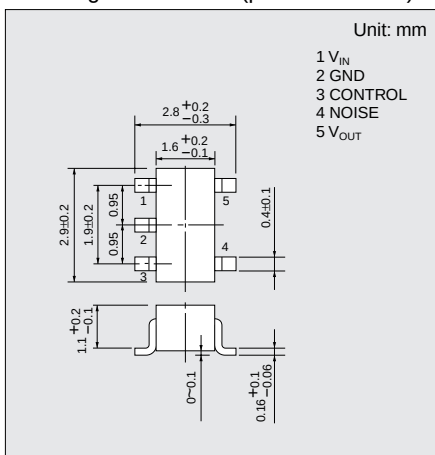
#### Features

- Small package (SMV: SC-74A, SOT-25)
- Dropout voltage 130 mV (typ.), 200 mV (max) @50 mA
- Connection to a noise bypass capacitor realizes low noise of 30  $\mu$ Vrms (typ.).
- High performance with ripple rejection of 70 dB (typ. @f = 1 kHz)
- ON/OFF control function (ON at 1.5 V or higher; OFF at 0.4 V or lower)
- Standby current of 0.1  $\mu$ A or less (when control OFF)
- Built-in overtemperature and overcurrent protection circuits
- Uses a ceramic capacitor

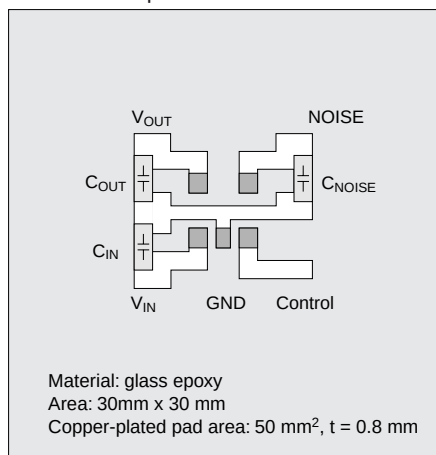
#### • Comparison between Current and New pin assignment



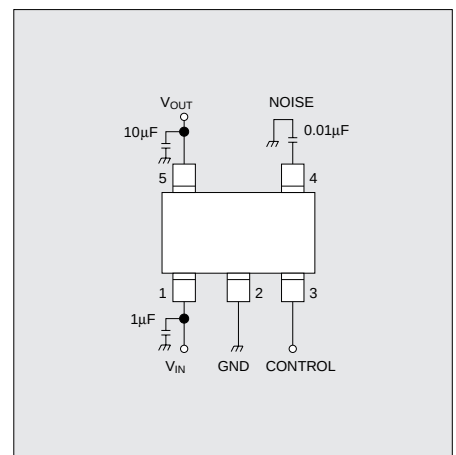
#### ■ Package dimensions (pin connections)



#### ■ Power dissipation evaluation board



#### ■ Recommend circuit



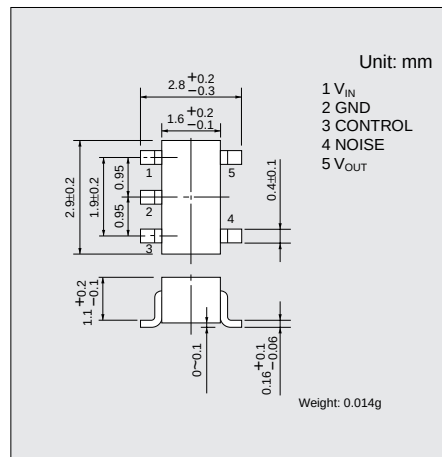
# 6. Point Regulator ICs (Low-Dropout Regulators)

## TAR5Sxx Series (single-output type)

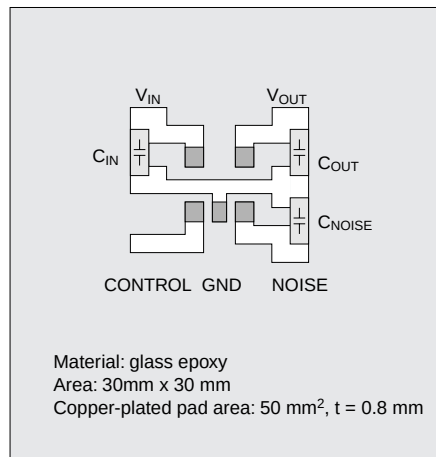
### Features

- Small package (SMV: SC-74A, SOT-25)
- Dropout voltage 130 mV (typ.), 200 mV (max) @50 mA
- Connection to a noise bypass capacitor realizes low noise of 30  $\mu$ Vrms (typ.).
- High performance with ripple rejection of 70 dB (typ. @f = 1 kHz)
- ON/OFF control function (ON at 1.5 V or higher; OFF at 0.4 V or lower)
- Standby current of 0.1  $\mu$ A or less (when control OFF)
- Built-in overtemperature and overcurrent protection circuits
- Uses a ceramic capacitor

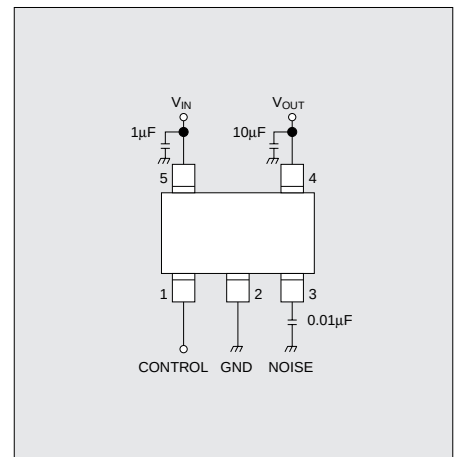
### Package dimensions (pin connections)



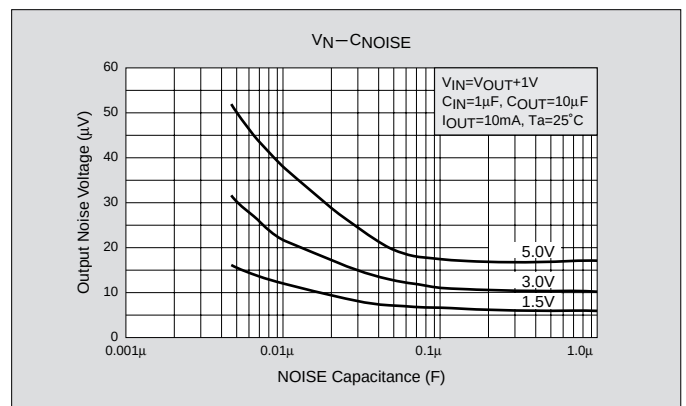
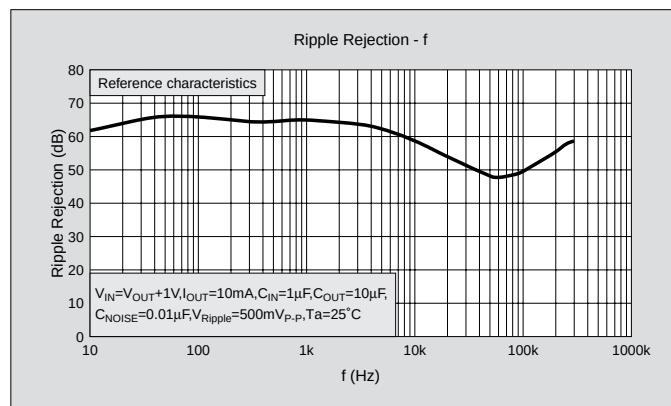
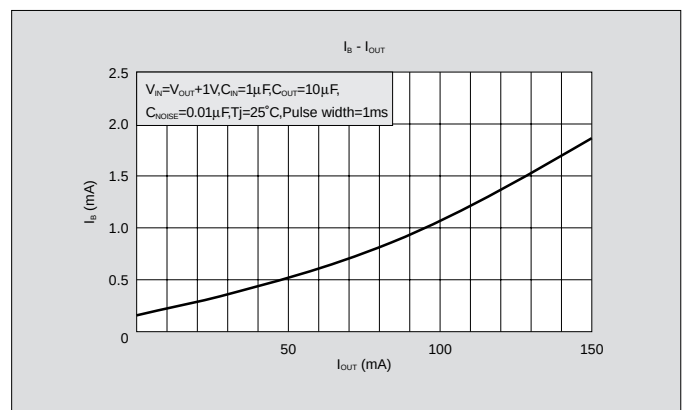
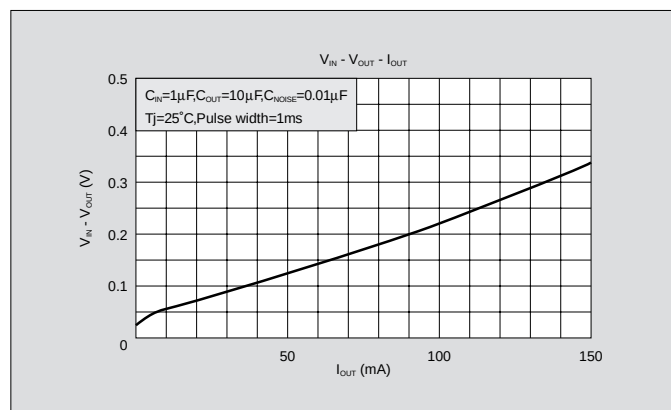
### Power dissipation evaluation board



### Recommend circuit



## TAR5S xx U/TAR5SB xx/TAR5S xx series Typical characteristic curves

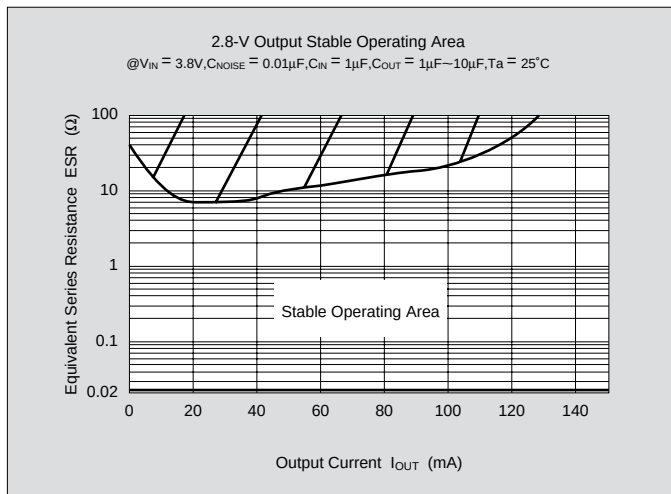
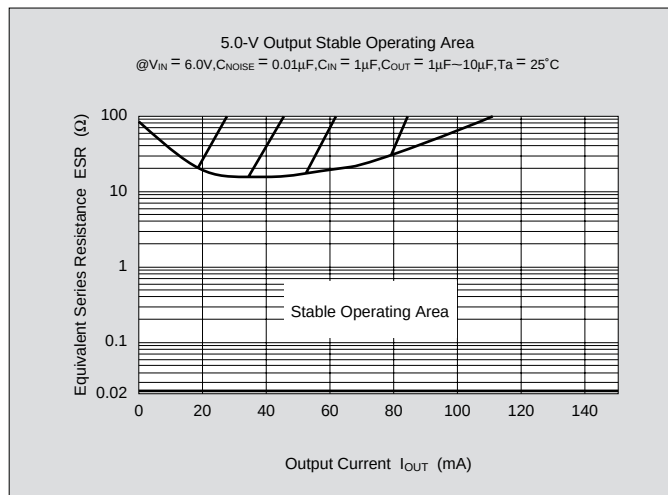
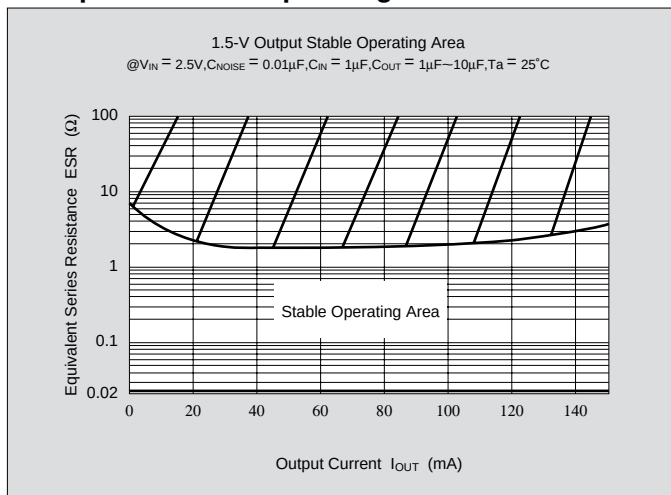


## Application Note for TAR5S xx U/TAR5SB xx /TAR5S xx Series

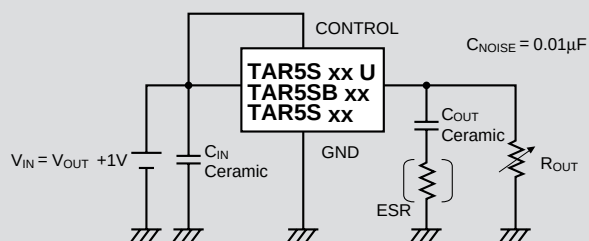
### ■ Stable Operating Area Characteristics

Shown below is the stable operation area, where the output voltage does not oscillate, evaluated using a Toshiba evaluation circuit. The equivalent series resistance (ESR) of the output capacitor and output current determines this area. TAR5Sxx Series devices operate stably even when a ceramic capacitor is used as the output capacitor.

### Examples of stable operating area characteristics



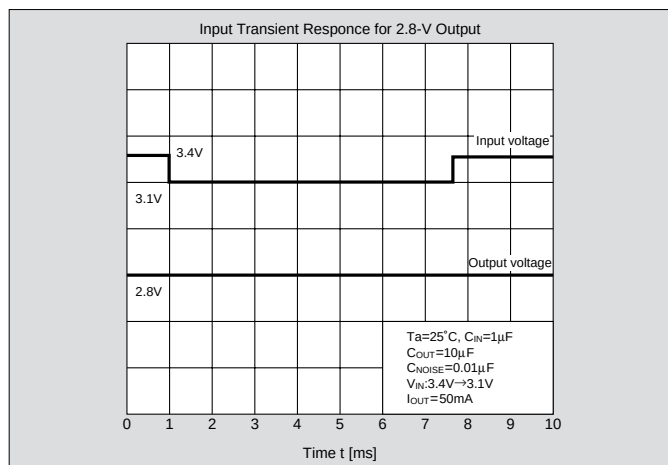
### Evaluation Circuit for Stable Operating Area



Capacitors used for evaluation  
Manufactured by Murata  $C_{IN}$ : GRM40B105K  
 $C_{OUT}$ : GRM40B105K/GRM40B106K

### ■ Input transient response characteristic

The TAR5S xx U/TAR5SB xx /TAR5S xx series feature an excellent characteristic in output fluctuation (input transient response characteristic) caused by a rapid drop in supply voltage.



# 6. Point Regulator ICs (Low-Dropout Regulators)

## 6.2 Dual Output type

### New Products

#### TAR8DxxK Series (Dual-output type, Independent ON/OFF control)

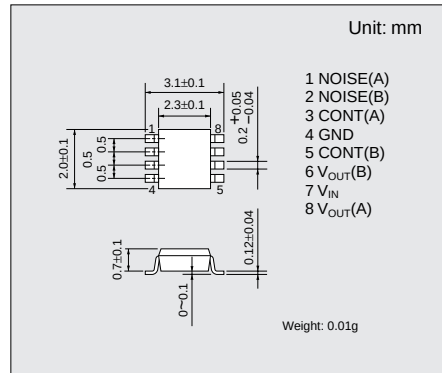
##### Features

- Incorporates two-output regulator IC in ultra-super-mini 8-pin package (US8), the smallest package type in the World.
- Output voltage can be set 0.1 V step, from 1.5 V to 5.0 (semi-custom products)

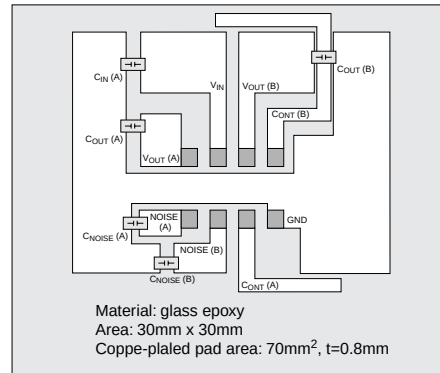
##### Typical Characteristics

- Dropout voltage: 120 mV (typ.), 180 mV (max)@30 mA
- Connection to a noise bypass capacitor realizes low noise of 30  $\mu$ Vrms (typ.).
- High-performance with ripple rejection of 70dB (typ.@f = 1 kHz)
- Both channel can be controlled individually.
- Standby current of 1 $\mu$ A or less (when control OFF)
- Built-in overtemperature and overcurrent protection circuits

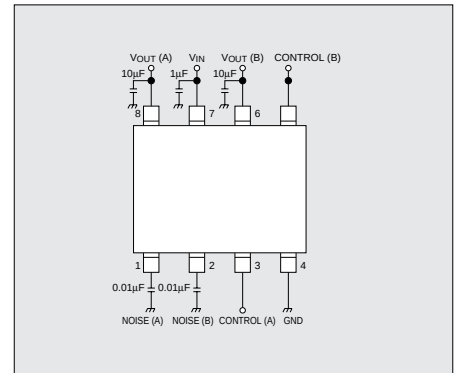
##### ■Package dimensions (pin connection)



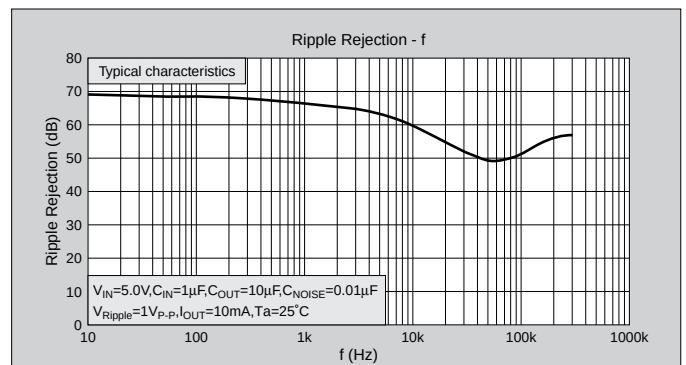
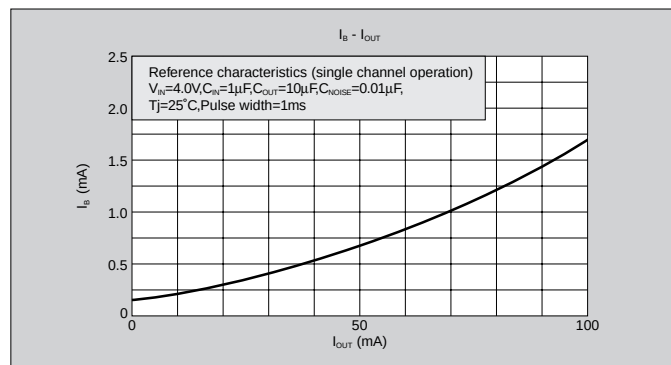
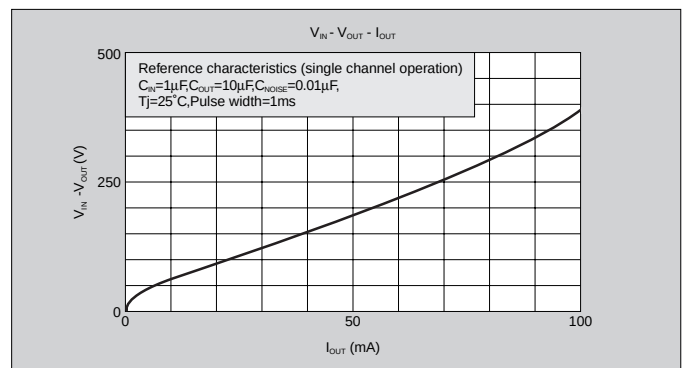
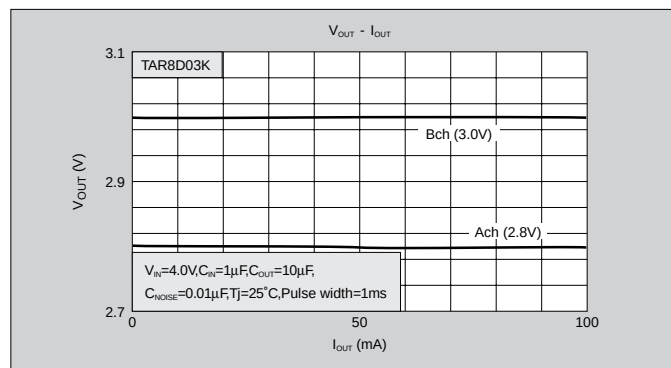
##### ■Power dissipation evaluation board



##### ■Recommended Circuit



##### ■Typical Characteristic curves







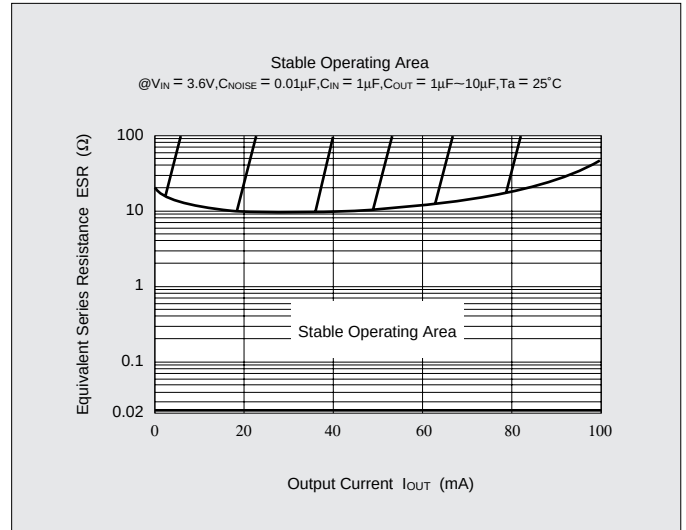
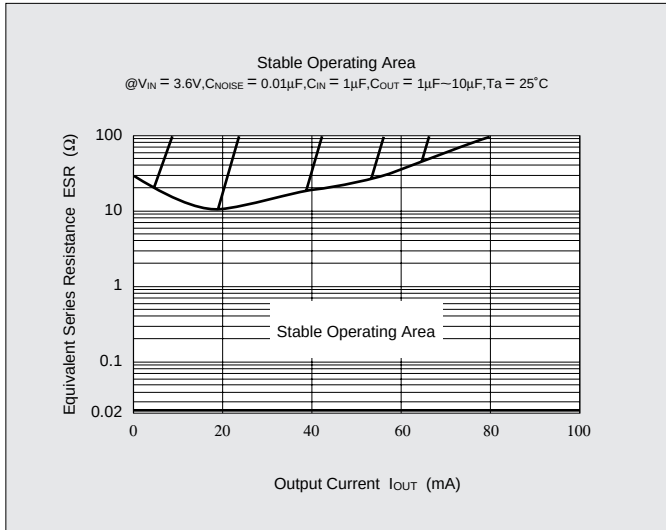
## 6. Point Regulator ICs (Low-Dropout Regulators)

### Application Note for TAR8HxxK Series

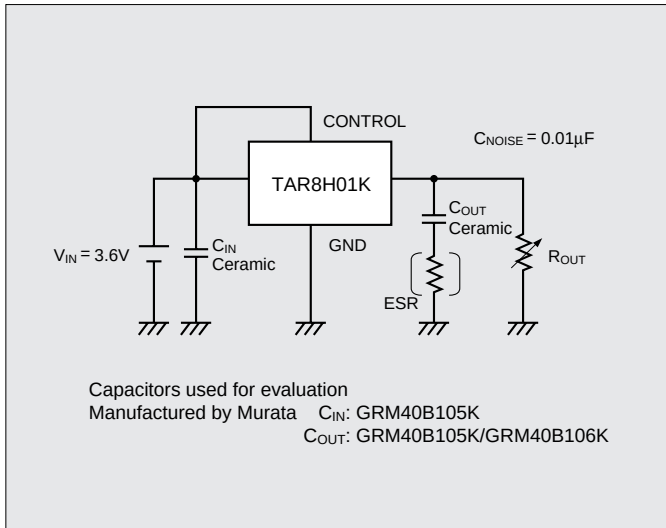
#### ■ Stable Operating Area Characteristics

Shown below is the stable operation area, where the output voltage does not oscillate, evaluated using a Toshiba evaluation circuit. The equivalent series resistance (ESR) of the output capacitor and output current determines this area. TAR8Hxx Series devices operate stably even when a ceramic capacitor is used as the output capacitor.

#### Examples of stable operating area characteristics



#### Evaluation Circuit for Stable Operating Area



## 6.3 Product Line-up

### 6.3.1 Single Output type

#### New Products

#### TAR5SxxU Series

| Product No.     | Output Voltage(V) (@50mA typ)*2 |      |      | Maximum Rating      |                          | Package |
|-----------------|---------------------------------|------|------|---------------------|--------------------------|---------|
|                 | Min                             | Typ. | Max  | Output Current (mA) | Power Dissipation (mW)*1 |         |
| <b>TAR5S15U</b> | 1.44                            | 1.5  | 1.56 | 200                 | 450                      | UFV     |
| <b>TAR5S18U</b> | 1.74                            | 1.8  | 1.86 |                     |                          |         |
| <b>TAR5S25U</b> | 2.43                            | 2.5  | 2.57 |                     |                          |         |
| <b>TAR5S28U</b> | 2.73                            | 2.8  | 2.87 |                     |                          |         |
| <b>TAR5S29U</b> | 2.83                            | 2.9  | 2.97 |                     |                          |         |
| <b>TAR5S30U</b> | 2.92                            | 3.0  | 3.08 |                     |                          |         |
| <b>TAR5S33U</b> | 3.21                            | 3.3  | 3.39 |                     |                          |         |

\*1: Mounted on a glass epoxy circuit board of 30 mm x 30 mm. Pad dimension of 35mm<sup>2</sup>.

\*2: Other output voltage products can be realized by 0.1V step between 1.5V and 5.0V range.

#### New Products

#### TAR5SBxx Series

| Product No.     | Output Voltage(V) (@50mA typ)*4 |      |      | Maximum Rating      |                          | Package                     |
|-----------------|---------------------------------|------|------|---------------------|--------------------------|-----------------------------|
|                 | Min                             | Typ. | Max  | Output Current (mA) | Power Dissipation (mW)*3 |                             |
| <b>TAR5SB15</b> | 1.44                            | 1.5  | 1.56 | 200                 | 380                      | SMV<br>(SC-74A)<br>(SOT-25) |
| <b>TAR5SB18</b> | 1.74                            | 1.8  | 1.86 |                     |                          |                             |
| <b>TAR5SB23</b> | 2.24                            | 2.3  | 2.36 |                     |                          |                             |
| <b>TAR5SB24</b> | 2.34                            | 2.4  | 2.46 |                     |                          |                             |
| <b>TAR5SB25</b> | 2.43                            | 2.5  | 2.57 |                     |                          |                             |
| <b>TAR5SB27</b> | 2.63                            | 2.7  | 2.77 |                     |                          |                             |
| <b>TAR5SB28</b> | 2.73                            | 2.8  | 2.87 |                     |                          |                             |
| <b>TAR5SB29</b> | 2.83                            | 2.9  | 2.97 |                     |                          |                             |
| <b>TAR5SB30</b> | 2.92                            | 3.0  | 3.08 |                     |                          |                             |
| <b>TAR5SB33</b> | 3.21                            | 3.3  | 3.39 |                     |                          |                             |

\*3: Mounted on a glass epoxy circuit board of 30 mm x 30 mm. Pad dimension of 50mm<sup>2</sup>.

\*4: Other output voltage products can be realized by 0.1V step between 1.5V and 5.0V range.

#### TAR5Sxx Series

| Product No.    | Output Voltage(V) (@50mA typ) |      |      | Maximum Rating      |                          | Package                     |
|----------------|-------------------------------|------|------|---------------------|--------------------------|-----------------------------|
|                | Min                           | Typ. | Max  | Output Current (mA) | Power Dissipation (mW)*3 |                             |
| <b>TAR5S15</b> | 1.44                          | 1.5  | 1.56 | 200                 | 380                      | SMV<br>(SC-74A)<br>(SOT-25) |
| <b>TAR5S16</b> | 1.54                          | 1.6  | 1.66 |                     |                          |                             |
| <b>TAR5S17</b> | 1.64                          | 1.7  | 1.76 |                     |                          |                             |
| <b>TAR5S18</b> | 1.74                          | 1.8  | 1.86 |                     |                          |                             |
| <b>TAR5S19</b> | 1.84                          | 1.9  | 1.96 |                     |                          |                             |
| <b>TAR5S20</b> | 1.94                          | 2.0  | 2.06 |                     |                          |                             |
| <b>TAR5S21</b> | 2.04                          | 2.1  | 2.16 |                     |                          |                             |
| <b>TAR5S22</b> | 2.14                          | 2.2  | 2.26 |                     |                          |                             |
| <b>TAR5S23</b> | 2.24                          | 2.3  | 2.36 |                     |                          |                             |
| <b>TAR5S24</b> | 2.34                          | 2.4  | 2.46 |                     |                          |                             |
| <b>TAR5S25</b> | 2.43                          | 2.5  | 2.57 |                     |                          |                             |
| <b>TAR5S26</b> | 2.53                          | 2.6  | 2.67 |                     |                          |                             |
| <b>TAR5S27</b> | 2.63                          | 2.7  | 2.77 |                     |                          |                             |
| <b>TAR5S28</b> | 2.73                          | 2.8  | 2.87 |                     |                          |                             |
| <b>TAR5S29</b> | 2.83                          | 2.9  | 2.97 |                     |                          |                             |
| <b>TAR5S30</b> | 2.92                          | 3.0  | 3.08 |                     |                          |                             |
| <b>TAR5S31</b> | 3.02                          | 3.1  | 3.18 |                     |                          |                             |
| <b>TAR5S32</b> | 3.12                          | 3.2  | 3.28 |                     |                          |                             |
| <b>TAR5S33</b> | 3.21                          | 3.3  | 3.39 |                     |                          |                             |
| <b>TAR5S34</b> | 3.31                          | 3.4  | 3.49 |                     |                          |                             |
| <b>TAR5S35</b> | 3.41                          | 3.5  | 3.59 |                     |                          |                             |
| <b>TAR5S45</b> | 4.38                          | 4.5  | 4.62 |                     |                          |                             |
| <b>TAR5S48</b> | 4.68                          | 4.8  | 4.92 |                     |                          |                             |
| <b>TAR5S50</b> | 4.87                          | 5.0  | 5.13 |                     |                          |                             |

\*3: Mounted on a glass epoxy circuit board of 30 mm x 30 mm. Pad dimension of 50mm<sup>2</sup>.

## 6. Point Regulator ICs (Low-Dropout Regulators)

### 6.3.2 Dual Output type

#### New Products

#### TAR8Dxx Series (dual-circuit, independent ON/OFF control)

Output voltage can be set, 0.1 V step fro 1.5 V to 5.0 V (semi-custom products)

| Product No. | Ch | Output Voltage (V) |      |      |                          | Maximum Rating      |                        | Package |
|-------------|----|--------------------|------|------|--------------------------|---------------------|------------------------|---------|
|             |    | Min                | Typ. | Max  | Measurement current (mA) | Output Current (mA) | Power Dissipation (mW) |         |
| TAR8D01K    | A  | 2.43               | 2.5  | 2.57 | 30                       | 100                 | 400                    | US8     |
|             | B  | 2.73               | 2.8  | 2.87 | 30                       |                     |                        |         |
| TAR8D02K    | A  | 1.94               | 2.0  | 2.06 | 30                       |                     |                        |         |
|             | B  | 2.73               | 2.8  | 2.87 | 30                       |                     |                        |         |
| TAR8D03K    | A  | 2.73               | 2.8  | 2.87 | 30                       |                     |                        |         |
|             | B  | 2.92               | 3.0  | 3.08 | 30                       |                     |                        |         |
| TAR8D04K    | A  | 1.44               | 1.5  | 1.56 | 30                       |                     |                        |         |
|             | B  | 1.44               | 1.5  | 1.56 | 30                       |                     |                        |         |
| TAR8D05K    | A  | 2.73               | 2.8  | 2.87 | 30                       |                     |                        |         |
|             | B  | 2.73               | 2.8  | 2.87 | 30                       |                     |                        |         |
| TAR8D06K    | A  | 2.83               | 2.9  | 2.97 | 30                       |                     |                        |         |
|             | B  | 2.83               | 2.9  | 2.97 | 30                       |                     |                        |         |
| TAR8D07K    | A  | 2.92               | 3.0  | 3.08 | 30                       |                     |                        |         |
|             | B  | 2.92               | 3.0  | 3.08 | 30                       |                     |                        |         |

#### Dual-output type: TAR8Hxx Series (dual-circuit, synchronous ON/OFF control)

Output voltage can be set, 0.1 V step fro 1.5 V to 5.0 V (semi-custom products)

| Product No. | Ch | Output Voltage (V) |      |      |                          | Maximum Rating      |                        | Package |
|-------------|----|--------------------|------|------|--------------------------|---------------------|------------------------|---------|
|             |    | Min                | Typ. | Max  | Measurement current (mA) | Output Current (mA) | Power Dissipation (mW) |         |
| TAR8H01K    | A  | 2.73               | 2.8  | 2.87 | 30                       | 100                 | 400                    | US8     |
|             | B  | 2.92               | 3.0  | 3.08 | 60                       | 150                 |                        |         |
| TAR8H02K    | A  | 2.73               | 2.8  | 2.87 | 30                       | 100                 |                        |         |
|             | B  | 2.73               | 2.8  | 2.87 | 30                       | 150                 |                        |         |
| TAR8H03K    | A  | 2.43               | 2.5  | 2.57 | 30                       | 100                 |                        |         |
|             | B  | 2.73               | 2.8  | 2.87 | 60                       | 150                 |                        |         |
| TAR8H04K    | A  | 2.43               | 2.5  | 2.57 | 30                       | 100                 |                        |         |
|             | B  | 2.92               | 3.0  | 3.08 | 60                       | 150                 |                        |         |
| TAR8H05K    | A  | 1.74               | 1.8  | 1.86 | 30                       | 100                 |                        |         |
|             | B  | 2.73               | 2.8  | 2.87 | 60                       | 150                 |                        |         |

### Precautions for Use

The noise capacitor should be connected to NOISE pin to GND for stable operation, the recommended value is higher than 0.0047  $\mu$ F.

Although all devices in this catalog is built-in overtemperature and overcurrent protection circuits, these functions do not restrict use of the devices within their absolute maximum ratings.

Toshiba recommend that the specific technical data which relates to a product be checked before it is used, and that products always be used within their absolute maximum ratings.

# 7. Op Amp Comparator ICs

## 7.1 Product Line-up

Single type 1616 size ESV packages are added to the product line-up.

Dual 2.0 mm x 2.3 mm size US8 packages are added to the product line-up.

**Single Circuit: SMV (F type: SOT-25, SC-74A), USV (FU type: SOT-353, SC-88A), ESV(FE type)**

| Function              | Bipolar Comparators                             | CMOS Comparators                                                           |                                                                     |                                                                             |                                                                      | Bipolar Op Amps                                 |                          | CMOS Op Amps                                                         |                                                                                                      |                                                                                                      |                                                                                                   |
|-----------------------|-------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------|--------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Product No.           | <b>TA75S393F</b>                                | <b>TC75S56F</b><br>TC75S56FU<br>TC75S56FE                                  | <b>TC75S57F</b><br>TC75S57FU<br>TC75S57FE                           | <b>TC75S58F</b><br>TC75S58FU<br>TC75S58FE                                   | <b>TC75S59F</b><br>TC75S59FU<br>TC75S59FE                            | <b>TA75S01F</b>                                 | <b>TA75S558F</b>         | <b>TC75S51F</b><br>TC75S51FU<br>TC75S51FE                            | <b>TC75S54F</b><br>TC75S54FU<br>TC75S54FE                                                            | <b>TC75S55F</b><br>TC75S55FU<br>TC75S55FE                                                            | <b>TC75S60F</b><br>TC75S60FU                                                                      |
| Marking               | TA                                              | TC                                                                         | TD                                                                  | TE                                                                          | TF                                                                   | SA                                              | SB                       | SC                                                                   | SE                                                                                                   | SF                                                                                                   | SH                                                                                                |
| Features              | Single/dual power supply, open collector output | Single/dual power supply, push-pull output, supper-low current consumption | Single/dual power supply, push-pull output, low current consumption | Single/dual power supply, open drain output, supper-low current consumption | Single/dual power supply, open drain output, low current consumption | Single/dual power supply, unity gain capability | Dual power supply        | Single/dual power supply, low-voltage operations, wide dynamic range | Single/dual power supply, low-voltage operations, supper-low current consumption, wide dynamic range | Single/dual power supply, low-voltage operations, supper-low current consumption, wide dynamic range | Single/dual power supply, high slew rate, high fT, low-voltage operation, low current consumption |
| Operating voltage     | 2 to 36 V<br>or<br>$\pm 1$ to $\pm 18$ V        | 1.8 to 7 V<br>or<br>$\pm 0.9$ to $\pm 3.5$ V                               |                                                                     |                                                                             |                                                                      | 3 to 12 V<br>or<br>$\pm 1.5$ to $\pm 6$ V       | $\pm 4$ to 18 V          | 1.5 to 7 V<br>or<br>$\pm 0.75$ to $\pm 3.5$ V                        | 1.8 to 7 V<br>or<br>$\pm 0.9$ to $\pm 3.5$ V                                                         |                                                                                                      |                                                                                                   |
| Equivalent products   | <b>TA75393</b><br>(LM393)<br>(LM2903)           | —                                                                          | —                                                                   | —                                                                           | —                                                                    | <b>TA75358C</b><br>(LM358)<br>(LM2804)          | <b>TA75558</b><br>(4558) | —                                                                    | —                                                                                                    | —                                                                                                    | —                                                                                                 |
| Pin layout (TOP VIEW) |                                                 |                                                                            |                                                                     |                                                                             |                                                                      |                                                 |                          |                                                                      |                                                                                                      |                                                                                                      |                                                                                                   |

New products Note : The layout of input pins for the SMV op amp and the comoarator IC are different. The pin layout of the op amp and comparator IC are the same as that of the SM8 type.

**Dual Circuit: SM8 (FU type), US8 (FK type)**

| Function              | Bipolar Comparators                             | CMOS Comparators                                                           |                                                                     |                                                                             |                                                                      | Bipolar Op Amps                                 |                          | CMOS Op Amps                                                         |                                                                                                      |                                                                                                      |                                                                                                   |
|-----------------------|-------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------|--------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Product No.           | <b>TA75W393FU</b>                               | <b>TC75W56FU</b><br>TC75W56FK                                              | <b>TC75W57FU</b><br>TC75W57FK                                       | <b>TC75W58FU</b><br>TC75W58FK                                               | <b>TC75W59FU</b><br>TC75W59FK                                        | <b>TA75W01FU</b>                                | <b>TA75W558FU</b>        | <b>TC75W51FU</b><br>TC75W51FK                                        | <b>TC75W54FU</b><br>TC75W54FK                                                                        | <b>TC75W55FU</b><br>TC75W55FK                                                                        | <b>TC75W60FU</b><br>TC75W60FK                                                                     |
| Marking               | 5W393                                           | 5W56                                                                       | 5W57                                                                | 5W58                                                                        | 5W59                                                                 | 5W01                                            | 5W558                    | 5W51                                                                 | 5W54                                                                                                 | 5W55                                                                                                 | 5W60                                                                                              |
| Features              | Single/dual power supply, open collector output | Single/dual power supply, push-pull output, supper-low current consumption | Single/dual power supply, push-pull output, low current consumption | Single/dual power supply, open drain output, supper-low current consumption | Single/dual power supply, open drain output, low current consumption | Single/dual power supply, unity gain capability | Dual power supply        | Single/dual power supply, low-voltage operations, wide dynamic range | Single/dual power supply, low-voltage operations, supper-low current consumption, wide dynamic range | Single/dual power supply, low-voltage operations, supper-low current consumption, wide dynamic range | Single/dual power supply, high slew rate, high fT, low-voltage operation, low current consumption |
| Operating voltage     | 2 to 36 V<br>or<br>$\pm 1$ to $\pm 18$ V        | 1.8 to 7 V<br>or<br>$\pm 0.9$ to $\pm 3.5$ V                               |                                                                     |                                                                             |                                                                      | 3 to 12 V<br>or<br>$\pm 1.5$ to $\pm 6$ V       | $\pm 4$ to 18 V          | 1.5 to 7 V<br>or<br>$\pm 0.75$ to $\pm 3.5$ V                        | 1.8 to 7 V<br>or<br>$\pm 0.9$ to $\pm 3.5$ V                                                         |                                                                                                      |                                                                                                   |
| Equivalent products   | <b>TA75393</b><br>(LM393)<br>(LM2903)           | —                                                                          | —                                                                   | —                                                                           | —                                                                    | <b>TA75358C</b><br>(LM358)<br>(LM2804)          | <b>TA75558</b><br>(4558) | —                                                                    | —                                                                                                    | —                                                                                                    | —                                                                                                 |
| Pin layout (TOP VIEW) |                                                 |                                                                            |                                                                     |                                                                             |                                                                      |                                                 |                          |                                                                      |                                                                                                      |                                                                                                      |                                                                                                   |

New products

# 7. Op Amp Comparator ICs

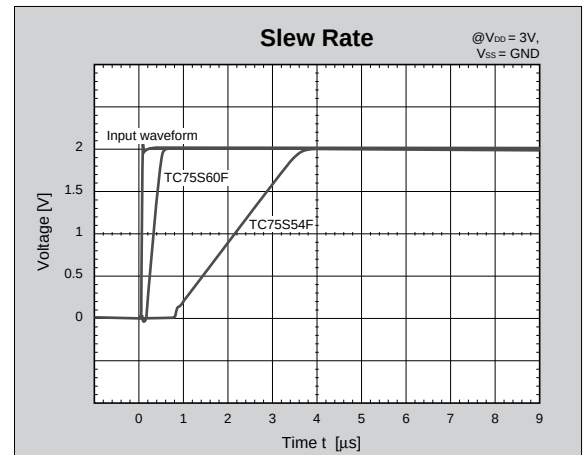
## 7.2 New Product

### New Products

## High Slew Rate Single and Dual CMOS Op Amp: TC75S60/TC75W60 Series

### Features

- High slew rate: 5.1 V/μs (typ.) @V<sub>DD</sub> = 3 V
- Low supply current: 330 μA (typ.), V<sub>DD</sub> = 3 V (single-circuit)
- Single and dual power supplies are used.
- Low-voltage operation possible: 1.8 V ~ 7 V



### Line-up

|                | Product No.      | Package                         | Marking     | Pin Assignment |
|----------------|------------------|---------------------------------|-------------|----------------|
| Single-Circuit | <b>TC75S60F</b>  | <b>SMV</b><br>(SC-74A, SOT-25)  | <b>SH</b>   |                |
|                | <b>TC75S60FU</b> | <b>USV</b><br>(SC-88A, SOT-353) |             |                |
| Dual-Circuit   | <b>TC75W60FU</b> | <b>SM8</b>                      | <b>5W60</b> |                |
|                | <b>TC75W60FK</b> | <b>US8</b>                      |             |                |

### New Products

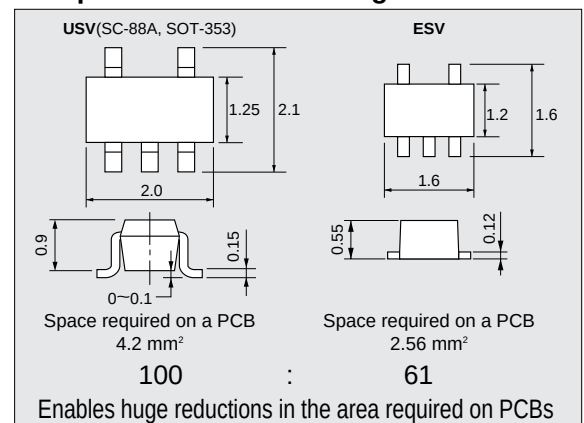
## CMOS Op Amps and Comparator ICs Housed in ESV Package

### Line-up

| Function            | ESV Package      | Equivalent USV Package |
|---------------------|------------------|------------------------|
| CMOS OP Amps        | <b>TC75S51FE</b> | <b>TC75S51FU</b>       |
|                     | <b>TC75S54FE</b> | <b>TC75S54FU</b>       |
|                     | <b>TC75S55FE</b> | <b>TC75S55FU</b>       |
| CMOS Comparator ICs | <b>TC75S56FE</b> | <b>TC75S56FU</b>       |
|                     | <b>TC75S57FE</b> | <b>TC75S57FU</b>       |
|                     | <b>TC75S58FE</b> | <b>TC75S58FU</b>       |
|                     | <b>TC75S59FE</b> | <b>TC75S59FU</b>       |

### Compared with USV Package

Unit: mm



## 7.3 Current Products

### Single and Dual CMOS Op Amp ICs: TC75S51/54/55 and TC75W51/54/55 Series

#### Features

- Low supply current:
  - Single-circuit
    - 10  $\mu$ A: TC75S55F/FU
    - 60  $\mu$ A: TC75S51F/FU
    - 100  $\mu$ A: TC75S54F/FU
  - Dual-circuit
    - 20  $\mu$ A: TC75W55FU/FK
    - 120  $\mu$ A: TC75W51FU/FK
    - 200  $\mu$ A: TC75W54FU/FK
- Wide range of output voltage:  $V_{DD}-0.1V@V_{DD}=3V, R_L=100k\Omega$
- Single and dual power supplies are used.
  - 1.5 V  $\sim$  7 V: TC75S51F Series
  - 1.8 V  $\sim$  7 V: TC75S54F/55F Series

#### Line-up

|                | Product No.         | Marking     | Package                                                               | Pin Assignment |
|----------------|---------------------|-------------|-----------------------------------------------------------------------|----------------|
| Single-circuit | <b>TC75S51F/FU</b>  | <b>SC</b>   | <b>SMV</b><br>(SC-74A, SOT-25)<br><br><b>USV</b><br>(SC-88A, SOT-353) |                |
|                | <b>TC75S54F/FU</b>  | <b>SE</b>   |                                                                       |                |
|                | <b>TC75S55F/FU</b>  | <b>SF</b>   |                                                                       |                |
| Dual-circuit   | <b>TC75W51FU/FK</b> | <b>5W51</b> | <b>SM8/US8</b>                                                        |                |
|                | <b>TC75W54FU/FK</b> | <b>5W54</b> |                                                                       |                |
|                | <b>TC75W55FU/FK</b> | <b>5W55</b> |                                                                       |                |

### Single and Dual CMOS Comparator ICs: TC75S56/57/58/59 and TC75W56/57/58/59 Series

#### Features

- Output circuit type
  - Push-pull output circuit (TC75S56F/57F Series)
  - Open drain (TC75S58F/59F Series)
- Low supply current
  - Single-circuit
    - 10  $\mu$ A: TC75S56F/58F Series
    - 100  $\mu$ A: TC75S57F/59F Series
  - Dual Circuit
    - 20  $\mu$ A: TC75W56FU/58FU Series
    - 200  $\mu$ A: TC75W57FU/59FU Series
- Low-voltage operation: 1.8 V  $\sim$  7 V,
- Full-swing output

#### Line-up

|                | Product No.        | Marking     | Package                                                               | Pin Assignment |
|----------------|--------------------|-------------|-----------------------------------------------------------------------|----------------|
| Single-circuit | <b>TC75S56F/FU</b> | <b>TC</b>   | <b>SMV</b><br>(SC-74A, SOT-25)<br><br><b>USV</b><br>(SC-88A, SOT-353) |                |
|                | <b>TC75S57F/FU</b> | <b>TD</b>   |                                                                       |                |
|                | <b>TC75S58F/FU</b> | <b>TE</b>   |                                                                       |                |
|                | <b>TC75S59F/FU</b> | <b>TF</b>   |                                                                       |                |
| Dual-circuit   | <b>TC75W56F/FU</b> | <b>5W56</b> | <b>SM8/US8</b>                                                        |                |
|                | <b>TC75W57F/FU</b> | <b>5W57</b> |                                                                       |                |
|                | <b>TC75W58F/FU</b> | <b>5W58</b> |                                                                       |                |
|                | <b>TC75W59F/FU</b> | <b>5W59</b> |                                                                       |                |

# 7. Op Amp Comparators ICs

## Power Supply Current in CMOS Op Amp ICs

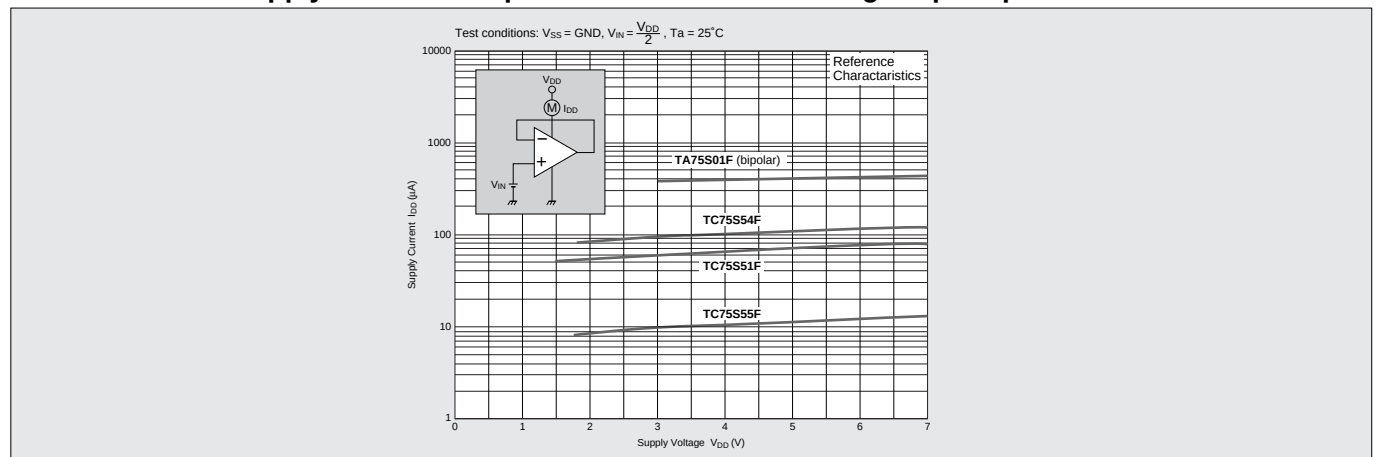
Power supply current in CMOS operational amplifiers varies depending on the use conditions.

The standard method for measuring operational amplifier power supply current is specified by JEITA and JIS. Toshiba's test circuit for measuring power supply current is standard type. Note that with CMOS operational amplifiers, even if power supply current is small in the test circuit, power supply current may vary depending on the mode used.

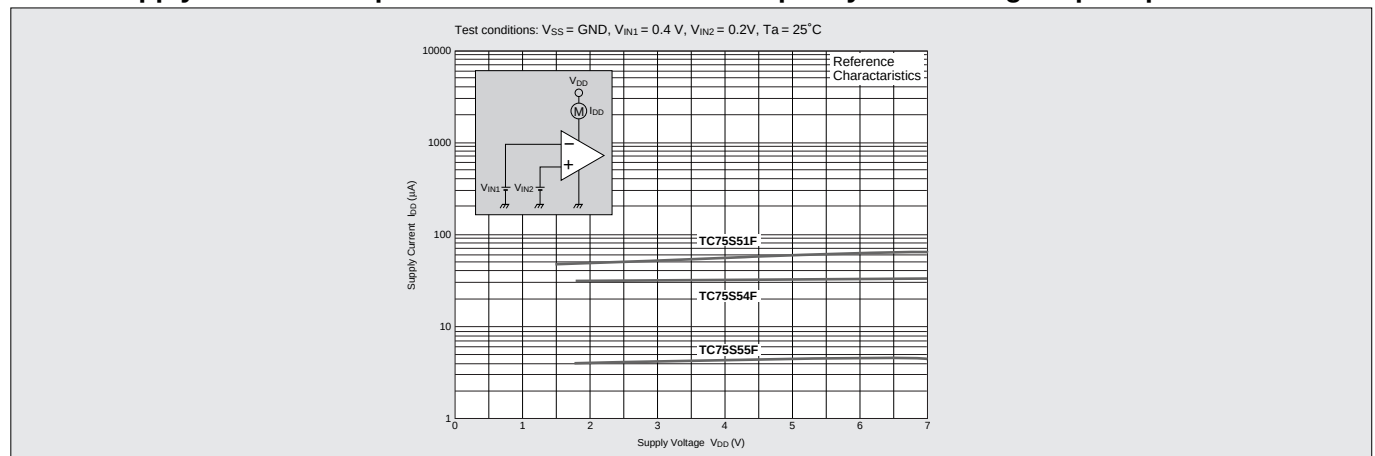
Toshiba's line-up features several types of CMOS operational amplifier, each with individual features. In principle, Toshiba design for low-voltage operation and low power supply current.

Comparison data for CMOS operational amplifier power supply current are shown below.

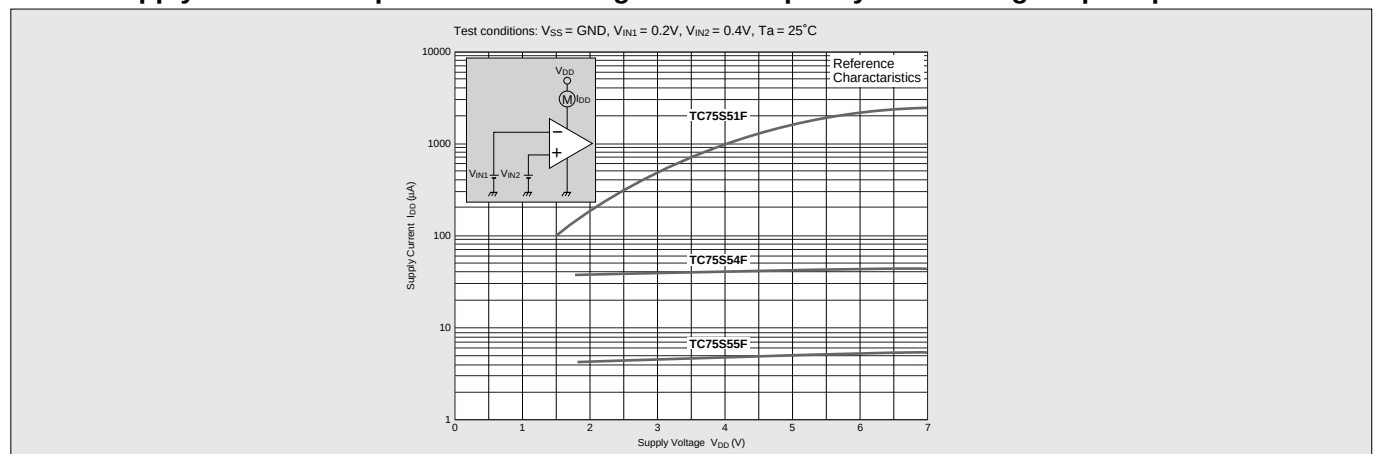
## Standard Power Supply Current Comparison Data for CMOS Single Op Amp



## Power Supply Current Comparison Data at Low-Level Output by CMOS Single Op Amp



## Power Supply Current Comparison Data at High-Level Output by CMOS Single Op Amp

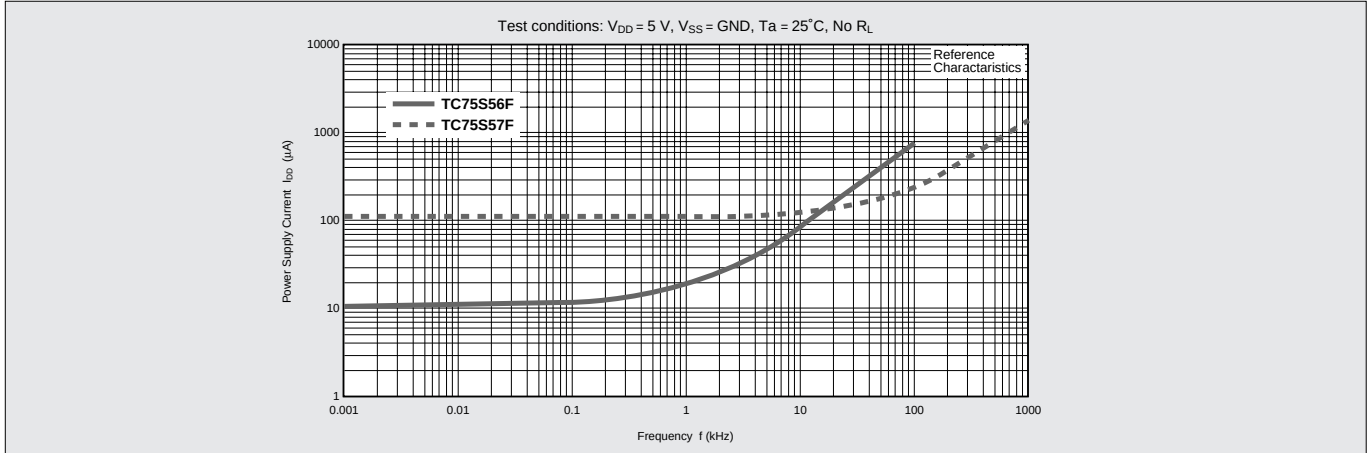




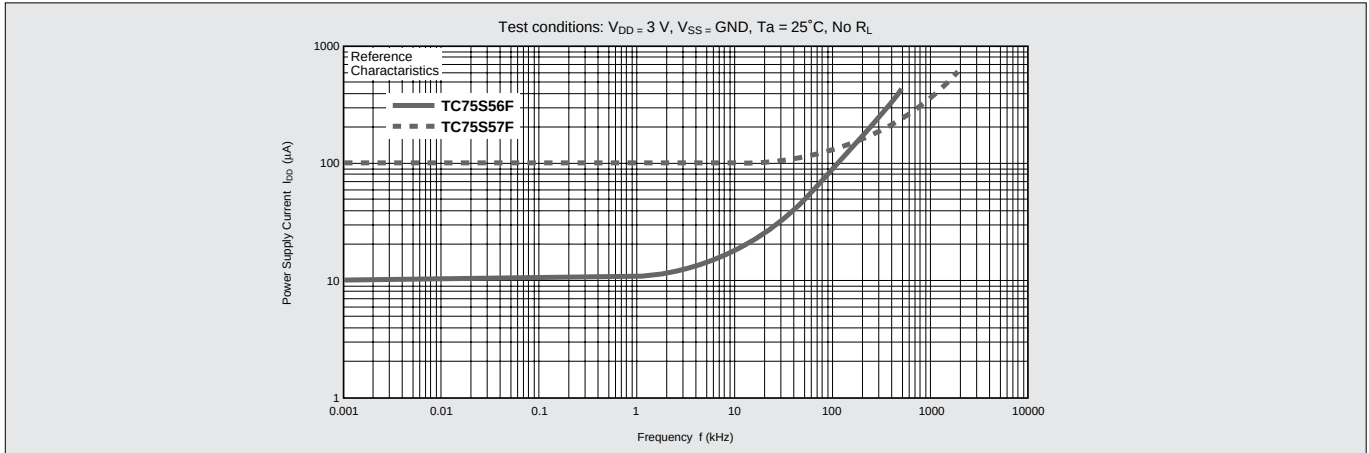
### Power Supply Current and Frequency Characteristics in CMOS Comparator ICs

In CMOS comparators power supply current rises as the operating frequency increases, since the overlap current increases in step with the operating frequency. Therefore, select a comparator according to the frequency of the signal to be used.

#### TC75S56F/TC75S57F Power Supply Current — Frequency Characteristics



#### TC75S56F/TC75S57F Power Supply Current — Frequency Characteristics



### Comparison of CMOS Op Amp ICs and Bipolar Op Amp ICs Characteristics

Our super-miniature operational amplifier product line includes both CMOS and bipolar operational amplifier, both of which offer excellent characteristics. However, our existing CMOS operational amplifier series was developed specifically for low-voltage operation and low power supply current. Therefore, compared to the bipolar operational amplifier, the CMOS operational amplifier can substantially reduce power dissipation. The following table compares the principal characteristics of typical Toshiba bipolar and CMOS operational amplifier.

| Characteristic                       | CMOS Operational Amplifier                                                                   |                                                                                              | Bipolar Operational Amplifier                                 |
|--------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---------------------------------------------------------------|
|                                      | TC75S54F                                                                                     | TC75S55F                                                                                     | TA75S01F                                                      |
| Operating Power Supply Voltage Range | 1.8~7.0 V                                                                                    | 1.8~7.0 V                                                                                    | 3.0~12.0 V                                                    |
| Power Supply Current (typ.)          | 100 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>80 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ )  | 10 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>8 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ )    | 400 $\mu\text{A}$ ( $V_{CC} = 5\text{ V}$ )                   |
| Input Bias Current (typ.)            | 1 pA( $V_{DD} = 3\text{ V}$ )                                                                | 1 pA( $V_{DD} = 3\text{ V}$ )                                                                | 45 nA( $V_{CC} = 5\text{ V}$ )                                |
| Maximum Output Voltage (typ.)        | $V_{DD} - 0.1\text{ V}$<br>( $V_{DD} = 3\text{ V}$ , $R_L = 100\text{ k}\Omega$ )            | $V_{DD} - 0.1\text{ V}$<br>( $V_{DD} = 3\text{ V}$ , $R_L = 1\text{ M}\Omega$ )              | 3.4 V<br>( $V_{CC} = 5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ) |
| Source Current (typ.)                | 200 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>160 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ ) | 20 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>16 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ )   | 40 mA( $V_{CC} = 5\text{ V}$ )                                |
| Sink Current (typ.)                  | 700 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>600 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ ) | 450 $\mu\text{A}$ ( $V_{DD} = 3\text{ V}$ )<br>400 $\mu\text{A}$ ( $V_{DD} = 1.8\text{ V}$ ) | 20 mA( $V_{CC} = 5\text{ V}$ )                                |

## 8. Products line-up for Over sea's factory which located in Malaysia and Thailand.

### Diodes

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| 1SS181          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS184          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS187          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | -    |
| 1SS190          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | -    |
| 1SS193          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS196          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS226          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS250          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 17   |
| 1SS294          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 18   |
| 1SS300          | USM          | SC-70 | SOT-323 | ◎          |          | 17   |
| 1SS301          | USM          | SC-70 | SOT-323 | ◎          |          | 17   |
| 1SS302          | USM          | SC-70 | SOT-323 | ◎          |          | 17   |
| 1SS322          | USM          | SC-70 | SOT-323 | ◎          |          | 18   |

### FETs

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| 2SK208          | S-MINI       | SC-59 | SOT-346 | ◎          |          | 16   |
| 2SK209          | S-MINI       | SC-59 | SOT-346 | ◎          |          | 16   |
| 2SK879          | USM          | SC-70 | SOT-323 | ◎          |          | 16   |
| 2SK880          | USM          | SC-70 | SOT-323 | ◎          |          | 16   |

### Transistors

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| 2SA1162         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1163         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1182         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1298         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1313         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1362         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SA1586         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SA1587         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SA1588         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC2712         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC2713         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC2859         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC3265         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC3295         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC3325         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC3326         | S-MINI       | SC-59 | SOT-346 | ◎          |          | 8    |
| 2SC4116         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC4117         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC4118         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC4213         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC4666         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |
| 2SC4667         | USM          | SC-70 | SOT-323 | ◎          |          | 8    |

### BRTs

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| RN1301          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1302          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1303          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1304          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1305          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| RN1306          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1307          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1308          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1309          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1310          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1311          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN1401          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1402          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1403          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1404          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1405          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1406          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1407          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1408          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1409          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1410          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2301          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2302          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2303          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2304          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2305          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2306          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2307          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2308          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2309          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2310          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2311          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2401          | USM          | SC-70 | SOT-323 | ◎          | ◎        | 10   |
| RN2402          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2403          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2404          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2405          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2406          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2407          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2408          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2409          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN1405          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2410          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |
| RN2411          | S-MINI       | SC-59 | SOT-346 | ◎          | ◎        | 10   |

### MCDs

| Products Number | Package Name |        |         | Production |          | Page |
|-----------------|--------------|--------|---------|------------|----------|------|
|                 | Toshiba      | JEITA  | JEDEC   | Malaysia   | Thailand |      |
| HN1A01F         | SM6          | SC-74  | SOT-26  |            | ◎        | 9    |
| HN1A01FU        | US6          | SC-88A | SOT-363 |            | ◎        | 9    |
| HN1B01F         | SM6          | SC-74  | SOT-26  |            | ◎        | 9    |
| HN1B04FU        | US6          | SC-88A | SOT-363 |            | ◎        | 9    |
| HN1C01F         | SM6          | SC-74  | SOT-26  |            | ◎        | 9    |
| HN1C01FU        | US6          | SC-88A | SOT-363 |            | ◎        | 9    |
| HN1C03F         | SM6          | SC-74  | SOT-26  |            | ◎        | 9    |
| HN1D01F         | SM6          | SC-74  | SOT-26  |            | ◎        | 17   |
| HN1D01FU        | US6          | SC-88A | SOT-363 |            | ◎        | 17   |
| HN1D02F         | SM6          | SC-74  | SOT-26  |            | ◎        | 17   |
| HN1D02FU        | US6          | SC-88A | SOT-363 |            | ◎        | 17   |
| HN1D03F         | SM6          | SC-74  | SOT-26  |            | ◎        | 17   |
| HN1D03FU        | US6          | SC-88A | SOT-363 |            | ◎        | 17   |
| HN1K02FU        | US6          | SC-88A | SOT-363 |            | ◎        | 12   |
| HN1K03FU        | US6          | SC-88A | SOT-363 |            | ◎        | 12   |
| HN1L02FU        | US6          | SC-88A | SOT-363 |            | ◎        | 12   |

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| HN2D01F         | SM6          | SC-74 | SOT-26  |            | ◎        | 17   |
| HN2S01F         | SM6          | SC-74 | SOT-26  |            | ◎        | 18   |
| HN2B01F         | SM6          | SC-74 | SOT-26  |            | ◎        | -    |
| HN7G01FU        | US6          | SC-88 | SOT-363 |            | ◎        | -    |
| RN1601          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1602          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1603          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1604          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1605          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1606          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1607          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1608          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1609          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1610          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1611          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN1901          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1902          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1903          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1904          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1905          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1906          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1907          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1908          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1909          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1910          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN1911          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2601          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2602          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2603          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2604          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2605          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2606          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2607          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2608          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2609          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2610          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2611          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN2901          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2902          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2903          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2904          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2905          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2906          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2907          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2908          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2909          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2910          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN2911          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4601          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4602          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4603          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4604          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4605          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4606          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4607          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4608          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4609          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4610          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4611          | SM6          | SC-74 | SOT-26  |            | ◎        | 11   |
| RN4901          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |

| Products Number | Package Name |       |         | Production |          | Page |
|-----------------|--------------|-------|---------|------------|----------|------|
|                 | Toshiba      | JEITA | JEDEC   | Malaysia   | Thailand |      |
| RN4902          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4903          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4904          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4905          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4906          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4907          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4908          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4909          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4910          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4911          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4981          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4982          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4983          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4984          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4985          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4986          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4987          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4988          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4989          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4990          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN4991          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |
| RN49A1          | US6          | SC-88 | SOT-363 |            | ◎        | 11   |

## L-MOS

| Products Number | Package Name |        |        | Production |          | Page |
|-----------------|--------------|--------|--------|------------|----------|------|
|                 | Toshiba      | JEITA  | JEDEC  | Malaysia   | Thailand |      |
| TC4S01F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S11F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S30F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S584F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S66F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S69F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S71F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4S81F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC4SU69F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S00F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S02F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S04F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S08F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S14F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S32F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S66F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7S86F         | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET00F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET02F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET04F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET08F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET32F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SET86F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH00F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH02F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH04F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH08F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH14F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH32F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SH86F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SHU04F       | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |
| TC7SU04F        | SMV          | SC-74A | SOT-25 |            | ◎        | 24   |

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