**HIGH WITHSTAND-VOLTAGE VOLTAGE REGULATOR WITH RESET FUNCTION**

# S-87X Series

The S-87X is a series of low-power high withstand-voltage regulators with a reset function, which integrates high-precision voltage detection and voltage regulation circuits on a single chip. The S-87X Series has higher withstand-voltage characteristic and higher accuracy of detection voltage and output voltage, ±2.4% respectively. The S-87X Series has also lineups for lithium-ion battery packs.

## ■ Features

- Accuracy of output voltage: ±2.4%
  2.6V to 5.8V (0.1V step)
- Accuracy of detection voltage: ±2.4%
  (For the S-87XXXXF Series, the release voltage ±1.1%)
  2.1V to 11.3V (0.1V step)
- Low I/O voltage difference:
  0.15 V typ. at IOUT=30 mA, VOUT=5.0 V
  0.45 V typ. at IOUT=30 mA, VOUT=3.0 V
- Low current consumption: Operation: 8μA max.
  Power off : 3.5μA max. (Available for the S-87XXXXC/E/G Series)
- Wide operating voltage range: 24 V max.
- Wide operating temperature range:
  -40°C to +85°C
- Built-in delay circuit or power off circuit
- Small package: SOT-89-5
- Built-in short-circuit protection

## ■ Applications

- Constant voltage power supply or reset circuit of battery-powered equipment, VTR, camera, communications equipment and others.
- Lithium-ion secondary battery pack

## ■ Pin Assignment

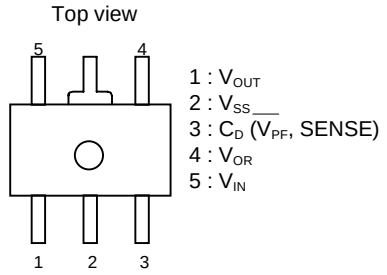



**Figure 1 Pin Assignment**

## ■ Pin Description

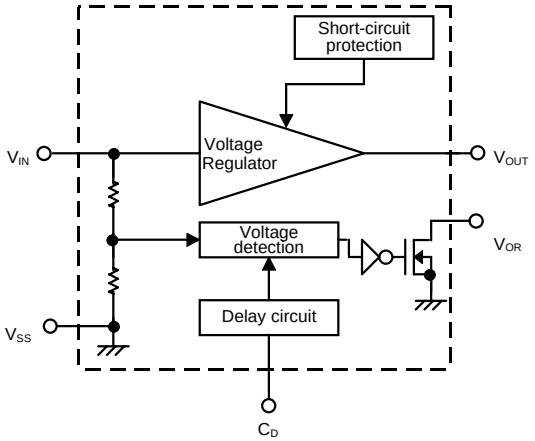
**Table 1**

| Pin No. | Name | Description |
|---|---|---|
| 1 | $V_{OUT}$ | Voltage output pin of voltage regulator |
| 2 | $V_{SS}$ | Ground |
| 3 | $C_D$ | Connection pin of external capacitor for delay of voltage detector |
| | $\overline{V_{PF}}$ | Input pin of power off circuit |
| | SENSE | Voltage monitoring pin of voltage detector |
| 4 | $V_{OR}$ | Output pin of voltage detector (Nch opendrain output) |
| 5 | $V_{IN}$ | Positive power-supply |

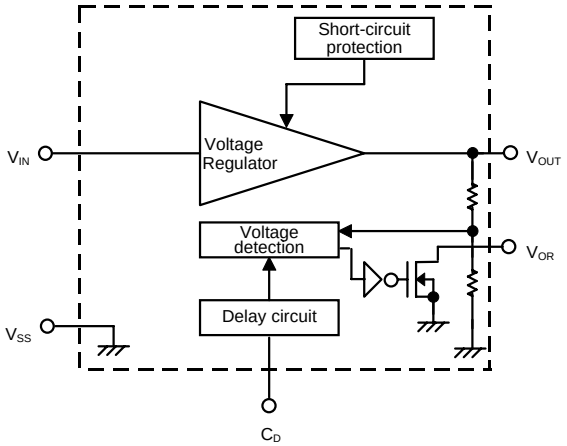
## ■ Block Diagram

1. Product Name

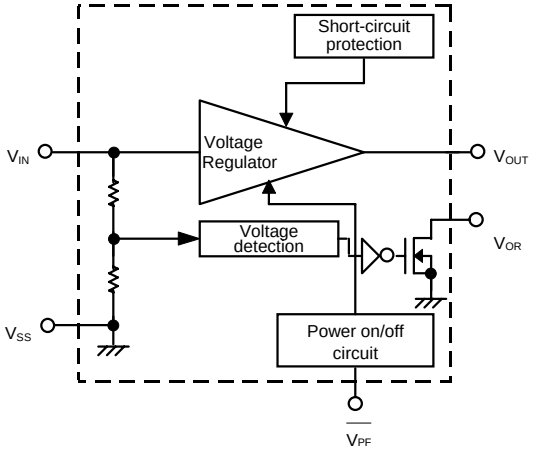
1) Built-in Delay Circuit, $V_{IN}$ Detection
(S-87XXXXA/F Series)



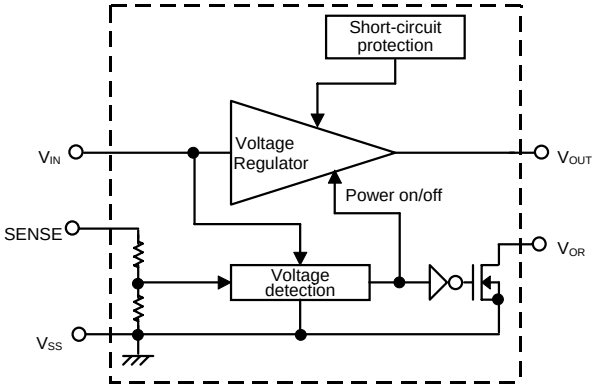

2) Built-in Delay Circuit, $V_{OUT}$ Detection
(S-87XXXXB Series)




3) Built-in power off Circuit (for regulator)
$V_{IN}$ Detection (S-87XXXXC Series)




4) Built-in Power ON/OFF (for regulator)
SENSE Detection (S-87XXXXE Series)




5) Built-in power off Circuit (for regulator)
$V_{OUT}$ Detection (S-87XXXXG Series)

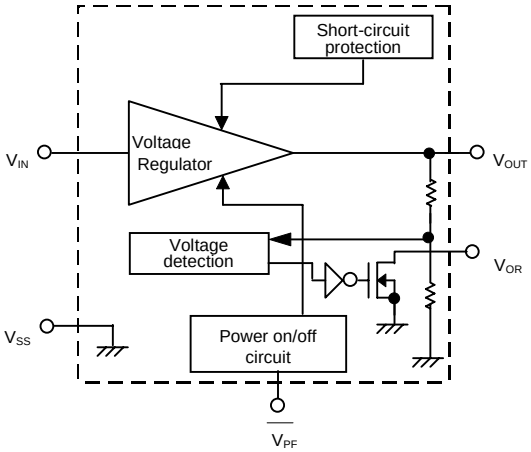



**Figure 2 Block Diagram**

## ■ Selection Guide

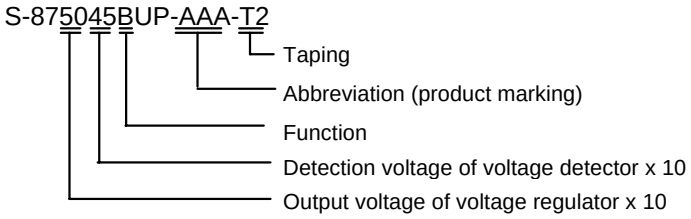
1. Series Selection

**Table 2**

| Series name | Voltage detector (VD) | Detection voltage accuracy (%) | Release voltage accuracy (%) | Built-in delay circuit | Power off function | |
|---|---|---|---|---|---|---|
| | | | | | VR | VD |
| S-87XXXXA | Detects $V_{IN}$ | ±2.4 | -- | Yes | No | No |
| S-87XXXXB | Detects $V_{OUT}$ | ±2.4 | -- | Yes | No | No |
| S-87XXXXC | Detects $V_{IN}$ | ±2.4 | -- | No | Yes | No |
| S-87XXXXE | Detects SENSE | ±2.4 | -- | No | Yes | No |
| S-87XXXXF | Detects $V_{IN}$ | -- | ±1.1 | Yes | No | No |
| S-87XXXXG | Detects $V_{OUT}$ | ±2.4 | -- | No | Yes | No |

2. Product Name

Example:




3. Product List

**Table 3**

| VR output voltage | VD detection voltage | S-87XXXXA Series | S-87XXXXB Series | S-87XXXXC Series | S-87XXXXG Series |
|---|---|---|---|---|---|
| 5.6V | 3.5V | -- | S-875635BUP-AGA-T2 | -- | |
| 5.2V | 9.4V | | | S-875294CUP-AHC-T2 | |
| 5.2V | 7.1V | -- | -- | S-875271CUP-AHA-T2 | |
| 5.2V | 5.5V | | | S-875255CUP-AHB-T2 | |
| 5.0V | 11.0V | -- | -- | S-8750B0CUP-ACG-T2 | |
| 5.0V | 7.7V | -- | -- | S-875077CUP-ACF-T2 | |
| 5.0V | 6.1V | -- | -- | S-875061CUP-ACH-T2 | |
| 5.0V | 4.5V | S-875045AUP-AAA-T2 | S-875045BUP-ABA-T2 | S-875045CUP-ACA-T2 | |
| 5.0V | 4.3V | S-875043AUP-AAB-T2 | S-875043BUP-ABB-T2 | S-875043CUP-ACB-T2 | |
| 5.0V | 4.1V | S-875041AUP-AAC-T2 | S-875041BUP-ABC-T2 | S-875041CUP-ACC-T2 | |
| 5.0V | 3.9V | S-875039AUP-AAD-T2 | S-875039BUP-ABD-T2 | S-875039CUP-ACD-T2 | |
| 5.0V | 3.7V | S-875037AUP-AAE-T2 | S-875037BUP-ABE-T2 | S-875037CUP-ACE-T2 | S-875037GUP-ANE-T2 |
| 3.3V | 6.1V | -- | -- | S-873361CUP-AOH-T2 | |
| 3.3V | 2.5V | -- | S-873325BUP-ALA-T2 | -- | |
| 3.0V | 6.9V | -- | -- | S-873069CUP-AFF-T2 | |
| 3.0V | 5.9V | -- | -- | S-873059CUP-AFG-T2 | |
| 3.0V | 2.5V | S-873025AUP-ADA-T2 | S-873025BUP-AEA-T2 | S-873025CUP-AFA-T2 | |
| 3.0V | 2.4V | S-873024AUP-ADB-T2 | S-873024BUP-AEB-T2 | S-873024CUP-AFB-T2 | |
| 3.0V | 2.3V | S-873023AUP-ADC-T2 | S-873023BUP-AEC-T2 | S-873023CUP-AFC-T2 | |
| 3.0V | 2.2V | S-873022AUP-ADD-T2 | S-873022BUP-AED-T2 | S-873022CUP-AFD-T2 | |
| 3.0V | 2.1V | S-873021AUP-ADE-T2 | S-873021BUP-AEE-T2 | S-873021CUP-AFE-T2 | |

| VR output voltage | VD detection voltage | S-87XXXXE Series |
|---|---|---|
| 5.0V | 7.7V | S-875077EUP-AJF-T2 |
| 5.0V | 6.1V | S-875061EUP-AJH-T2 |
| 3.3V | 3.0V | S-873330EUP-APB-T2 |
| 3.0V | 8.2V | S-873082EUP-AMC-T2 |
| 3.0V | 6.2V | S-873062EUP-AMB-T2 |

| VR output voltage | VD detection voltage | S-87XXXXE Series |
|---|---|---|
| VR output voltage | VD detection voltage | S-87XXXXF Series |
| 5.0V | 8.7V | S-875087FUP-AKA-T2 |

**Note** In the S-87XXXXB/S-87XXXXG Series, When the output voltage of the voltage regulator is close to the detection voltage of the voltage detector, the transient response of the voltage regulator may cause false detection. Please take transient response into account when deciding voltages.

## ■ Absolute Maximum Ratings

**Table 4**

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Input voltage * | $V_{IN}$, $V_{PF}$ | 26 | V |
| Output voltage | $V_{OUT}$ | $V_{IN}$+0.3 to $V_{SS}$-0.3 | V |
| Output voltage of voltage detector | $V_{OR}$ | $V_{SS}$-0.3 to 26 | V |
| Power dissipation | $P_D$ | 500 | mW |
| Operating temperature | $T_{opr}$ | -40 to +85 | °C |
| Storage temperature | $T_{stg}$ | -40 to +125 | °C |

* Even pulse (msec) noise exceeding the above input voltage (26 V) may damage the IC. Observe the rated input voltage (26 V).

## ■ Electrical Characteristics

1. S-8750XXA/B Series

**Table 5**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA | | 4.88 | 5.00 | 5.12 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7 V<br>$I_{OUT}$=50 µA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.38 | ±1.52 | mV/°C | 1 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Delay time*1 | $t_{pd}$ | $C_D$=4.7 nF | | 15 | 27 | 41 | ms | 3 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-875045A/B | | 4.392 | 4.50 | 4.608 | V | 2 |
| | | S-875043A/B | | 4.196 | 4.30 | 4.404 | V | 2 |
| | | S-875041A/B | | 4.001 | 4.10 | 4.199 | V | 2 |
| | | S-875039A/B | | 3.806 | 3.90 | 3.994 | V | 2 |
| | | S-875037A/B | | 3.611 | 3.70 | 3.789 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | µA | 4 |
| Hysteresis width | $V_{HYS}$ | S-875045A/B | | $-V_{DET}$ ×0.01 | -- | $-V_{DET}$ ×0.025 | V | 2 |
| | | S-875043A/B, 41A/B, 39A/B, 37A/B | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption*2 | $I_{SS}$ | $V_{IN}$=7 V, Unloaded | | -- | 3 | 8 | mA | 5 |

*1 tpd (ms)=(3.18 min.,5.74 typ., 8.73 max.)×CD (nF)

*2 Excluding the charging current of CD

2. S-8730XXA/B Series

**Table 6**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA | | 2.928 | 3.000 | 3.072 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5 V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.23 | ±0.92 | mV/°C | 1 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Delay time*1 | $t_{pd}$ | $C_D$=4.7 nF | | 15 | 27 | 41 | ms | 3 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.3 | ±1.2 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-873025A/B | | 2.440 | 2.500 | 2.560 | V | 2 |
| | | S-873024A/B | | 2.342 | 2.400 | 2.458 | V | 2 |
| | | S-873023A/B | | 2.244 | 2.300 | 2.356 | V | 2 |
| | | S-873022A/B | | 2.147 | 2.200 | 2.253 | V | 2 |
| | | S-873021A/B | | 2.049 | 2.100 | 2.151 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | $V_{DS}$=0.5 V | $V_{IN}$=2.4 V*3 | 1.50 | 2.60 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | μA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption*2 | $I_{SS}$ | $V_{IN}$=5 V, Unloaded | | -- | 3 | 8 | μA | 5 |

*1 tpd (ms)=(3.18 min.,5.74 typ., 8.73 max.)×CD (nF)

*2 Excluding the charging current of CD

*3 S-873025A/B only

3. S-875635B

**Table 7**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard | | | Unit | Test |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | | cir. |
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7.6 V, $I_{OUT}$=30 mA | | 5.465 | 5.60 | 5.735 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6.6 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7.6 V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7.6 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.43 | ±1.72 | mV/°C | 1 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Delay time*1 | $t_{pd}$ | $C_D$=4.7 nF | | 15 | 27 | 41 | ms | 3 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.3 | ±1.2 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | | | 3.416 | 3.50 | 3.584 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | $V_{DS}$=0.5 V | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | μA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption*2 | $I_{SS}$ | $V_{IN}$=7.6 V, Unloaded | | -- | 4 | 8 | μA | 5 |

*1 tpd (ms)=(3.18 min.,5.74 typ., 8.73 max.)×CD (nF)

*2 Excluding the charging current of CD

4. S-873325B

**Table 8**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard | | | Unit | Test |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | | cir. |
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5.3 V, $I_{OUT}$=30 mA | | 3.220 | 3.300 | 3.380 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4.3 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5.3 V<br>$I_{OUT}$=50 µA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5.3 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.25 | ±1.00 | mV/°C | 1 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Delay time*1 | $t_{pd}$ | $C_D$=4.7 nF | | 15 | 27 | 41 | ms | 3 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.2 | ±0.8 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | | | 2.440 | 2.500 | 2.560 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | µA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption*2 | $I_{SS}$ | $V_{IN}$=5.3 V, Unloaded | | -- | 4 | 8 | µA | 5 |

*1 tpd (ms)=(3.18 min.,5.74 typ., 8.73 max.)×CD (nF)

*2 Excluding the charging current of CD

5. S-875294C

**Table 9**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=14.4V, $I_{OUT}$=30 mA | | 5.075 | 5.20 | 5.325 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6 .2to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=14.4V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=14.4V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.40 | ±1.60 | mV/°C | 1 |
| Power off output voltage | $V_{OUTOFF}$ | $V_{IN}$=14.4V,<br>$\overline{V_{PF}}$="L" $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.7 | ±2.0 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-875294C | | 9.174 | 9.40 | 9.626 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | μA | 4 |
| Hysteresis width | $V_{HYS}$ | S-875271C | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=14.4V, Unloaded | | -- | 4 | 9 | μA | 5 |
| | Iof | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=14.4V | | -- | 1.5 | 4.7 | μA | 5 |
| **Input Voltage** | | | | | | | | |
| Power on/off input voltage | $V_{IL}$ | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=14.4V | | -- | -- | 0.4 | V | 6 |
| | $V_{IH}$ | $\overline{V_{PF}}$="H": Power on,<br>$V_{IN}$=14.4V | | 2.6 | -- | -- | V | 6 |

6. S-8752XXC

**Table 10**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7.2 V, $I_{OUT}$=30 mA | | 5.075 | 5.20 | 5.325 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6.2 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7.2 V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7.2 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.40 | ±1.60 | mV/°C | 1 |
| Power off output voltage | $V_{OUTOFF}$ | $V_{IN}$=7.2V,<br>$\overline{V_{PF}}$="L" $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | S-875271C | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| | | | S-875255C | -- | ±0.4 | ±1.6 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-875271C | | 6.929 | 7.10 | 7.271 | V | 2 |
| | | S-875255C | | 5.368 | 5.50 | 5.632 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | μA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=7.2 V, Unloaded | | -- | 4 | 8 | μA | 5 |
| | Iof | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=7.2 V | | -- | 1.5 | 3.5 | μA | 5 |
| **Input Voltage** | | | | | | | | |
| Power on/off input voltage | $V_{IL}$ | $\overline{V_{PF}}$="L": Power off, $V_{IN}$=7.2 V | | -- | -- | 0.4 | V | 6 |
| | $V_{IH}$ | $\overline{V_{PF}}$="H": Power on,<br>$V_{IN}$=7.2 V | | 2.0 | -- | -- | V | 6 |

7. S-8750XXC/G Series

**Table 11**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA | | 4.88 | 5.00 | 5.12 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7 V<br>$I_{OUT}$=50 µA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.38 | ±1.52 | mV/°C | 1 |
| Power off output voltage | $V_{OUTOFF}$ | $V_{IN}$=7 V,<br>$\overline{V_{PF}}$="L" $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | S-8750B0C | -- | ±0.8 | ±3.2 | mV/°C | 2 |
| | | | S-875077C | -- | ±0.6 | ±2.4 | mV/°C | 2 |
| | | | S-875061C,45C, 43C, 41C,39C,37C/G | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-8750B0C | | 10.736 | 11.00 | 11.264 | V | 2 |
| | | S-875077C | | 7.515 | 7.70 | 7.885 | V | 2 |
| | | S-875061C | | 5.953 | 6.10 | 6.247 | V | 2 |
| | | S-875045C | | 4.392 | 4.50 | 4.608 | V | 2 |
| | | S-875043C | | 4.196 | 4.30 | 4.404 | V | 2 |
| | | S-875041C | | 4.001 | 4.10 | 4.199 | V | 2 |
| | | S-875039C | | 3.806 | 3.90 | 3.994 | V | 2 |
| | | S-875037C/G | | 3.611 | 3.70 | 3.789 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V<br>(S-8750B0C:$V_{IN}$=15 V) | | -- | -- | 0.1 | µA | 4 |
| Hysteresis width | $V_{HYS}$ | S-875045C | | $-V_{DET}$ ×0.01 | -- | $-V_{DET}$ ×0.025 | V | 2 |
| | | S-875043C, 41C, 39C, 37C/G, B0C,77C,61C | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=7 V<br>Unloaded | S-8750B0C,77C,61C | -- | 4 | 8 | µA | 5 |
| | | | S-875045C,43C, 41C,39C,37C/G | -- | 3 | 8 | µA | 5 |
| | Iof | $\overline{V_{PF}}$="L": Power off, $V_{IN}$=7 V | | -- | 1.5 | 3.5 | µA | 5 |
| **Input Voltage** | | | | | | | | |
| Power on/off input voltage | $V_{IL}$ | $\overline{V_{PF}}$="L": Power off, $V_{IN}$=7 V | | -- | -- | 0.4 | V | 6 |
| | $V_{IH}$ | $\overline{V_{PF}}$="H": Power on, $V_{IN}$=7 V | | 2.0 | -- | -- | V | 6 |

8. S-873361C Series

**Table 12**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard | | | Unit | Test |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | | cir. |
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5.3V, $I_{OUT}$=30 mA | | 3.220 | 3.300 | 3.380 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4.3Vto 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5.3V<br>$I_{OUT}$=50 µA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5.3V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.25 | ±1.00 | mV/°C | 1 |
| Power off output voltage | $V_{OUTOFF}$ | $V_{IN}$=14.4V,<br>$\overline{V_{PF}}$="L" $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-873361C | | 5.953 | 6.100 | 6.247 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | µA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=5.3V, Unloaded | | -- | 4 | 8 | µA | 5 |
| | Iof | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=5.3V | | -- | 1.5 | 3.5 | µA | 5 |
| **Input Voltage** | | | | | | | | |
| Power on/off input voltage | $V_{IL}$ | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=5.3V | | -- | -- | 0.4 | V | 6 |
| | $V_{IH}$ | $\overline{V_{PF}}$="H": Power on,<br>$V_{IN}$=5.3V | | 2.0 | -- | -- | V | 6 |

9. S-8730XXC Series

**Table 13**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA | | 2.928 | 3.000 | 3.072 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5 V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.23 | ±0.92 | mV/°C | 1 |
| Power off output voltage | $V_{OUTOFF}$ | $V_{IN}$=5 V,<br>$\overline{V_{PF}}$="L" $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of $-V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta= -40°C to +85°C | S-873069C | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| | | | S-873025C, 24C,23C,22C, 21C, | -- | ±0.3 | ±1.2 | mV/°C | 2 |
| Detection voltage | $-V_{DET}$ | S-873069C | | 6.734 | 6.900 | 7.066 | V | 2 |
| | | S-873025C | | 2.440 | 2.500 | 2.560 | V | 2 |
| | | S-873024C | | 2.342 | 2.400 | 2.458 | V | 2 |
| | | S-873023C | | 2.244 | 2.300 | 2.356 | V | 2 |
| | | S-873022C | | 2.147 | 2.200 | 2.253 | V | 2 |
| | | S-873021C | | 2.049 | 2.100 | 2.151 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V* | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V** | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=10 V | | -- | -- | 0.1 | mA | 4 |
| Hysteresis width | $V_{HYS}$ | | | $-V_{DET}$ ×0.03 | -- | $-V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=5 V, Unloaded | | -- | 3 | 8 | mA | 5 |
| | Iof | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=5 V | | -- | 1.5 | 3.5 | mA | 5 |
| **Input Voltage** | | | | | | | | |
| Power on/off input voltage | $V_{IL}$ | $\overline{V_{PF}}$="L": Power off,<br>$V_{IN}$=5 V | | -- | -- | 0.4 | V | 6 |
| | $V_{IH}$ | $\overline{V_{PF}}$="H": Power on,<br>$V_{IN}$=5 V | | 2.0 | -- | -- | V | 6 |

* For only S-873069C and S-873025C

** For only S-873069C

10. S-8750XXE Series

**Table 14**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | 4.88 | 5.00 | 5.12 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA SENSE=-$V_{DET}$ Typ.+2V | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6 to 24 V $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7 V, SENSE=-$V_{DET}$ Typ.+2V $I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA, Ta=-40°C to +85°C, SENSE=-$V_{DET}$ Typ.+2V | | -- | ±0.38 | ±1.52 | mV/°C | 1 |
| Output voltage during voltage detection | $V_{OUTOFF}$ | $V_{IN}$=-$V_{DET}$ Typ.-1V $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of -$V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C | S-875077E | -- | ±0.6 | ±2.4 | mV/°C | 2 |
| | | to +85°C | S-875061E | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| Detection voltage | -$V_{DET}$ | S-875077E | | 7.515 | 7.70 | 7.885 | V | 2 |
| | | S-875061E | | 5.953 | 6.10 | 6.247 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch $V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch $V_{DS}$=24 V, $V_{IN}$=-$V_{DET}$ Typ.+2V | | -- | -- | 0.1 | μA | 4 |
| SENSE pin input current | $I_{SENSE}$ | $V_{IN}$=7V SENSE=-$V_{DET}$ Typ.+2V | S-875077E | -- | 0.6 | 1.7 | μA | 7 |
| | | | S-875061E | -- | 0.7 | 1.8 | μA | 7 |
| Hysteresis width | $V_{HYS}$ | | | -$V_{DET}$ ×0.03 | -- | -$V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=-$V_{DET}$ Typ.+2V Unloaded | S-875077E | -- | 4 | 8 | μA | 5 |
| | | | S-875061E | -- | 4 | 9 | μA | 5 |
| | Iof | $V_{IN}$=-$V_{DET}$ Typ.-1V: Power off | | -- | 1.5 | 3.5 | μA | 5 |

Unless otherwise specified, connect the SENSE pin to $V_{IN}$.

11. S-873330E Series

**Table 15**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5.3 V, $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | 3.220 | 3.300 | 3.380 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA SENSE=-$V_{DET}$ Typ.+2V | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4.3 to 24 V $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5.3 V, SENSE=-$V_{DET}$ Typ.+2V $I_{OUT}$=50 µA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5.3 V, $I_{OUT}$=30 mA, Ta=-40°C to +85°C, SENSE=-$V_{DET}$ Typ.+2V | | -- | ±0.25 | ±1.00 | mV/°C | 1 |
| Output voltage during voltage detection | $V_{OUTOFF}$ | $V_{IN}$=-$V_{DET}$ Typ.-1V $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of -$V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.2 | ±0.8 | mV/°C | 2 |
| Detection voltage | -$V_{DET}$ | | | 2.928 | 3.000 | 3.072 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch $V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch $V_{DS}$=24 V, $V_{IN}$=-$V_{DET}$ Typ.+2V | | -- | -- | 0.1 | µA | 4 |
| SENSE pin input current | $I_{SENSE}$ | $V_{IN}$=5.3V SENSE=-$V_{DET}$ Typ.+2V | | -- | 0.5 | 1.3 | µA | 7 |
| Hysteresis width | $V_{HYS}$ | | | -$V_{DET}$ ×0.03 | -- | -$V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=-$V_{DET}$ Typ.+2V Unloaded | | -- | 4 | 8 | µA | 5 |
| | Iof | $V_{IN}$=-$V_{DET}$ Typ.-1V: Power off | | | 1.5 | 3.5 | µA | 5 |

12. S-8730XXE Series

**Table 16**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | 2.928 | 3.000 | 3.072 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA SENSE=-$V_{DET}$ Typ.+2V | | -- | 0.45 | 0.70 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=4 to 24 V $I_{OUT}$=30 mA, SENSE=-$V_{DET}$ Typ.+2V | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=5 V, SENSE=-$V_{DET}$ Typ.+2V $I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp.coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=5 V, $I_{OUT}$=30 mA, Ta=-40°C to +85°C, SENSE=-$V_{DET}$ Typ.+2V | | -- | ±0.23 | ±0.92 | mV/°C | 1 |
| Output voltage during voltage detection | $V_{OUTOFF}$ | $V_{IN}$=-$V_{DET}$ Typ.-1V $R_L$=1 MΩ | | -- | -- | 0.1 | V | 6 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Temp. characteristic of -$V_{DET}$ | $\frac{\Delta -V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | S-873082E | -- | ±0.6 | ±2.4 | mV/°C | 2 |
| | | | S-873062E | -- | ±0.5 | ±2.0 | mV/°C | 2 |
| Detection voltage | -$V_{DET}$ | S-873082E | | 8.003 | 8.200 | 8.397 | V | 2 |
| | | S-873062E | | 6.051 | 6.200 | 6.349 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch $V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch $V_{DS}$=24 V, $V_{IN}$=-$V_{DET}$ Typ.+2V | | -- | -- | 0.1 | μA | 4 |
| SENSE pin input current | $I_{SENSE}$ | $V_{IN}$=5V SENSE=-$V_{DET}$Typ.+2V | S-873082E | -- | 0.6 | 1.7 | μA | 7 |
| | | | S-873062E | -- | 0.6 | 1.8 | μA | 7 |
| Hysteresis width | $V_{HYS}$ | | | -$V_{DET}$ ×0.03 | -- | -$V_{DET}$ ×0.08 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption | $I_{SS}$ | $V_{IN}$=-$V_{DET}$ Typ.+2V | Unloaded | -- | 4 | 8 | μA | 5 |
| | Iof | $V_{IN}$=-$V_{DET}$ Typ.-1V: | Power off | -- | 1.5 | 3.5 | μA | 5 |

Unless otherwise specified, connect the SENSE pin to $V_{IN}$.

13. S-875087F

**Table 17**

(Unless otherwise specified: Ta=25°C)

| Parameter | Symbol | Conditions | | Standard Min. | Standard Typ. | Standard Max. | Unit | Test cir. |
|---|---|---|---|---|---|---|---|---|
| **Voltage Regulator** | | | | | | | | |
| Output voltage | $V_{OUT}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA | | 4.88 | 5.00 | 5.12 | V | 1 |
| I/O voltage difference | $V_{dif}$ | $I_{OUT}$=30 mA | | -- | 0.15 | 0.40 | V | 1 |
| Line regulation | $\Delta V_{OUT1}$ | $V_{IN}$=6 to 24 V<br>$I_{OUT}$=30 mA | | -- | 15 | 50 | mV | 1 |
| Load regulation | $\Delta V_{OUT2}$ | $V_{IN}$=7 V<br>$I_{OUT}$=50 μA to 40 mA | | -- | 15 | 50 | mV | 1 |
| Input voltage | $V_{IN}$ | | | -- | -- | 24 | V | 1 |
| Temp. coefficient of $V_{OUT}$ | $\frac{\Delta V_{OUT}}{\Delta Ta}$ | $V_{IN}$=7 V, $I_{OUT}$=30 mA,<br>Ta=-40°C to +85°C | | -- | ±0.38 | ±1.52 | mV/°C | 1 |
| **Voltage Detector** | | | | | | | | |
| Operating voltage | $V_{SEN}$ | | | 1.3 | -- | 24 | V | 2 |
| Delay time*1 | $t_{pd}$ | $C_D$=4.7 nF | | 15 | 27 | 41 | ms | 3 |
| Release voltage vs Temperature | $\frac{\Delta +V_{DET}}{\Delta Ta}$ | Ta=-40°C to +85°C | | -- | ±0.7 | ±2.8 | mV/°C | 2 |
| Release voltage (Overcharge detection voltage) | $+V_{DET}$ | | | 8.600 | 8.700 | 8.800 | V | 2 |
| Sink current | $I_{DOUT}$ | Nch<br>$V_{DS}$=0.5 V | $V_{IN}$=1.3 V | 0.25 | 0.60 | -- | mA | 4 |
| | | | $V_{IN}$=2.4 V | 1.50 | 2.60 | -- | mA | 4 |
| | | | $V_{IN}$=3.6 V | 3.00 | 4.50 | -- | mA | 4 |
| Leakage current | $I_{LEAK}$ | Nch<br>$V_{DS}$=24 V, $V_{IN}$=15 V | | -- | -- | 0.1 | μA | 4 |
| Hysteresis width | $V_{HYS}$ | | | 0.085 | -- | 0.215 | V | 2 |
| **Input Current** | | | | | | | | |
| Current consumption*2 | $I_{SS}$ | $V_{IN}$=7 V, Unloaded | | -- | 4 | 8 | μA | 5 |

*1 tpd (ms)=(3.18 min.,5.74 typ., 8.73 max.)×CD (nF)

*2 Excluding the charging current of CD

## ■ Test Circuits

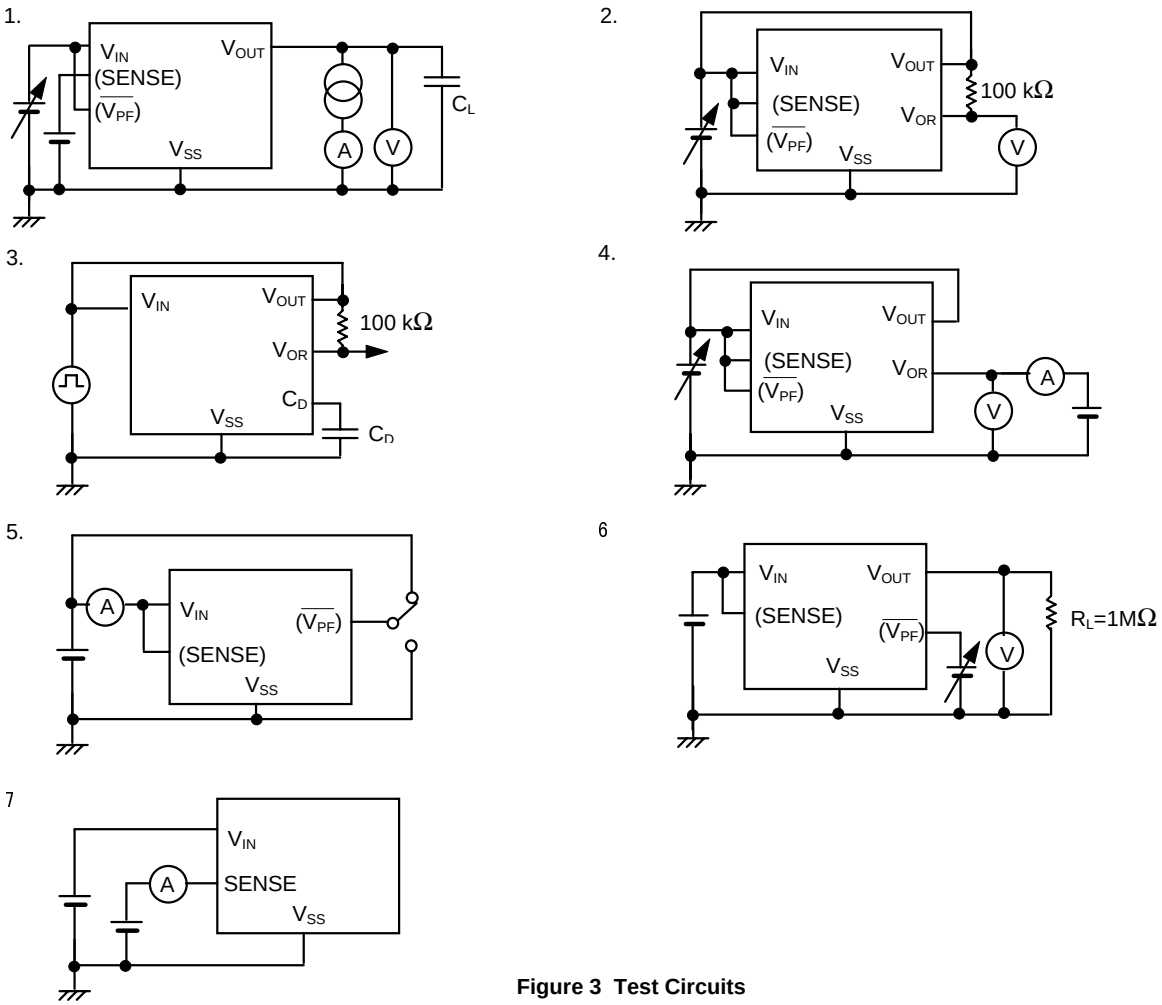



**Figure 3 Test Circuits**

## ■ Technical Terms

- I/O Voltage Difference ($V_{dif}$)
  $V_{dif} = V_{IN1} - V_{OUT1}$
  $V_{OUT1}$: Initial output voltage
  $V_{IN1}$: Input voltage which generates an output voltage ($V_{OUT2}$) decreased by 5% from $V_{OUT1}$

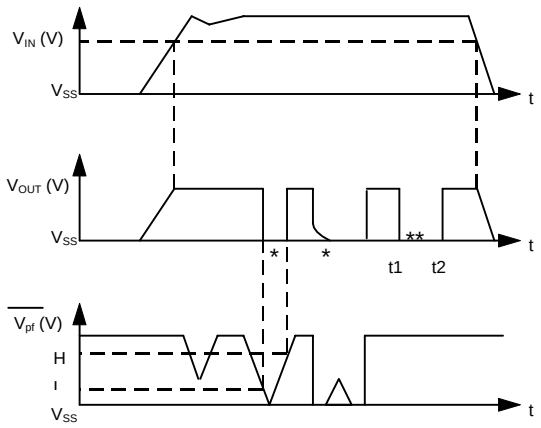
- Load Regulation ($DV_{OUT2}$)
  $DV_{OUT2} = V_{OUT1} - V_{OUT2}$
  $V_{OUT1}$: Output voltage when $I_{OUT}$ is 50 µA
  $V_{OUT2}$: Output voltage when $I_{OUT}$ is 40 mA

- Line Regulation ($\Delta V_{OUT1}$)
  $\Delta V_{OUT1} = V_{OUT1} - V_{OUT2}$
  $V_{OUT1}$: Output voltage when $V_{IN}$ is 24 V
  $V_{OUT2}$: Output voltage when $V_{IN}$ is ($V_{OUT}$+1) V

- Hysteresis Width ($V_{HYS}$)
  $V_{HYS} = (+V_{DET}) - (-V_{DET})$
  $+V_{DET}$ : Release voltage
  $-V_{DET}$ : Detection voltage

## ■ Operation Timing Charts

1. Voltage Regulator (S-87XXXXC/G Series)




* Indicates power off state. When the load current ($I_{OUT}$) is less than 1 μA, the $V_{OUT}$ is not always $V_{SS}$ level.
** When the $V_{OUT}$ is shorted at t1, $V_{OUT}$ becomes $V_{SS}$ level. When the short of $V_{OUT}$ is removed at t2, $V_{OUT}$ returns to normal output.

**Figure 4**

2. Voltage Detector (S-87XXXXA/B/F Series)

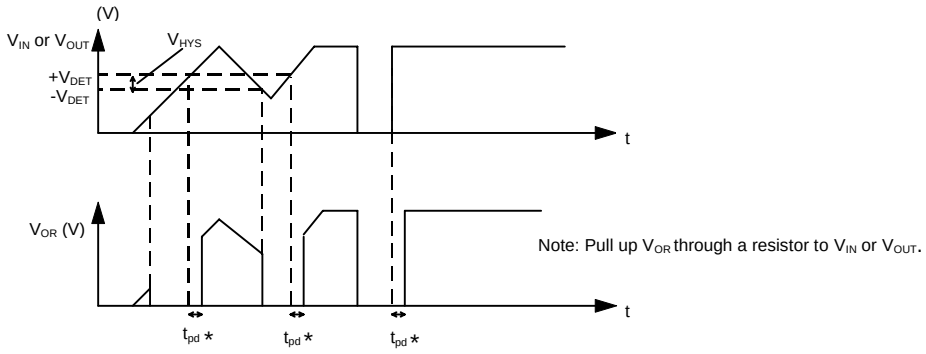
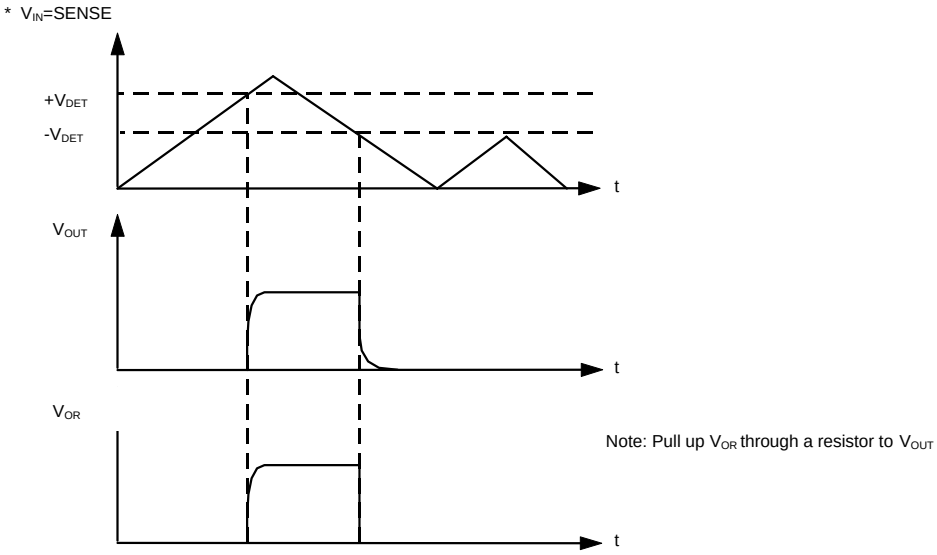



**Figure 5**

* Output delay time (tpd) of the voltage detector can be changed with an external capacitance value to CD pin.
** Delay circuit is not included in S-87XXXXC/G Series.

3. S-87XXXXE Series




* The SENSE is connected to $V_{IN}$.

**Figure 6**

## ■ Operation

1. Reference Voltage Circuit

   The reference voltage circuit operates all the time when the voltage is applied to $V_{IN}$ and is not affected by the $\overline{V_{PF}}$ signal.

2. Voltage Regulator

   Figure 7 shows the voltage regulator circuit. The S-87X Series has a Pch MOS transistor as the output control transistor.

   Reverse current may break IC if $V_{OUT}$ potential is higher than $V_{IN}$, because a parasitic diode is formed between $V_{IN}$ and $V_{OUT}$ due to the structure of the control transistor. Therefore, keep $V_{OUT}$ lower than $V_{IN}$+0.3 V.

   The output voltage of the voltage regulator can be selected as follows :

   2.6V to 5.8V ±2.4% (0.1V step)

   **Note** For an application with a load current of less than 1 μA, the leakage current of the control transistor M1 increases the output voltage.

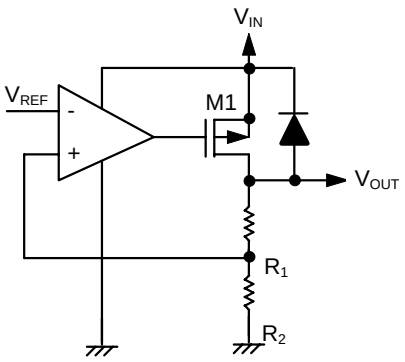



**Figure 7 Voltage Regulator**

3. Short-circuit Protection Circuit

   The S-87X Series has a built-in short-circuit protection circuit to protect the element from break caused by a large current in case of a short circuit. The output short current is internally limited to approx. 70 mA. Short-circuit protection circuit has three kinds characteristics according to VIN (input voltage) as shown in Figure 8.

At 5-V Output:

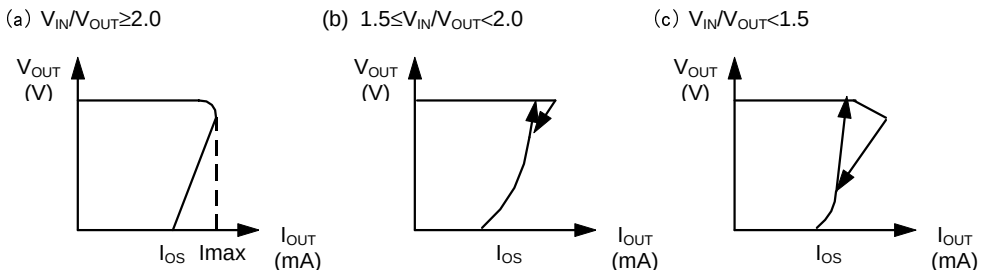



**Figure 8**

**Note:** Use a voltage regulator under the specified power dissipation of the package.

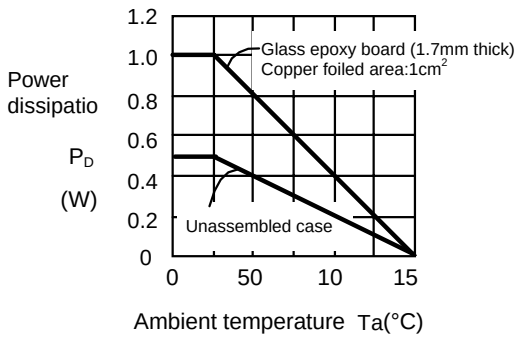



**Figure 9 Power Dissipation of Package**

4. Delay Circuit

The delay circuit outputs voltage detector output ($V_{OR}$) with delay after the voltage at $V_{IN}$ pin has become release voltage ($+V_{DET}$) at the rising of $V_{IN}$ pin.

In Fig. 9, when Vcd exceeds the reference voltage (Vref), the output voltage pin $V_{OR}$ changes from low to high level, providing delay output. When the voltage at $V_{IN}$ pin falls under the detection voltage ( $-V_{DET}$), the $N_2$ transistor turns ON, therefore the charge of $C_D$ is rapidly discharged and the voltage detector output ($V_{OR}$) changes from high to low level without delay.

The external capacitor ($C_D$) is charged with constant current, and is practically independent of $V_{IN}$ voltage. Its delay time ($t_{pd}$) is expressed by the following equation:

$t_{pd}$ (ms)=Delay coefficient (3.18 min., 5.74 typ., 8.73 max.)×$C_D$ (nF)

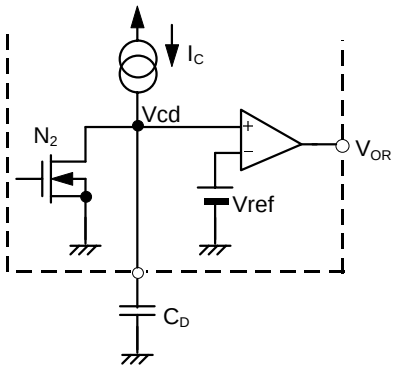



**Figure 10 Delay**

**Note** · Unless an output delay is needed, keep $C_D$ pin open. Do not apply external voltage other than ground potential to $C_D$ pins, which may cause IC breakdown.

· When designing your printed-circuit board layout, take care that no leakage current flows to the external capacitor ($C_D$), otherwise the correct delay time may not be obtained. Because the value of the constant current source $I_C$ is only 195 nA, $C_D$ to impedance is high.

5. Voltage Detection Circuit

The built-in voltage detection circuit (Nch opendrain type) is equivalent to our S-808/809 Series voltage detectors. A pull-up resistor of about 100 kΩ is required for output. Since the comparator power of this circuit is supplied from $V_{IN}$ pin, this circuit operates while voltage is applied to $V_{IN}$ pin.

The detection voltage of the voltage detector can be selected as follows :

2.1 V to 11.3 V ±2.4% (0.1V step)

In the S-87XXXXF Series, the release voltage ($+V_{DET}$) accuracy is±1.1%. So, it responds to the application for overcharge detection of lithium-ion battery packs.

In the S-87XXXXE Series, the input voltage monitoring pin of the voltage detector is externally connected as the SENSE pin. Because this pin is configured by a resistor only, temporary current such as a through-type current does not flow. Consequently, even when resistor $R_{IN}$ is inserted between input power supply and $V_{IN}$ pin, the input power voltage can be accurately monitored by connecting the SENSE pin to the input power supply. Also, when a drop in the SENSE pin input voltage is detected, the voltage detector generates a reset signal. At the same time, it powers off the voltage regulator.

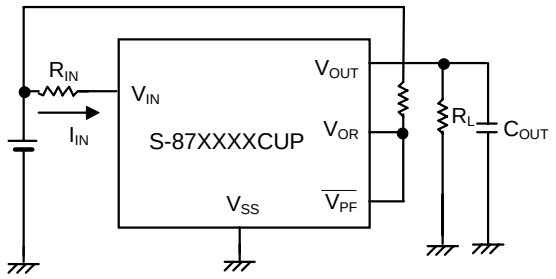
Notes: · As shown in Figure 11, when connecting $V_{OR}$ output to $\overline{V}_{PF}$ pin in the S-87XXXXC Series or connecting SENSE pin to $V_{IN}$ pin in the S-87XXXXE Series, the following phenomena occur if $R_{IN}$ is connected between input voltage and $V_{IN}$ pin. Be careful.

① At the time of voltage detection, the voltage regulator is shutdown and load current is cut. Therefore, $V_{IN}$ voltage increases by $\Delta V_{IN}= I_{IN}\times R_{IN}$, where the current flowing into $R_{IN}$ is set to $I_{IN}$. Hence, if $\Delta V_{IN}$ exceeds hysterisis width Vhys, oscillation starts immediately after detection and continues. It is necessary to set $\Delta V_{IN}$ less than Vhys.

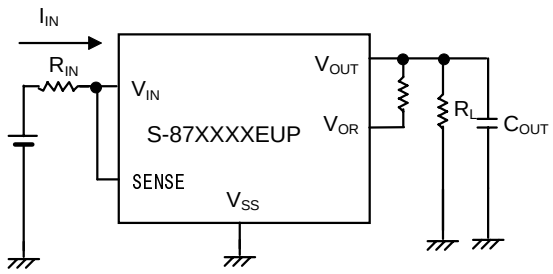
② At the time of voltage release, the voltage regulator is powered on and load current flows. Therefore, if $\Delta V_{IN}$ exceeds hysterisis width Vhys, oscillation starts immediately after release and continues. It is necessary to set $\Delta V_{IN}$ less than Vhys. Also at the time of voltage release, the rush current to charge output

capacitor Cout flows. Hence, oscillation momentarily starts until the output of regulator $V_{out}$ rises high enough even though $\Delta V_{IN}$ is set less than Vhys. But Short-circuit protection circuit controls the rush current less than Imax on fig.8. If this momentary oscillation is a problem in your applicaion, setting $R_{IN}$ less than Vhys/Imax prevents oscillation.

[Attention1]




[Attention2]



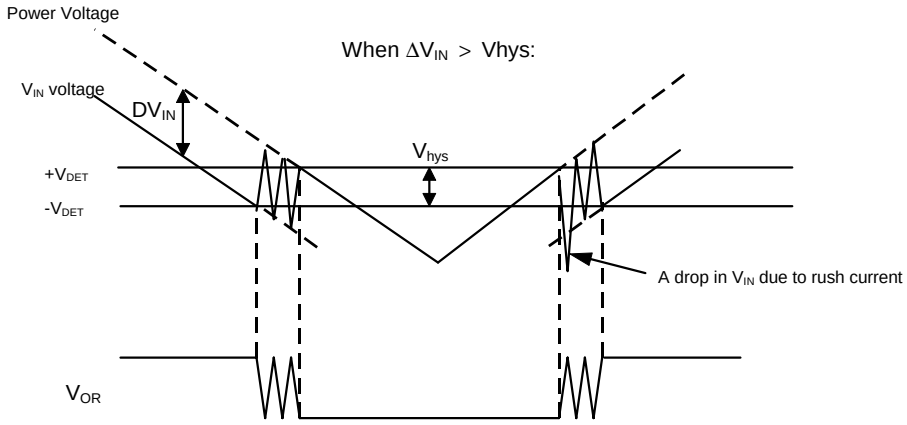




**Figure 11**

- In the S-87XXXXE series, the minimum operating voltage becomes 2.0 V as $V_{IN}$ voltage. If a drop in $V_{IN}$ voltage occurs due to load current or rush current to be charged to the output capacitor when load current or the voltage regulator is powered on at the time of release, set $V_{IN}$ to 2.0 V or more.
- Also, in the S-87XXXXE Series, when sharply increasing only $V_{IN}$ pin voltage at 1 ms/V or less, with the SENSE pin fixed to $-V_{DET} \geq V_{SENSE} \geq -V_{DET}-2V$, a release pulse is output to the output pin of voltage detector. Be careful. In this case, this release pulse is removed by setting the time constant of $V_{OR}$ pin 20ms or more with capacitance and pull-up resistance. In addition, when the voltage of SENSE pin is fixed to between the detection voltage and the release voltage at the detect condition, if sharply increasing only $V_{IN}$ pin voltage at 1 ms/V or less, the output of the detector turns to the release condition. If this action is a problem in your system, please connect SENSE pin to $V_{IN}$ pin.

6. Power off Circuit (S-87XXXXC/E/G Series)

When $\overline{V_{PF}}$ pin goes low (0.4 V or less) in the S-87XXXXC/G Series or at the time of voltage detection in the S-87XXXXE series, current for the voltage regulator is shut down, the current consumption (excluding the current which flows through the pull-up resistor) lowers to 3.5 μA or less.

During power off, the M1 transistor in the voltage regulator shown in the Figure 6 is off and $V_{OUT}$ pin is pulled down by R1 and R2, whose value (R1+R2) is 5MΩ to 10MΩ. Input current of $V_{PF}$ pin is 0.1μA or less.

**Notes** · The output voltage may not become 0 V when the load which makes $I_{OUT}$ under 1μA is connected during power off.

- DO NOT keep $\overline{V_{PF}}$ pin floating state or medium potential (between low and high levels). Otherwise through-type current flows.

## ■ Transient Response

An undershoot or an overshoot may occur in the output voltage of the voltage regulator if input voltage or load current fluctuates transiently. If an undershoot is large, the voltage detector operates to output reset signal in the S-87XXXXB Series in which the voltage detector detects the output voltage of the regulator. If an overshoot is large, the load circuit is adversely affected. Therefore it is important to determine the capacitor value so as to minimize undershoot and overshoot.

### 1. Line Transient Response due to Input Voltage Ffluctuation

Input voltage fluctuation differs depending on the types of the signal applied: type I which is a rectangular wave between ($V_{OUT}$ + 1) V and 10 V, and type II which is a rectangular wave from 0 V to 10 V (see Figure 12). The ringing waveforms and parameter dependency of each type are described below. The measuring circuit is shown in Figure 13 for reference, .

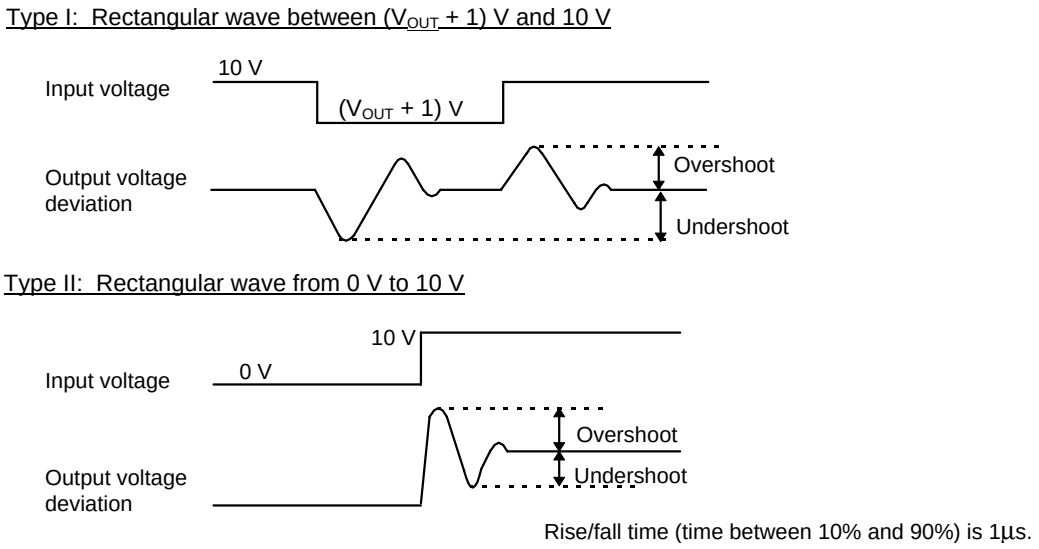



**Figure 12**

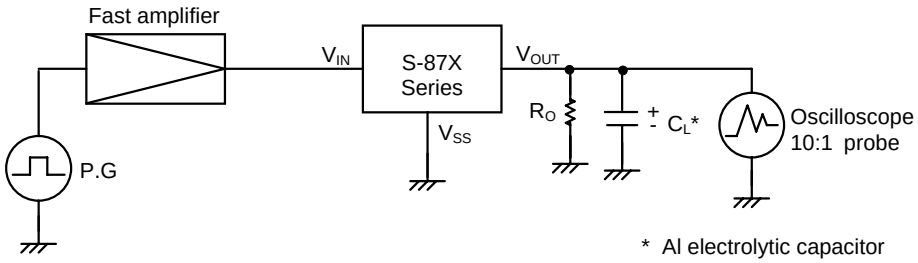



**Figure 13 Measuring Circuit**

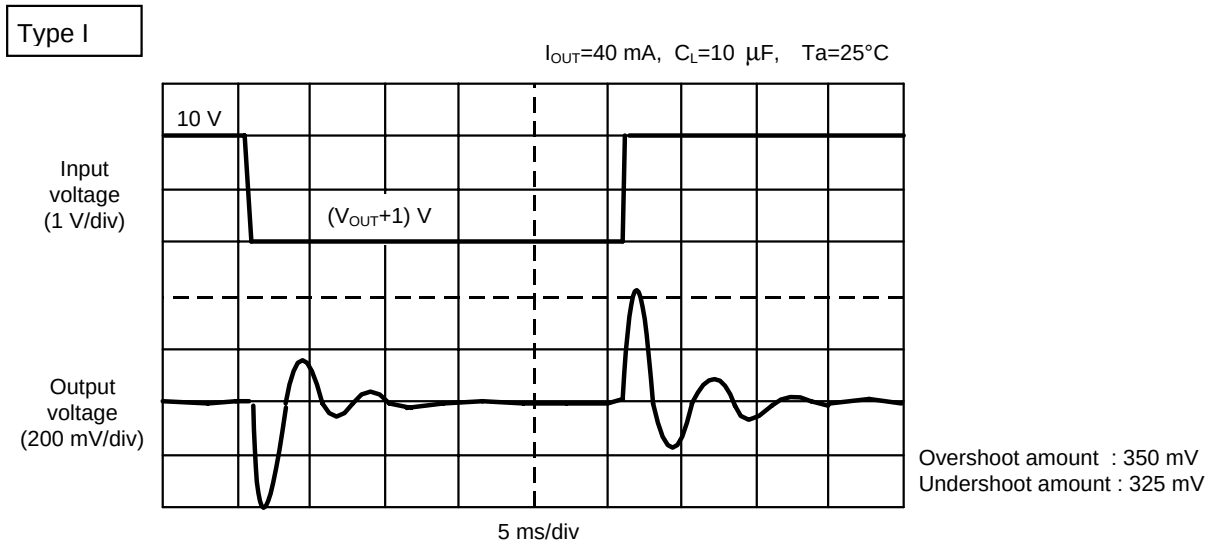



**Figure 14 Type Ⅰ Ringing Waveform**

**Table 18 Type Ⅰ Parameter Dependency**

| Series | Parameter | | Conditions | Method to decrease overshoot | Method to decrease undershoot |
|---|---|---|---|---|---|
| S-8750XXX | Load current | $I_{OUT}$ | 10 to 60 mA, $C_L$=10μF | Decrease | Decrease |
| | Load capacitance | $C_L$ | 1 to 47 μF, $I_{OUT}$=40 mA | Increase | Increase |
| | Input fluctuation | $\Delta V_{IN}$* | 2 to 4 V | Decrease | Decrease |
| | | | 4 to 18 V | Increase | Decrease |
| | Temperature | Ta | -40 °C to +85 °C | Low temperature | Low temperature |
| S-8730XXX | Load current | $I_{OUT}$ | 10 to 60 mA, $C_L$=10μF | Increase | Decrease |
| | Load capacitance | $C_L$ | 1 to 47 μF, $I_{OUT}$=40 mA | Increase | Increase |
| | Input fluctuation | $\Delta V_{IN}$* | 4 to 20 V | Increase | Decrease |
| | Temperature | Ta | -40 °C to +85 °C | Low temperature | Low temperature |

* $\Delta V_{IN}$ : High voltage value - low voltage value

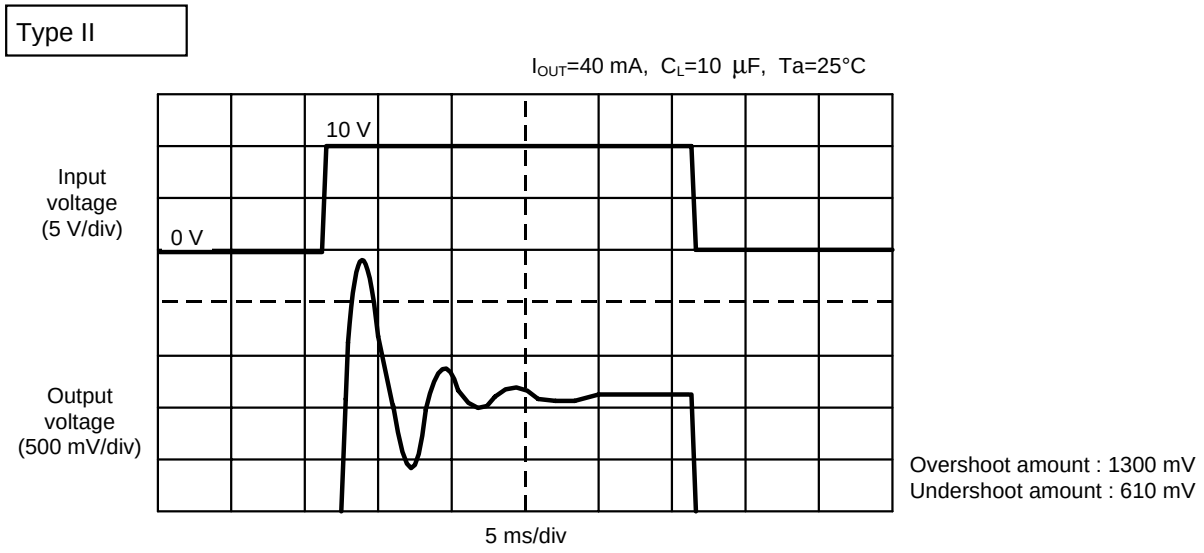



**Figure 15 Type II Ringing Waveform**

**Table 19 Type II Parameter Dependency**

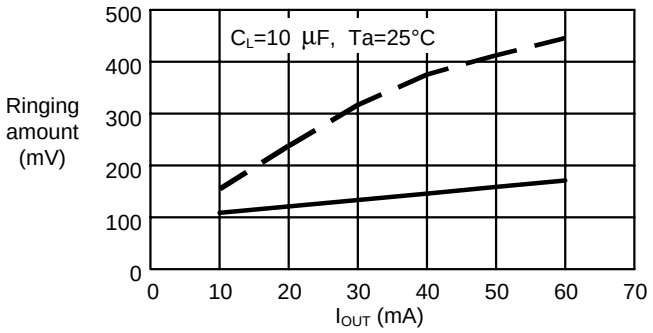
| Series | Parameter | | Conditions | Method to decrease overshoot | Method to decrease undershoot |
|---|---|---|---|---|---|
| S-8750XXX | Load current | $I_{OUT}$ | 10 to 60 mA, $C_L$=10μF | Increase | Increase |
| | Load capacitance | $C_L$ | 1 to 47 μF, $I_{OUT}$=40 mA | Decrease | Decrease |
| | Input fluctuation | $\Delta V_{IN}$* | 3 to 19 V | Increase | Increase |
| | Temperature | Ta | -40 °C to +85 °C | Low temperature | Low temperature |
| S-8730XXX | Load current | $I_{OUT}$ | 10 to 60 mA, $C_L$=10μF | Increase | Increase |
| | Load capacitance | $C_L$ | 1 to 47 μF, $I_{OUT}$=40 mA | Decrease | Decrease |
| | Input fluctuation | $\Delta V_{IN}$* | 5 to 21 V | Increase | Increase |
| | Temperature | Ta | -40 °C to +85 °C | Low temperature | Low temperature |

* $\Delta V_{IN}$: High voltage value - low voltage value

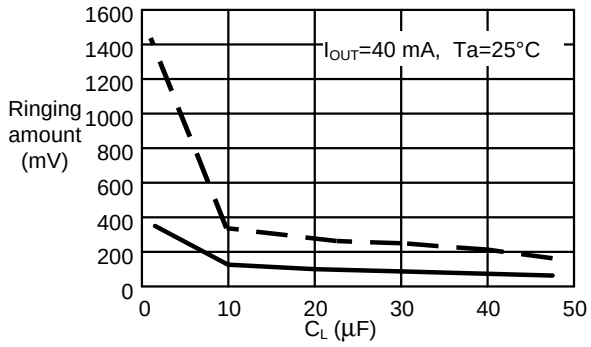
For reference, the following pages describe the ringing in $V_{OUT}$ measured using the output load current ($I_{OUT}$), output load capacitance ($C_L$), input fluctuation width ($\Delta V_{IN}$), and temperature as parameters.

Reference Data: Type I S-8750XXX Series

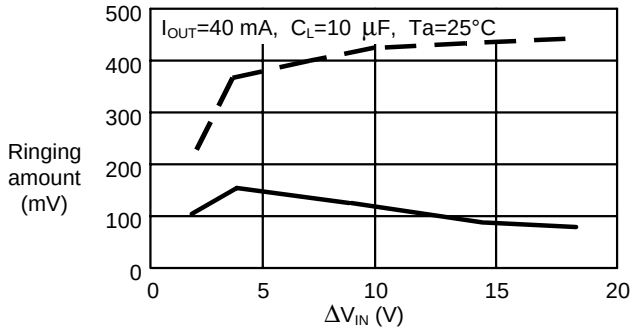
1. $I_{OUT}$ Dependency



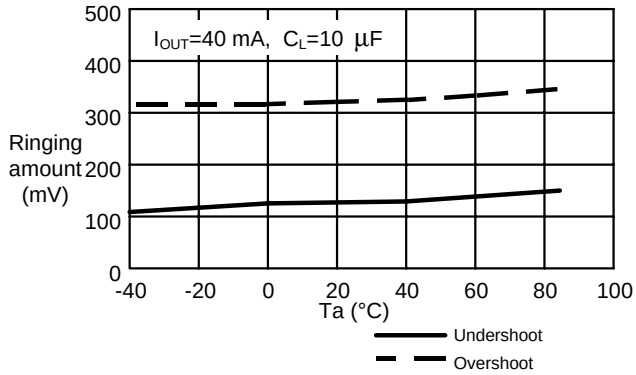

2. $C_L$ Dependency




3. $\Delta V_{IN}$ Dependency
The lower voltage is fixed at ($V_{OUT}$+1).

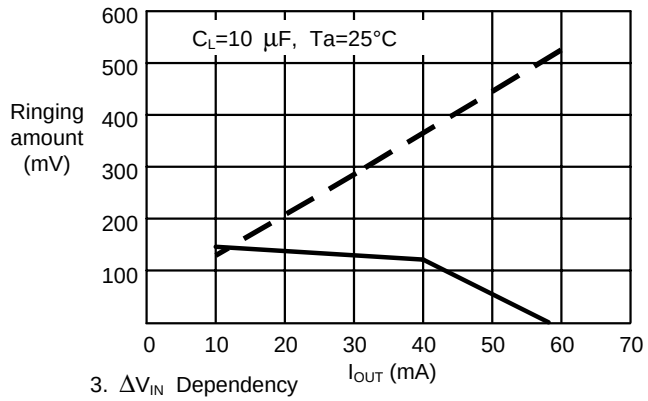



4. Temperature Dependency

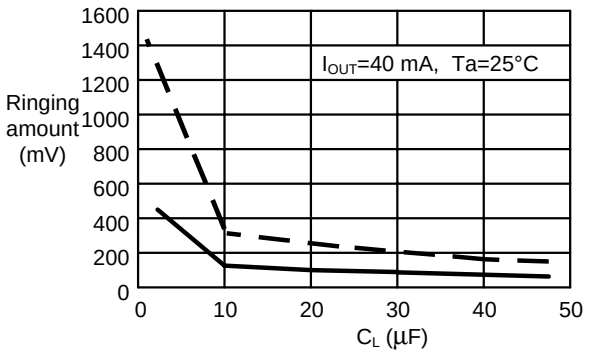



Reference Data: TypeI S-8730XXX Series

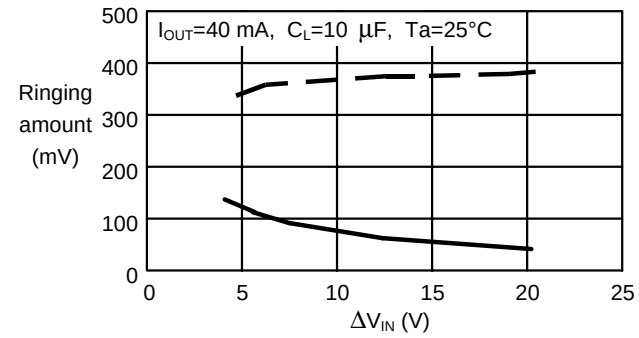
1. $I_{OUT}$ Dependency



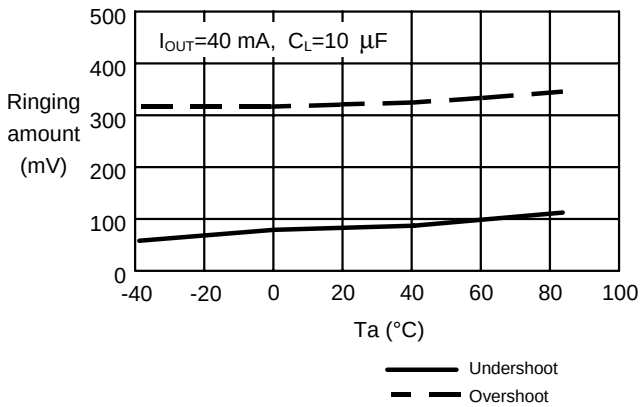

2. $C_L$ Dependency




3. $\Delta V_{IN}$ Dependency
The lower voltage is fixed at ($V_{OUT}$+1).

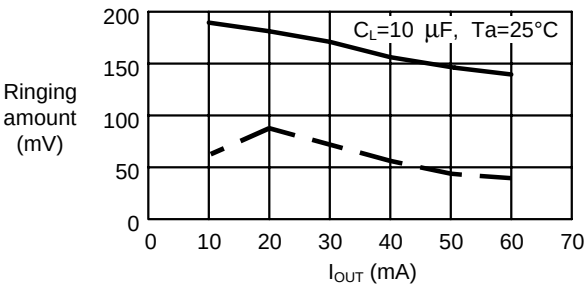



4. Temperature Dependency

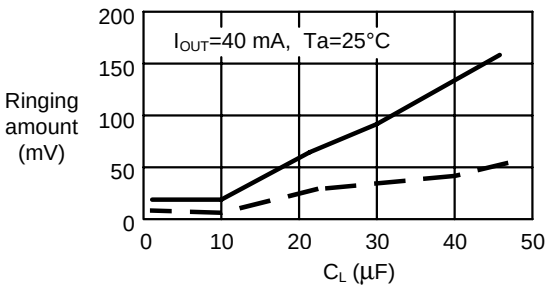


Reference Data: TypeII S-8750XXX Series

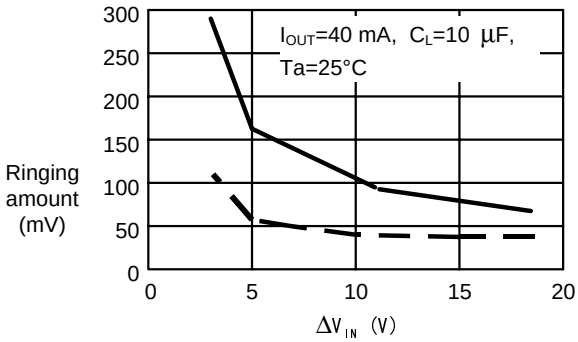
1. $I_{OUT}$ Dependency



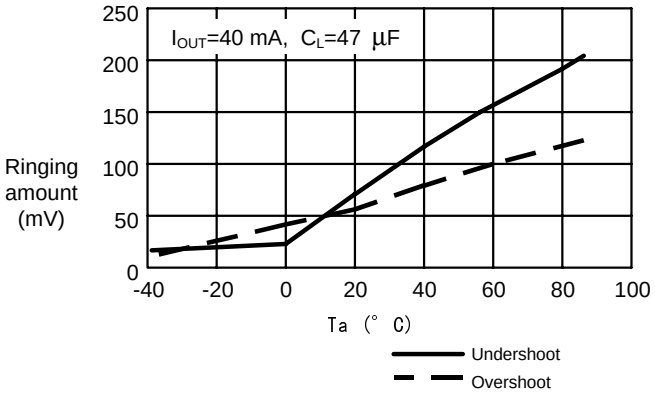

2. $C_L$ Dependency




3. $\Delta V_{IN}$ Dependency
The lower voltage is fixed at ($V_{OUT}$+1).

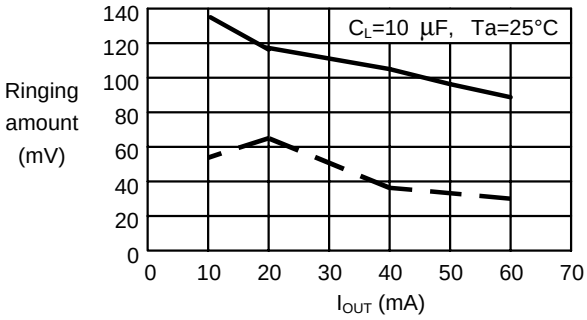



4. Temperature Dependency

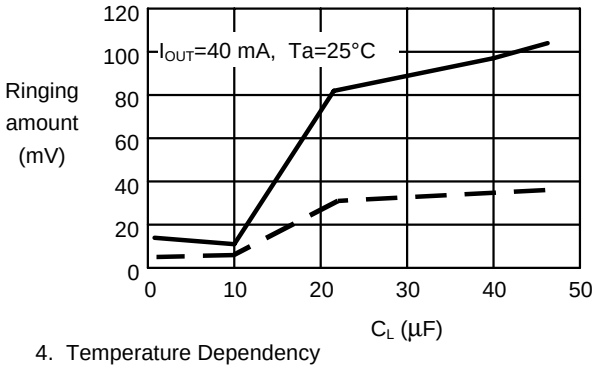



Reference Data: TypeII S-8730XXX Series

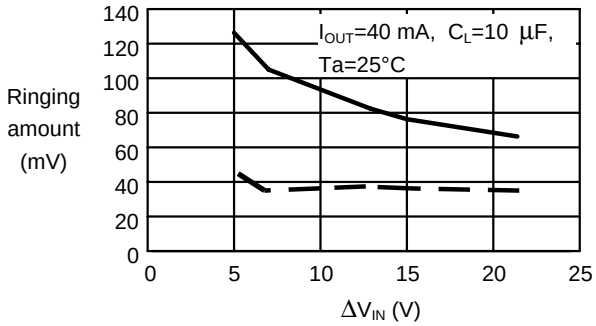
1. $I_{OUT}$ Dependency



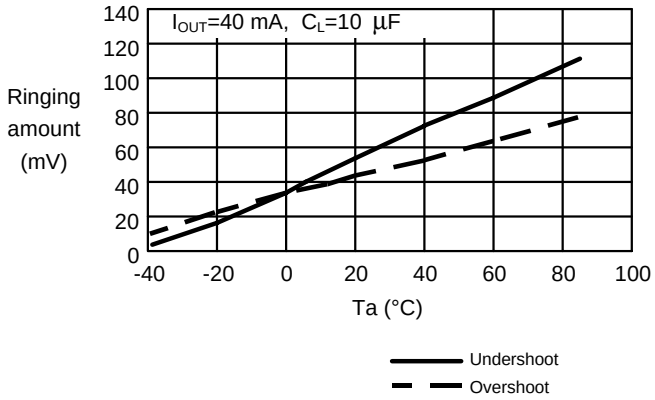

2. $C_L$ Dependency




3. $\Delta V_{IN}$ Dependency
The lower voltage is fixed at ($V_{OUT}$+1).




4. Temperature Dependency



2. Load Transient Response due to Load Current Fluctuation

An overshoot and an undershoot are caused in the output voltage if the load current is changed from 50 μA to 40 mA while the input voltage is kept constant. Figure 16 shows the output voltage fluctuation due to a change in the load current. The measuring circuit is shown in Figure 17 for reference. The latter half of this section describes ringing waveform and parameter dependency.

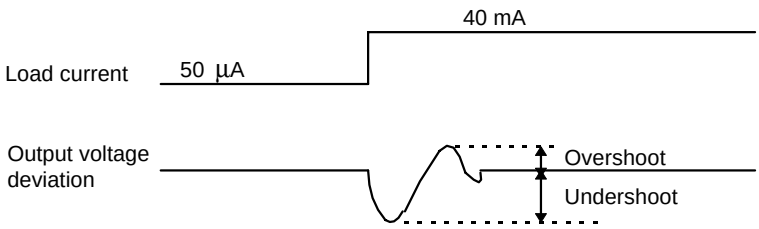
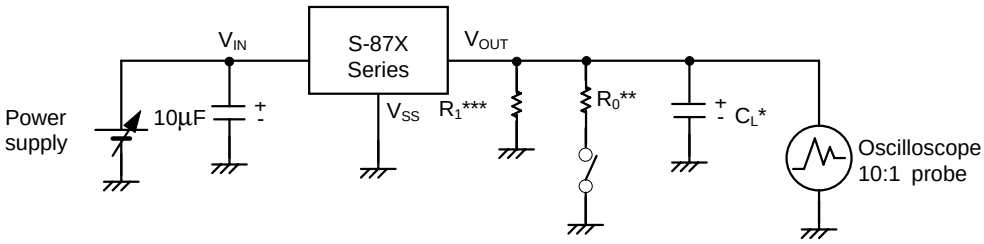



**Figure 16**




* Al electrolytic capacitor

** $R_0 = \frac{V_{OUT}\,[V]}{40\ mA}$ [Ω]

*** $R_1 = \frac{V_{OUT}\,[V]}{50\ \mu A}$ [Ω]

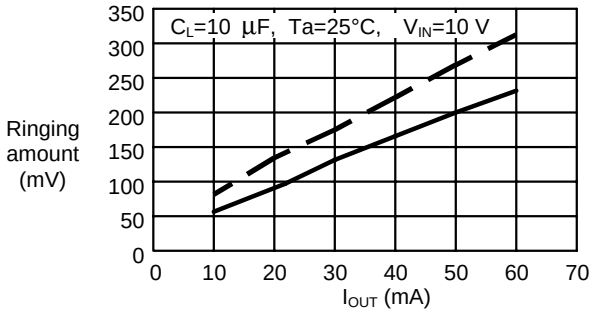
**Figure 17 Measuring Circuit**

**Table 20 Parameter Dependency due to Load Current Fluctuation**

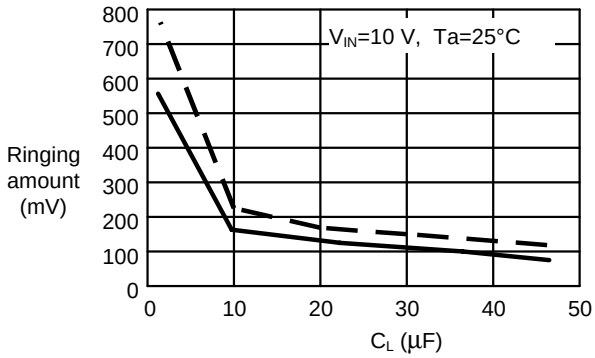
| Series | Parameter | | Conditions | Method to decrease overshoot | Method to decrease undershoot |
|---|---|---|---|---|---|
| S-8750XXX<br>S-8730XXX | Load current | $I_{OUT}$ | 10 to 60 mA, $C_L$=10μF | Decrease | Decrease |
| | Load capacitance | $C_L$ | 1 to 47μF, $I_{OUT}$=40 mA | Increase | Increase |
| | Power supply voltage | $V_{IN}$ | ($V_{OUT}$+1) to 24 V | Increase | Increase |
| | Temperature | Ta | -40°C to +85°C | Low temperature | Low temperature |

Reference Data S-8750XXX Series

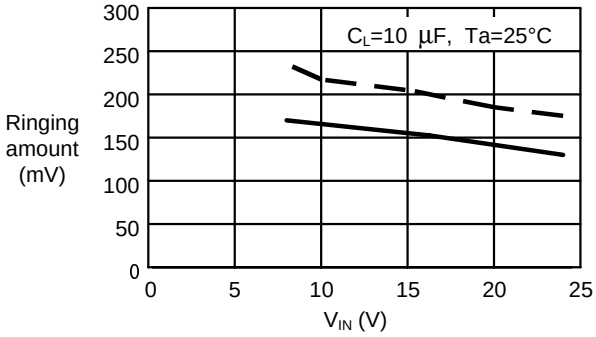
1. $I_{OUT}$ Dependency



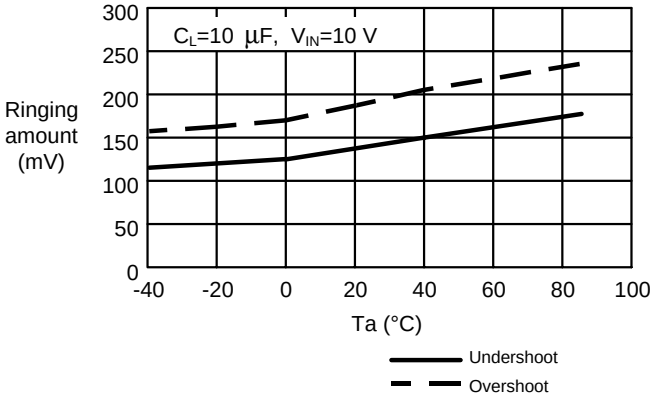

2. $C_L$ Dpendency




3. $V_{IN}$ Dependency

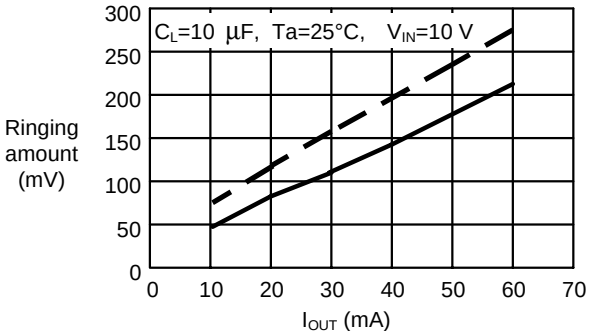



4. Temperature Dependency

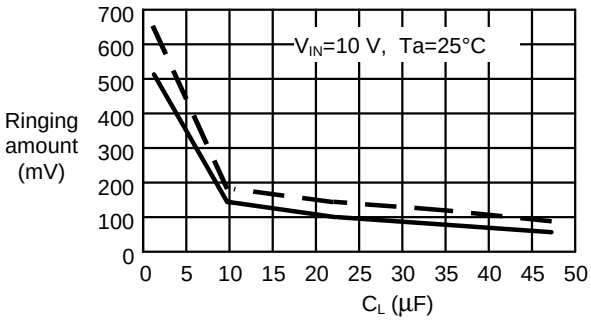



Reference S-8730XXX

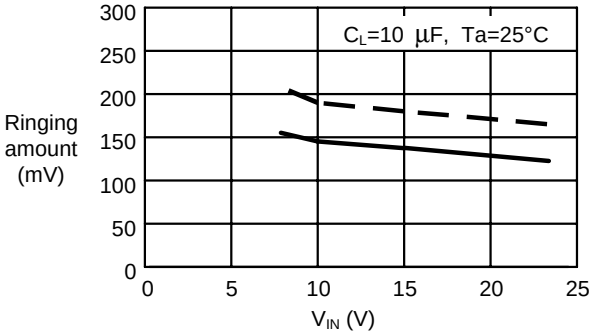
1. $I_{OUT}$ Dependency



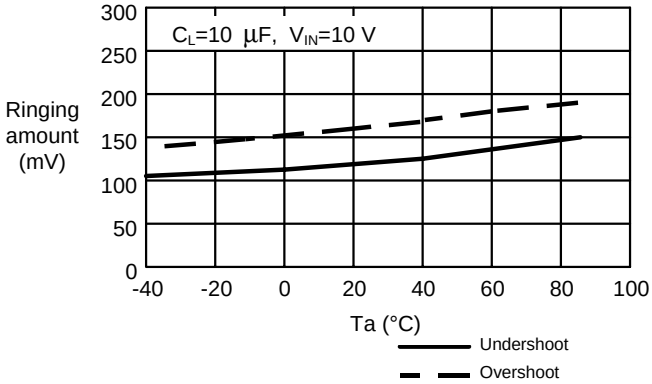

2. $C_L$ Dependency




3. $V_{IN}$ Dependency

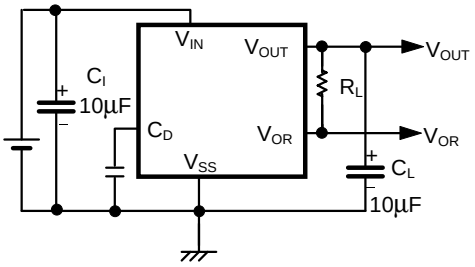



4. Temperature Dependency



## ■ Standard Circuits

1. S-87XXXXA/B/F




2. S-87XXXXC/E/G

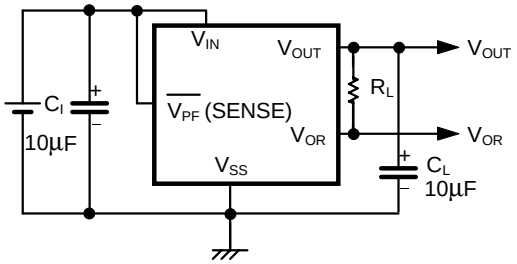



**Figure 18**

## ■ Application Circuits

1. Microcomputer Power Supply and Reset Circuit

To construct a microcomputer power supply and a reset circuit using conventional ICs, a voltage regulator IC, a voltage detector IC, a delay time generation circuit and others are required. The S-87XXXXA/B Series allows you to make these circuits without these ICs, and the delay time is variable.

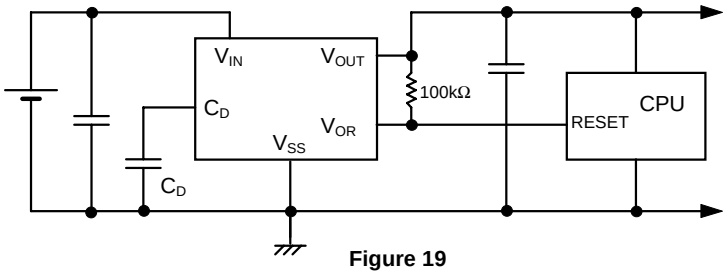
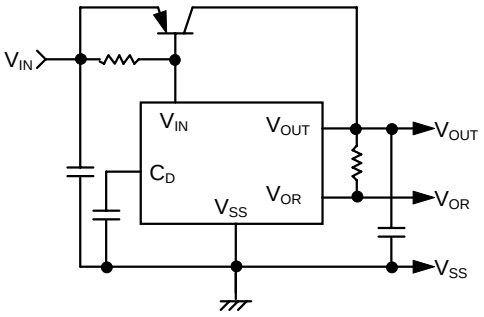



**Figure 19**

2. Output Current Boost Circuit

A PNP transistor is used to increase the output current.

(1) S-87XXXXA/B




(2) S-87XXXXC/G

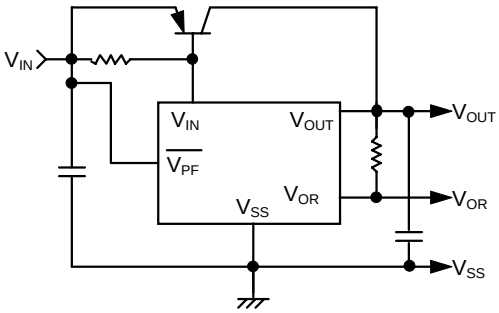



**Figure 20**

3. Power Supply for Lithium-Ion Battery Pack

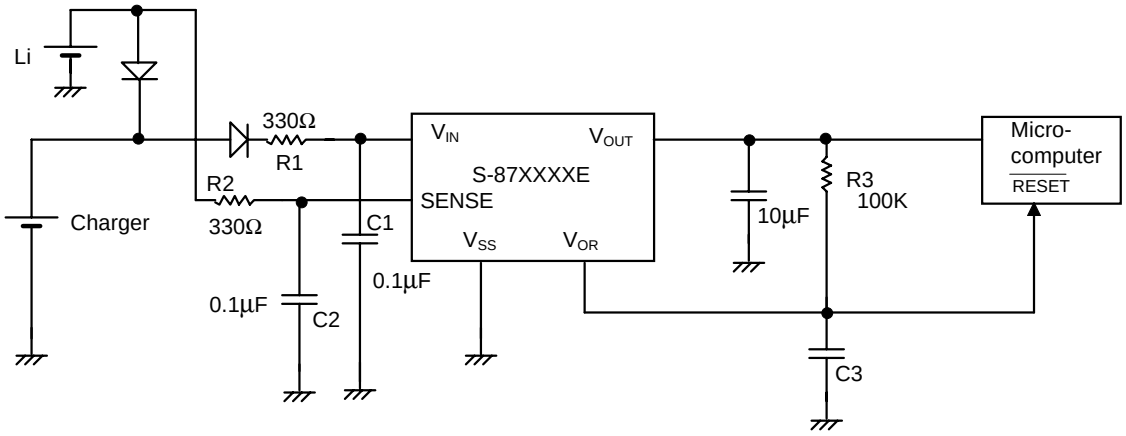
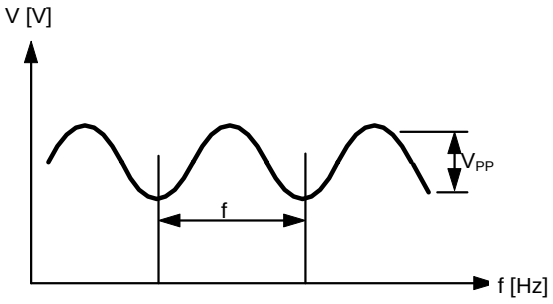



**Figure 21**

When the lithium-ion battery goes down to the overdischarge voltage, the built-in voltage detector powers OFF the voltage regulator, and at the same time it transmits the RESET signal to the microcomputer. R1, C1, R2 and C2 are attached to eliminate the voltage exceeding the absolute maximum ratings of charger. C3 is attached to give a delay and to release the RESET signal after power supply voltage for microcomputer($V_{OUT}$) rises high enough.

## ■ Notes

- DO NOT apply a ripple voltage of the conditions below to $V_{IN}$ pin.




$V_{PP} \geq 0.5V$
$f \geq 1000Hz$

**Figure 22**

- When connecting the voltage regulator output pin to another power supply, insert a diode to protect the IC.

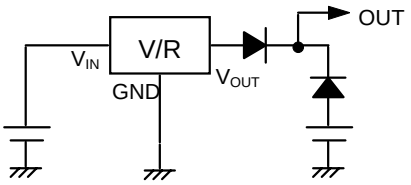
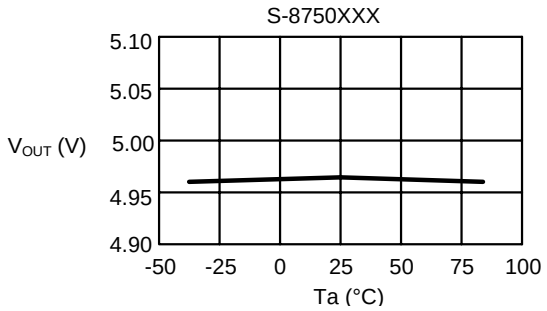


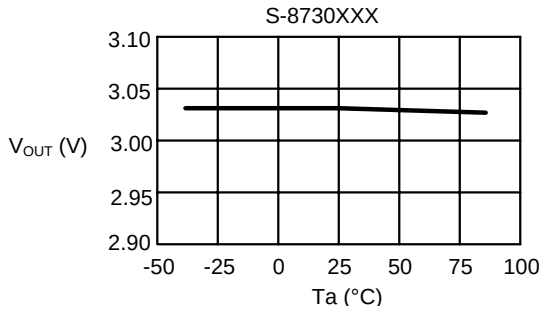

**Figure 23**

## ■ Characteristics

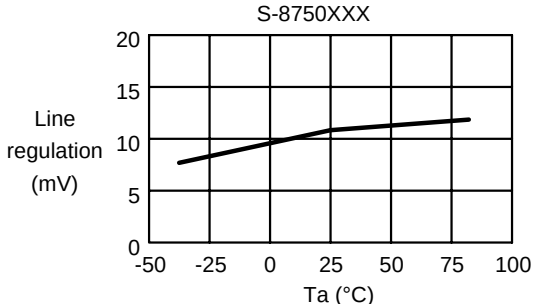
### 1. Voltage Regulator

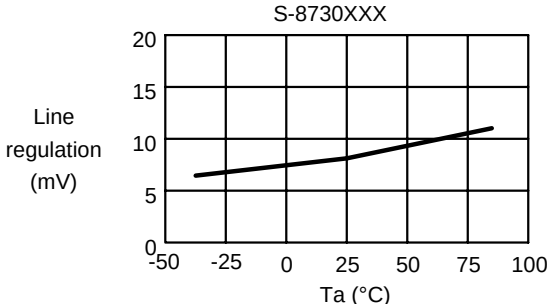
(1) Output Voltage ($V_{OUT}$) -Temperature (Ta)



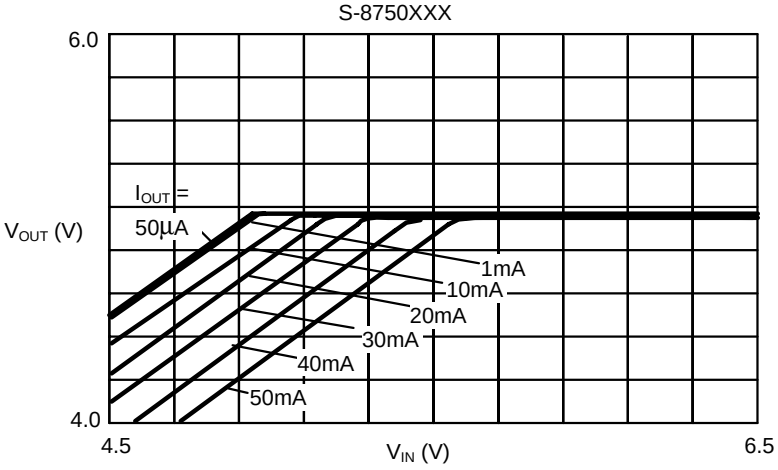



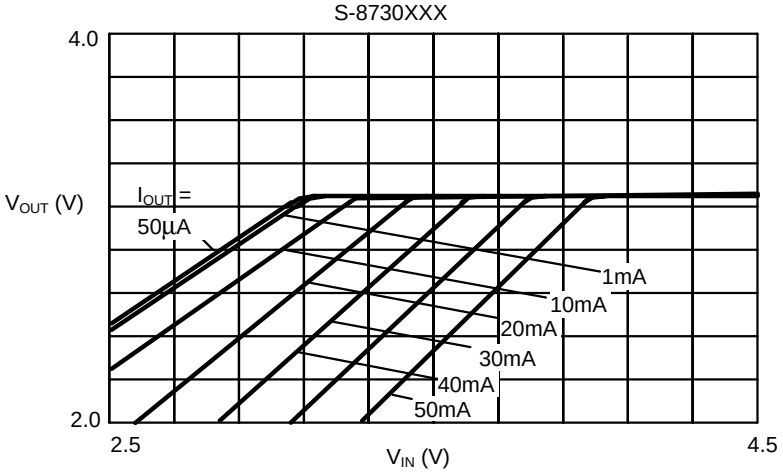

(2) Line Regulation -Temperature (Ta)



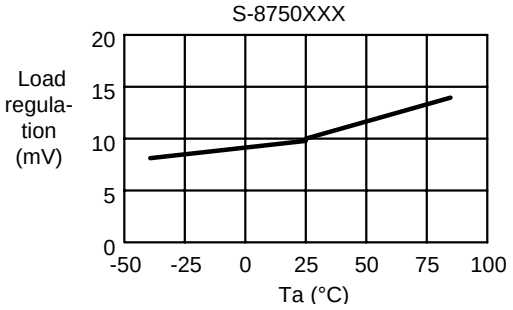



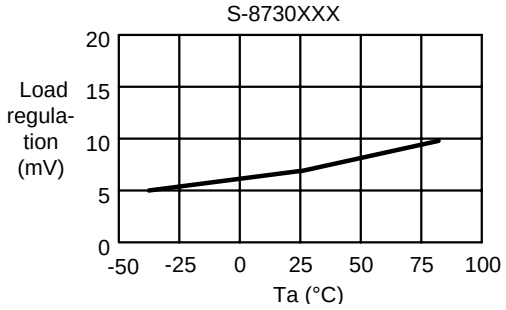

(3) Input Voltage ($V_{IN}$) - Output voltage ($V_{OUT}$)



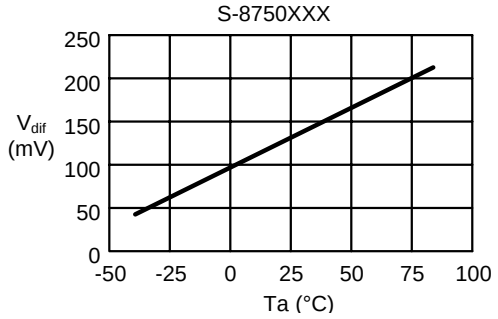



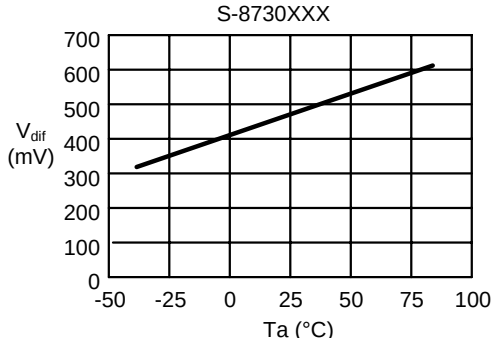
(4) Load Regulation - Temperature (Ta)



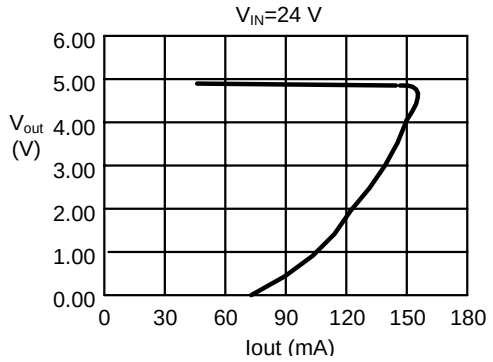

(5) I/O Voltage Difference ($V_{dif}$)- Temperature (Ta)

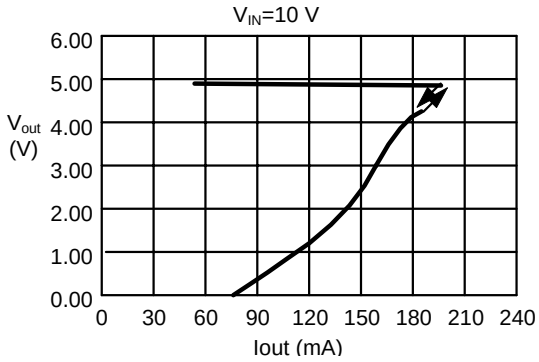


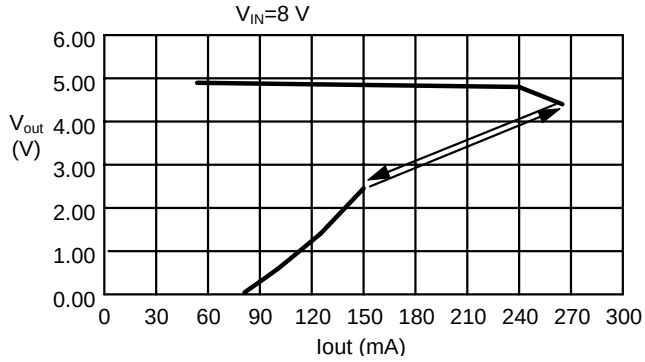



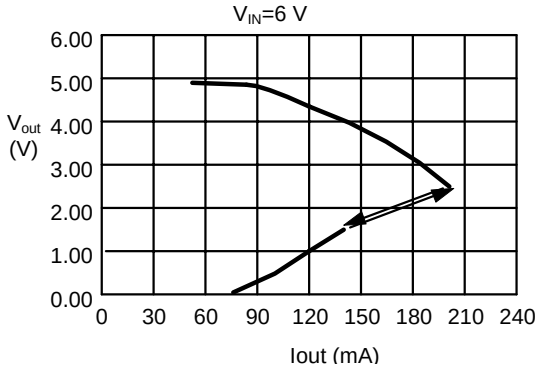

(6) Short-Circuit Protection Circuit

S-8750XXX Series Ta=25°C

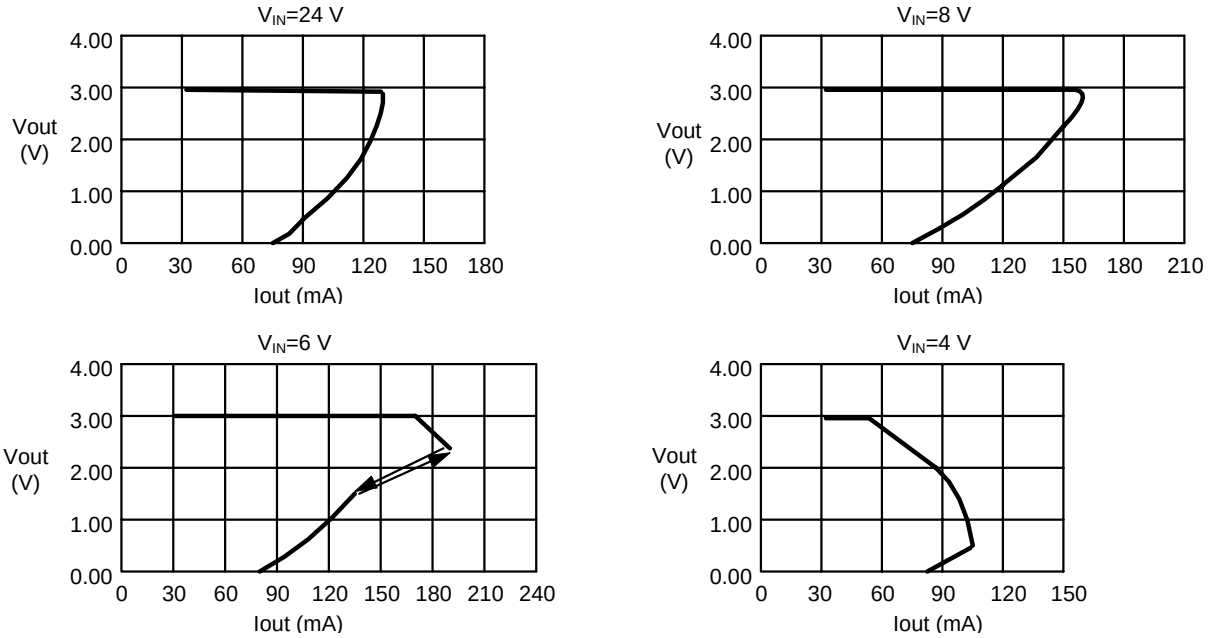


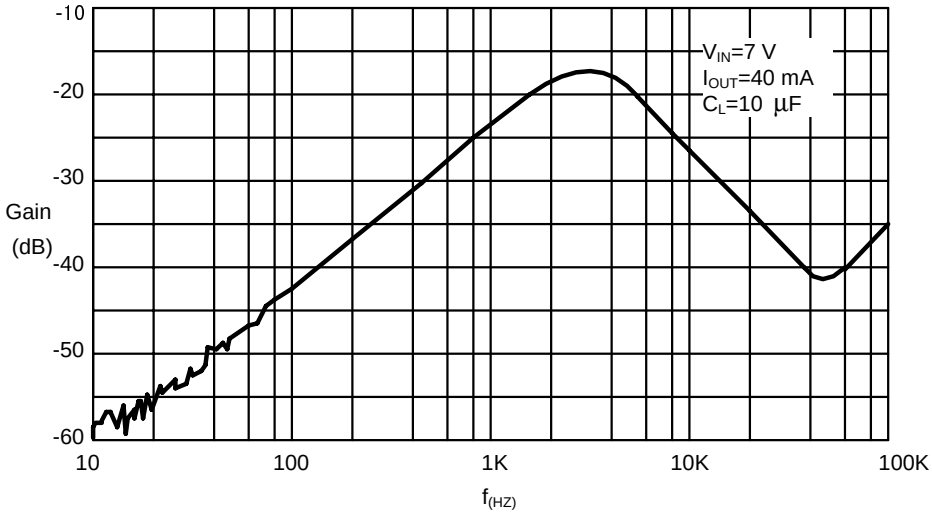



S-8730XXX Series Ta=25°C

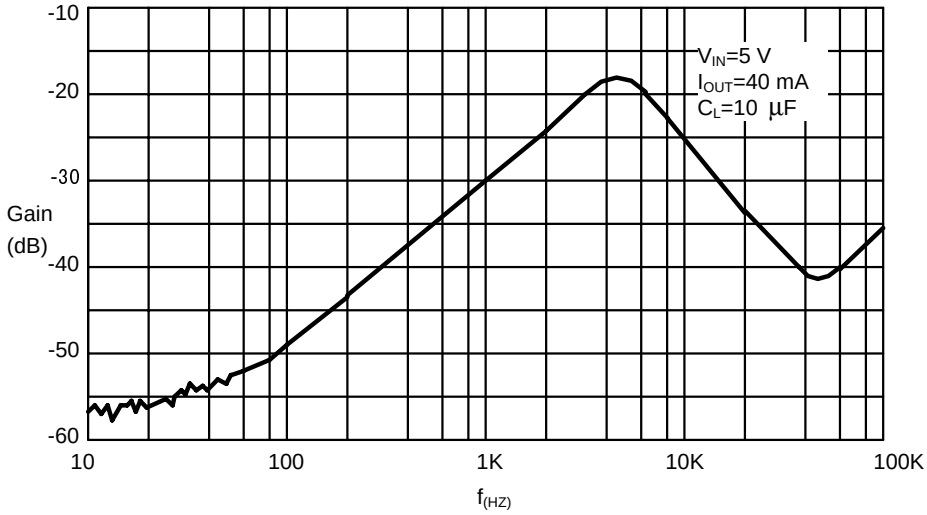



(7) Ripple rejection

S-8750XXX Series



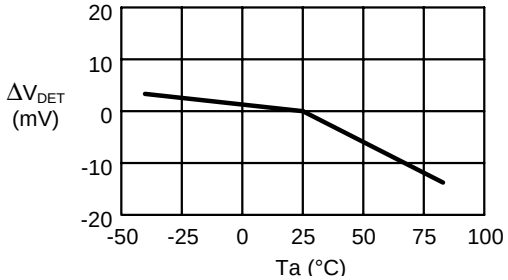

S-8730XXX Series



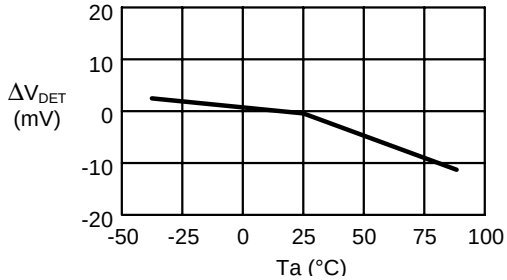
2. Voltage Detector

(1) Detection Voltage ($V_{DET}$) - Temperature (Ta)

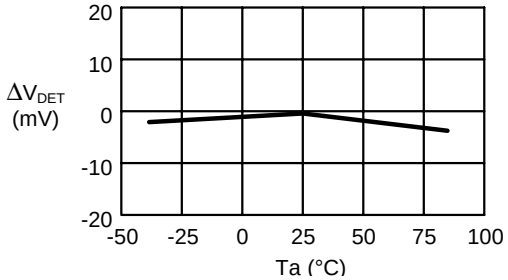
S-875045




S-875043

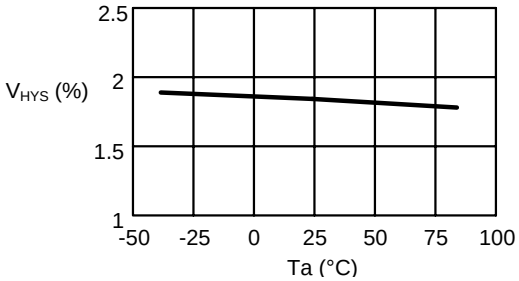



S-873023

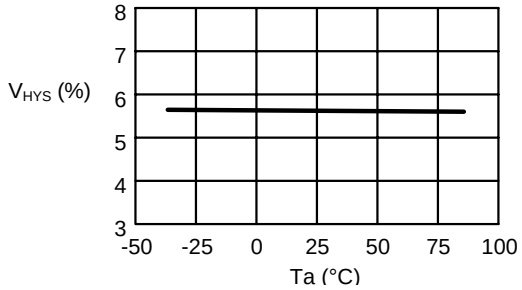



(2) Hysteresis Width ($V_{HYS}$) - Temperature (Ta)

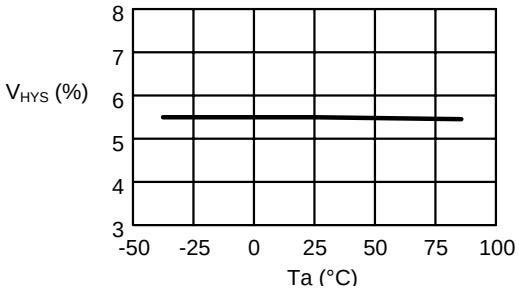
S-875045



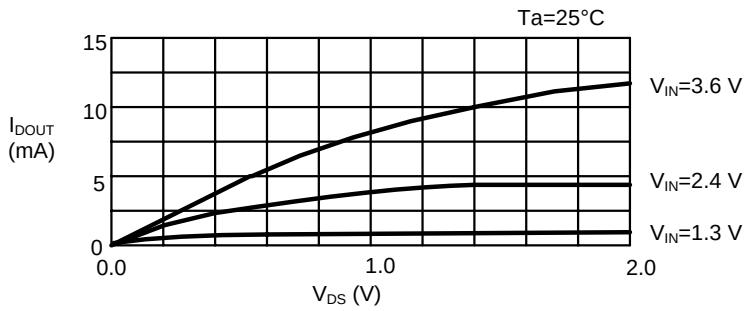

S-875043




S-873023

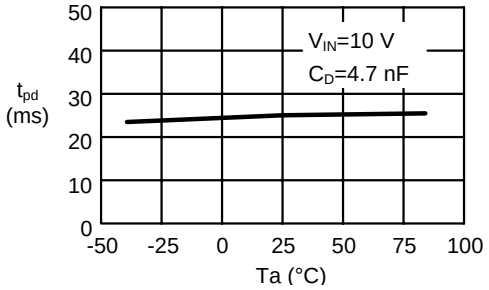


(3) Nch Transistor Output Current ($I_{DOUT}$)




(4) Delay Time (tpd)

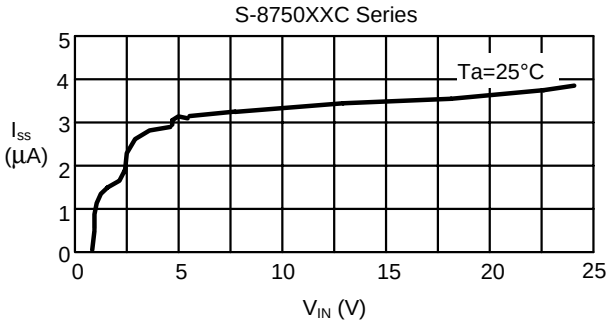
(a) Delay Time (tpd) - Temperature (Ta)

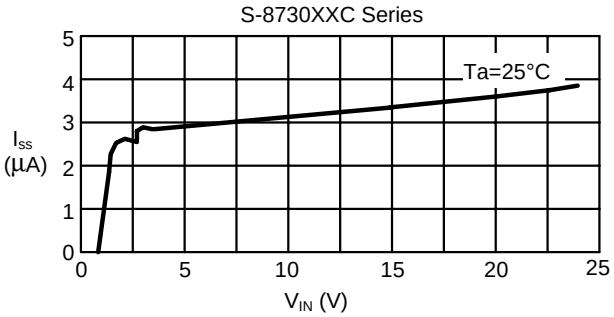



## 3. Total

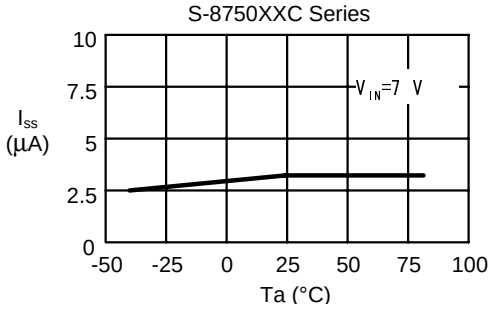
(1) Current Consumption (Iss)

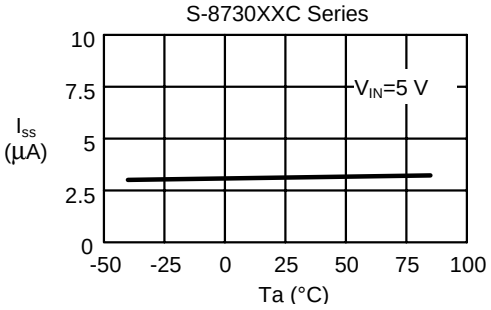
(a) Input Voltage($V_{IN}$)



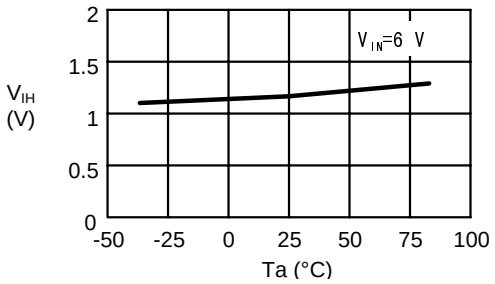

(b) Current Consumption (Iss) - Temperature (Ta)



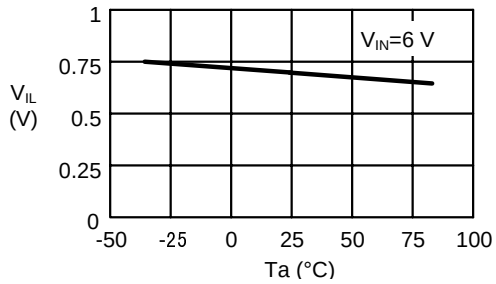



(2) Input Voltage of Shutdown Sircuit

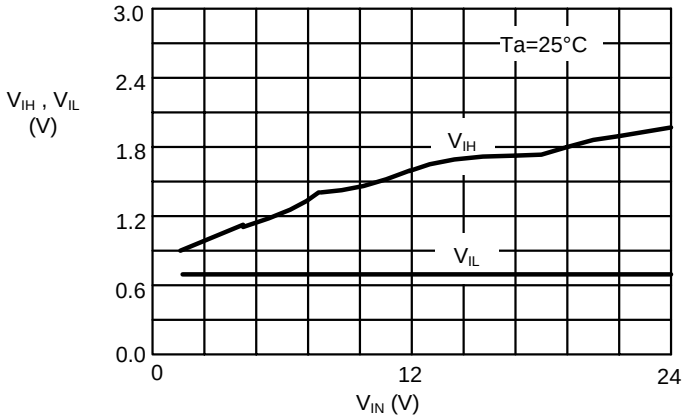
(a) High Level Input Voltage ($V_{IH}$) - Temperature (Ta)




(b) Low Level Input Voltage ($V_{IL}$) - Temperature (Ta)



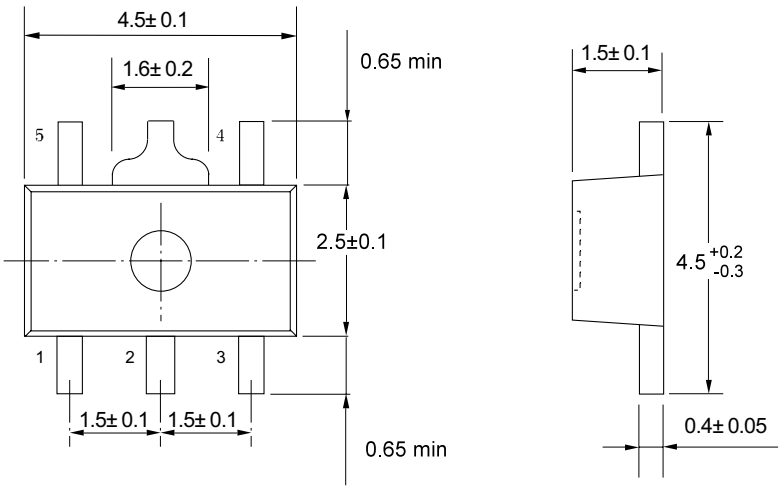

(c) $V_{IH}$ , $V_{IL}$ - Power Supply Voltage Dependency

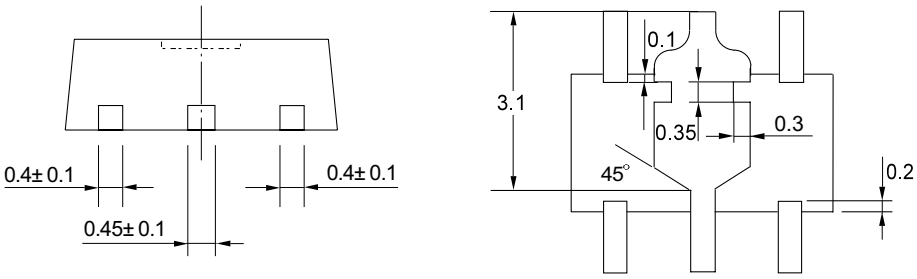


# ■ SOT-89-5

Unit : mm

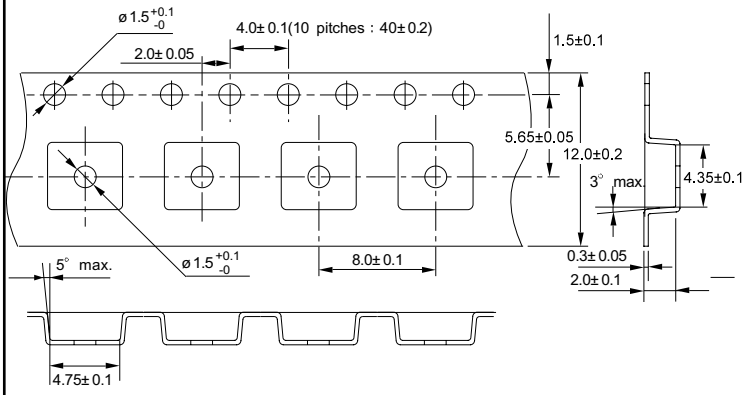
## ● Dimensions

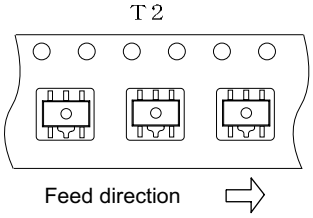



No. : UP005-A-P-SD-1. 1

## ● Taping Specifications

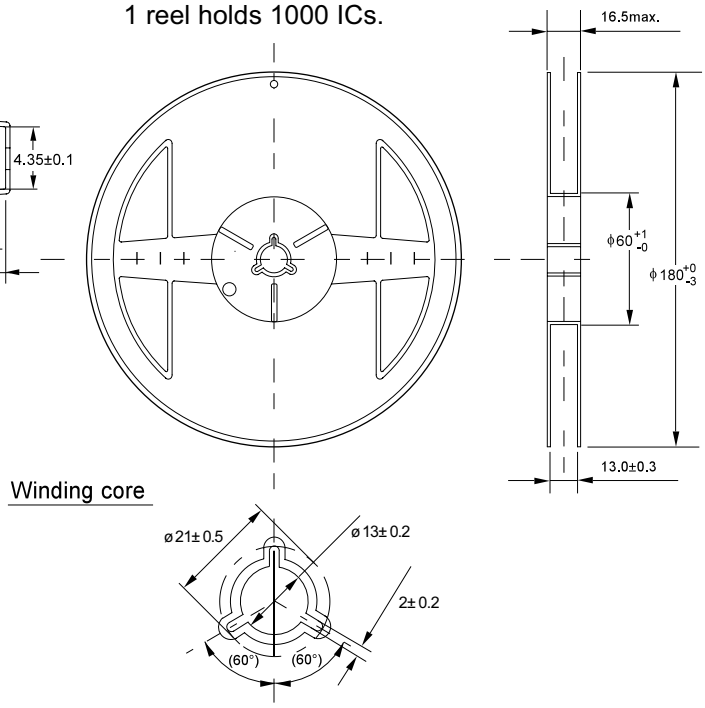



No. : UP005-A-C-SD-1. 0

## ● Reel Specifications

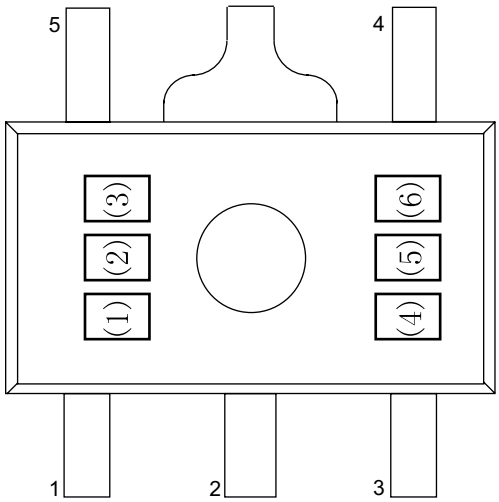
1 reel holds 1000 ICs.




No. : UP005-A-R-SD-1. 0

## ■Markings

### ● SOT-89-5




(1) to (3) : Product name (abbreviation)

(4) : Year of assembly

(5) : Month of assembly

(6) : Week of assembly

No.：UP005－A－M－S1－1．0

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