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S-87x Series

HIGH WITHSTAND-VOLTAGE VOLTAGE REGULATOR WITH RESET FUNCTION

www.sii-ic.com

Rev.8.0_00

The S-87x Series is a 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 lineups for lithium-ion battery packs.

■ Features

- Accuracy of output voltage: ±2.4 %
  2.5 V to 5.8 V (0.1 V step)
- Accuracy of detection voltage: ±2.4 % (For the F type, the release voltage is ±1.1 %)
  2.1 V to 11.3 V (0.1 V step)
- Low I/O voltage difference: 0.15 V typ. (at I_{OUT}=30 mA, V_{OUT}=5.0 V)
  0.45 V typ. (at I_{OUT}=30 mA, V_{OUT}=3.0 V)
- Low current consumption: At Operation mode: 8 μA max.
  At Shutdown mode: 3.5 μA max. (Available for the C/E/G type)
- Wide operating voltage range: 24 V max.
- Wide operating temperature range: −40°C to +85°C
- Built-in delay circuit or shutdown circuit
- Built-in short-circuit protection circuit
- Lead-free, Sn 100%, halogen-free[*1]

***1.** Refer to "■ **Product Name Structure**" for details.

■ Applications

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

■ Package

- SOT-89-5

■ Block Diagrams

1. A/F type

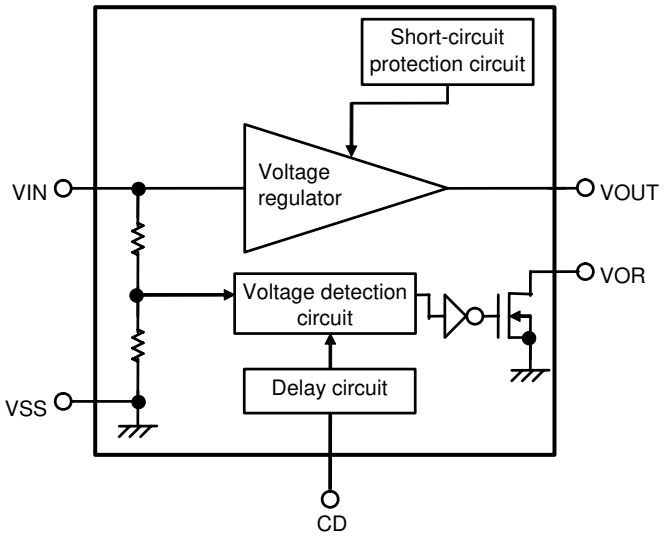


Figure 1

2. B type

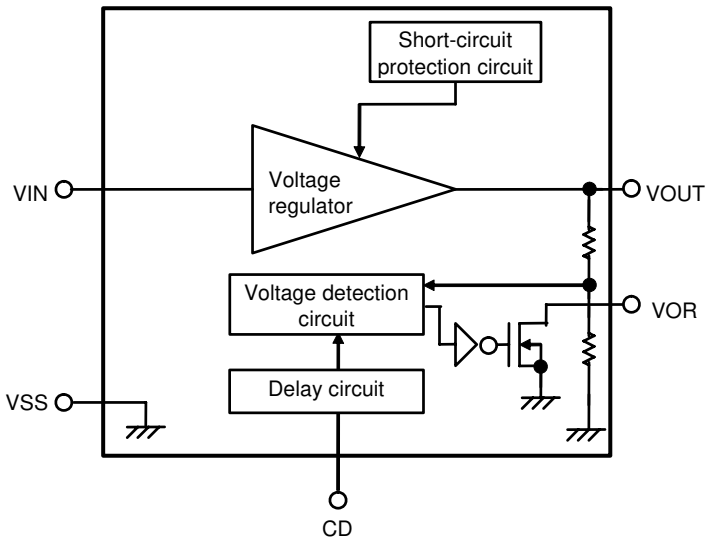


Figure 2

3. C type

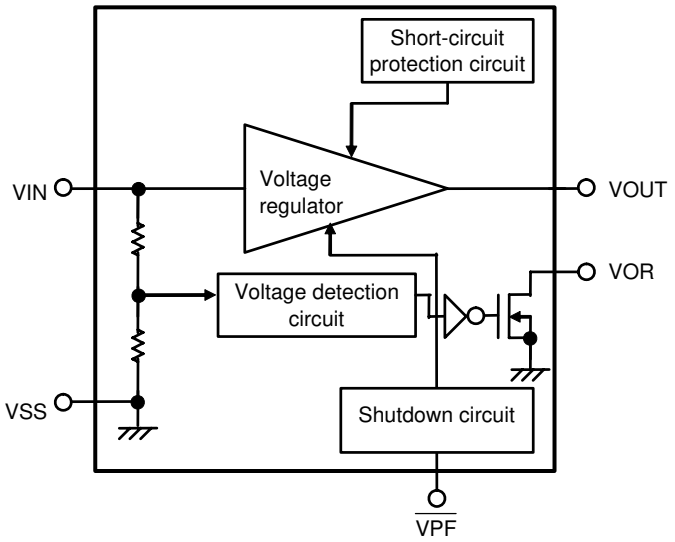


Figure 3

4. E type

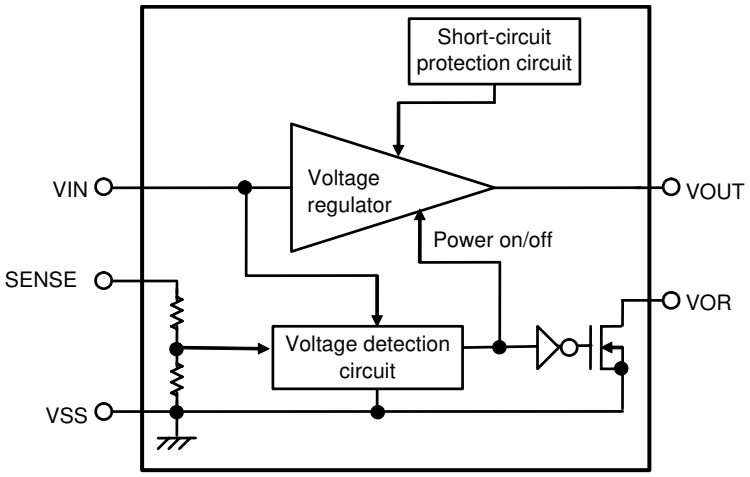


Figure 4

5. G type

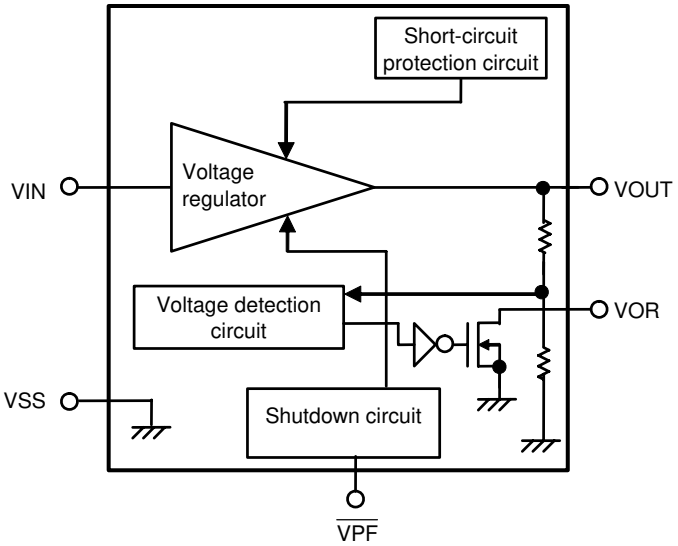


Figure 5

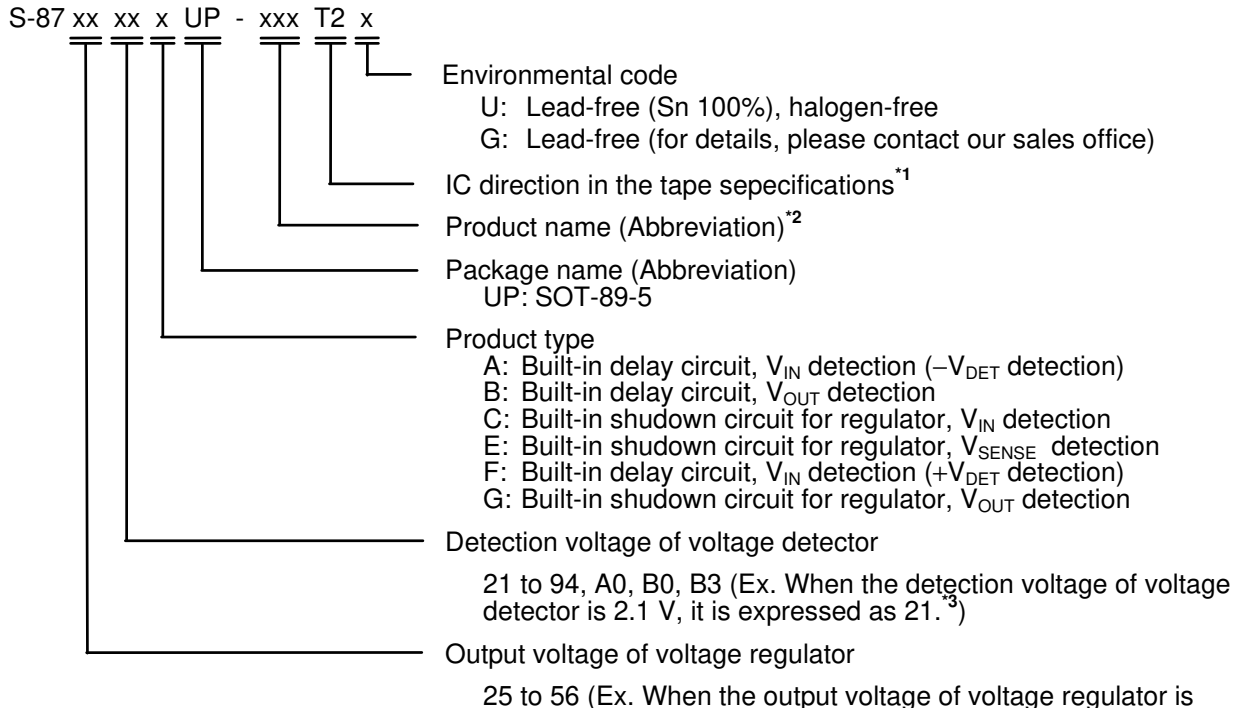
■ Product Name Structure

1. Function list

Table 1

Type name	Voltage detector (VD)	Detection voltage ($-V_{DET}$) accuracy [%]	Release voltage ($+V_{DET}$) accuracy [%]	Built-in delay circuit	Shutdown function	
					VR	VD
A type	Detects V_{IN}	±2.4	—	Yes	No	No
B type	Detects V_{OUT}	±2.4	—	Yes	No	No
C type	Detects V_{IN}	±2.4	—	No	Yes	No
E type	Detects V_{SENSE}	±2.4	—	No	Yes	No
F type	Detects V_{IN}	—	±1.1	Yes	No	No
G type	Detects V_{OUT}	±2.4	—	No	Yes	No

2. Product name selection guide



***1.** Refer to the tape specifications at the end of this document.
***2.** Refer to the **Table 2** to **Table 3** in the "**4. Product name list**".
***3.** A0 for 10.0 V, B0 for 11.0 V, B3 for 11.3 V.

3. Package

Package Name	Drawing Code		
	Package	Tape	Reel
SOT-89-5	UP005-A-P-SD	UP005-A-C-SD	UP005-A-R-SD

4. Product name list

Table 2 (1/2)

VR output voltage [V]	VD detection voltage [V]	S-87xxxxA Series	S-87xxxxB Series	S-87xxxxC Series
5.6	3.5	—	S-875635BUP-AGAT2x	—
5.2	9.4	—	—	S-875294CUP-AHCT2x
	7.1	—	—	S-875271CUP-AHAT2x
	5.5	—	—	S-875255CUP-AHBT2x
5.0	11.0	—	—	S-8750B0CUP-ACGT2x
	7.7	S-875077AUP-AAFT2x	—	S-875077CUP-ACFT2x
	6.1	—	—	S-875061CUP-ACHT2x
	4.5	S-875045AUP-AAAT2x	S-875045BUP-ABAT2x	S-875045CUP-ACAT2x
	4.3	S-875043AUP-AABT2x	S-875043BUP-ABBT2x	S-875043CUP-ACBT2x
	4.1	S-875041AUP-AACT2x	S-875041BUP-ABCT2x	S-875041CUP-ACCT2x
	3.9	S-875039AUP-AADT2x	S-875039BUP-ABDT2x	S-875039CUP-ACDT2x
	3.7	S-875037AUP-AAET2x	S-875037BUP-ABET2x	S-875037CUP-ACET2x
	3.4	—	S-875034BUP-ABFT2x	—
	2.9	—	S-875029BUP-ABHT2x	—
	2.1	—	S-875021BUP-ABGT2x	—
3.3	7.7	S-873377AUP-0AAT2x	—	—
	6.1	—	—	S-873361CUP-AOHT2x
	4.1	—	—	S-873341CUP-AOCT2x
	2.8	S-873328AUP-0ABT2x	—	—
	2.5	—	S-873325BUP-ALAT2x	—
3.0	6.9	—	—	S-873069CUP-AFFT2x
	5.9	—	—	S-873059CUP-AFGT2x
	2.5	S-873025AUP-ADAT2x	S-873025BUP-AEAT2x	S-873025CUP-AFAT2x
	2.4	S-873024AUP-ADBT2x	S-873024BUP-AEBT2x	S-873024CUP-AFBT2x
	2.3	S-873023AUP-ADCT2x	S-873023BUP-AECT2x	S-873023CUP-AFCT2x
	2.2	S-873022AUP-ADDT2x	S-873022BUP-AEDT2x	S-873022CUP-AFDT2x
	2.1	S-873021AUP-ADET2x	S-873021BUP-AEET2x	S-873021CUP-AFET2x
2.6	2.2	—	S-872622BUP-OLAT2x	—

Table 2 (2/2)

VR output voltage [V]	VD detection voltage [V]	S-87xxxxE Series	S-87xxxxG Series
5.0	11.0	S-8750B0EUP-AJIT2x	—
	8.7	S-875087EUP-AJGT2x	—
	7.7	S-875077EUP-AJFT2x	—
	6.1	S-875061EUP-AJHT2x	—
	4.2	—	S-875042GUP-ANCT2x
	3.7	—	S-875037GUP-ANET2x
	3.3	S-875033EUP-AJAT2x	—
	3.0	S-875030EUP-AJBT2x	—
3.3	11.0	S-8733B0EUP-APCT2x	—
	10.0	S-8733A0EUP-APFT2x	—
	8.2	S-873382EUP-APHT2x	—
	7.2	S-873372EUP-APET2x	—
	6.4	S-873364EUP-APGT2x	—
	4.8	S-873348EUP-APDT2x	—
	3.0	S-873330EUP-APBT2x	—
3.0	11.3	S-8730B3EUP-AMFT2x	—
	8.2	S-873082EUP-AMCT2x	—
	6.2	S-873062EUP-AMBT2x	—
	5.0	S-873050EUP-AMET2x	—
	4.2	S-873042EUP-AMDT2x	—
2.5	4.8	S-872548EUP-AZBT2x	—
	3.0	S-872530EUP-AZCT2x	—
	2.6	S-872526EUP-AZAT2x	—

Caution 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.

Remark 1. x: G or U
2. Please select products of environmental code = U for Sn 100%, halogen-free products.

Table 3

VR output voltage [V]	VD release voltage [V]	S-87xxxxF Series
5.0	8.7	S-875087FUP-AKAT2x

Remark 1. x: G or U
2. Please select products of environmental code = U for Sn 100%, halogen-free products.

■ Pin Configuration

SOT-89-5
Top view

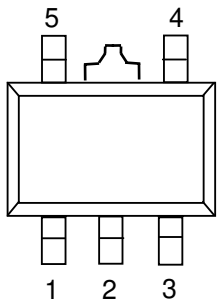


Figure 6

Table 4

Pin No.	Symbol	Description
1	VOUT	Voltage output pin of voltage regulator
2	VSS	Ground pin
3	CD (A/B/F type)	Connection pin of external capacitor for delay of voltage detector
	$\overline{\text{VPF}}$ (C/G type)	Input pin of shutdown circuit
	SENSE (E type)	Voltage monitoring pin of voltage detector
4	VOR	Output pin of voltage detector, Nch opendrain output
5	VIN	Positive power-supply

■ Absolute Maximum Ratings

Table 5

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Absolute maximum rating	Unit
Input voltage*1	V_{IN}	V_{SS}−0.3 to V_{SS}+26	V
	V_{CD} (A/B/F type)	V_{SS}−0.3 to V_{IN}+0.3	
	$\overline{V_{PF}}$ (C/G type)	V_{SS}−0.3 to V_{SS}+26	
	V_{SENSE} (E type)		
Output voltage	V_{OUT}	V_{SS}−0.3 to V_{IN}+0.3	
Output voltage of voltage detector	V_{OR}	V_{SS}−0.3 to V_{SS}+26	
Power dissipation	P_D	500 (When not mounted on board)	mW
		1000*2	
Operating ambient temperature	T_{opr}	−40 to +85	°C
Storage temperature	T_{stg}	−40 to +125	

***1.** Even pulse (μs) noise exceeding the above input voltage (V_{SS}+26 V) may damage the IC. Observe the rated input voltage (V_{SS}+26 V).

***2.** When mounted on board

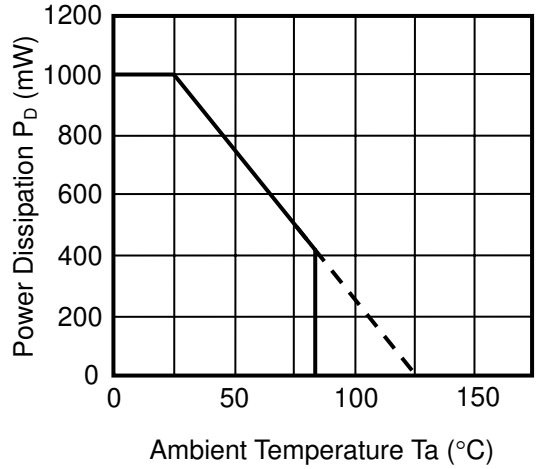
[Mounted board]

(1) Board size: 114.3 mm × 76.2 mm × t1.6 mm

(2) Board name: JEDEC STANDARD51-7

Caution The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

(1) When mounted on board



(2) When not mounted on board

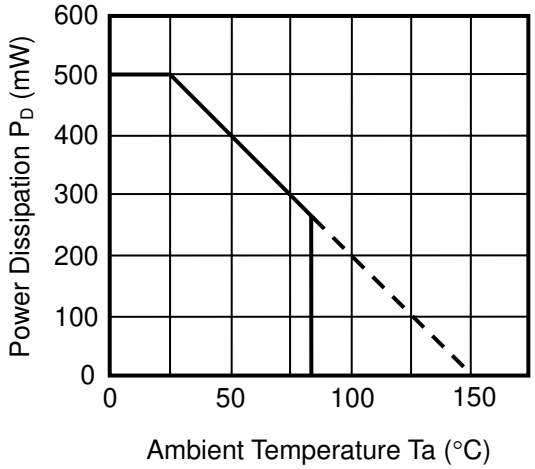


Figure 7 Power dissipation of package

■ Electrical Characteristics

1. S-8750xxA Series/S-8750xxB Series

Table 6

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=6 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7 V, I_{OUT}=50 µA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7 V, I_{OUT}=30 mA, Ta=−40°C to +85°C		—	±0.38	±1.52	mV /°C	
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Delay time[*1]	t_{pd}	C_D=4.7 nF		15	27	41	ms	3
Tempertue 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	
		S-875043A/B		4.196	4.30	4.404		
		S-875041A/B		4.001	4.10	4.199		
		S-875039A/B		3.806	3.90	3.994		
		S-875037A/B		3.611	3.70	3.789		
		S-875021B		2.049	2.10	2.151		
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V		—	—	0.1	µA	
Hysteresis width	V_{HYS}	S-875045A/B		$-V_{DET}$ ×0.01	—	$-V_{DET}$ ×0.025	V	2
		S-875043A/B to S-875021A/B		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08		
Total								
Current consumption[*2]	I_{SS}	V_{IN}=7 V, Unloaded		—	3	8	µA	5

***1.** t_{pd} (ms)=(3.18 min., 5.74 typ., 8.73 max.)×C_D (nF)
***2.** Excluding the charging current of C_D

2. S-8730xxA Series/S-8730xxB Series

Table 7

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=4 to 24 V, I_{OUT}=30 mA	—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5 V, I_{OUT}=50 µA to 40 mA	—	15	50		
Input voltage	V_{IN}	—	—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=5 V, I_{OUT}=30 mA, Ta=−40°C to +85°C	—	±0.23	±0.92	mV /°C	
Voltage Detector							
Operating voltage	V_{opr}	—	1.3	—	24	V	2
Delay time[*1]	t_{pd}	C_D=4.7 nF	15	27	41	ms	3
Temperature 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	
		S-873024A/B	2.342	2.400	2.458		
		S-873023A/B	2.244	2.300	2.356		
		S-873022A/B	2.147	2.200	2.253		
		S-873021A/B	2.049	2.100	2.151		
Sink current	I_{DOUT}	Nch, V_{DS}=0.5 V; V_{IN}=1.3 V Other than below	0.25	0.60	—	mA	4
		Nch, V_{DS}=0.5 V; V_{IN}=2.4 V S-873025A/B	1.50	2.60	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V	—	—	0.1	µA	
Hysteresis width	V_{HYS}	—	$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total							
Current consumption[*2]	I_{SS}	V_{IN}=5 V, Unloaded	—	3	8	µA	5

***1.** t_{pd} (ms)=(3.18 min., 5.74 typ., 8.73 max.)×C_D (nF)

***2.** Excluding the charging current of C_D

3. S-875635B

Table 8

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=6.6 to 24 V, I_{OUT}=30 mA	—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7.6 V, I_{OUT}=50 µA to 40 mA	—	15	50		
Input voltage	V_{IN}	—	—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7.6 V, I_{OUT}=30 mA, Ta=−40°C to +85°C	—	±0.43	±1.72	mV /°C	
Voltage Detector							
Operating voltage	V_{opr}	—	1.3	—	24	V	2
Delay time[*1]	t_{pd}	C_D=4.7 nF	15	27	41	ms	3
Temperature 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	
Sink current	I_{DOUT}	Nch, V_{DS}=0.5 V, V_{IN}=1.3 V	0.25	0.60	—	mA	4
		Nch, V_{DS}=0.5 V, V_{IN}=2.4 V	1.50	2.60	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V	—	—	0.1	µA	
Hysteresis width	V_{HYS}	—	$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total							
Current consumption[*2]	I_{SS}	V_{IN}=7.6 V, Unloaded	—	4	8	µA	5

***1.** t_{pd} (ms)=(3.18 min., 5.74 typ., 8.73 max.)×C_D (nF)
***2.** Excluding the charging current of C_D

4. S-873325B

Table 9

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=4.3 to 24 V, I_{OUT}=30 mA	—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5.3 V, I_{OUT}=50 µA to 40 mA	—	15	50		
Input voltage	V_{IN}	—	—	—	24	V	
Temperature 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	—	±0.25	±1.00	mV /°C	
Voltage Detector							
Operating voltage	V_{opr}	—	1.3	—	24	V	2
Delay time[*1]	t_{pd}	C_D=4.7 nF	15	27	41	ms	3
Temperature 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	
Sink current	I_{DOUT}	Nch, V_{DS}=0.5 V, V_{IN}=1.3 V	0.25	0.60	—	mA	4
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V	—	—	0.1	µA	
Hysteresis width	V_{HYS}	—	$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total							
Current consumption[*2]	I_{SS}	V_{IN}=5.3 V, Unloaded	—	4	8	µA	5

***1.** t_{pd} (ms)=(3.18 min., 5.74 typ., 8.73 max.)×C_D (nF)

***2.** Excluding the charging current of C_D

5. S-8750xxC Series/S-875037G

Table 10 (1/2)

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=6 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7 V, I_{OUT}=50 μA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7 V, I_{OUT}=30 mA, Ta=−40°C to +85°C		—	±0.38	±1.52	mV /°C	
Shutdown output voltage	$V_{OUT/OFF}$	V_{IN}=7 V, $\overline{V_{PF}}$="L", R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature 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		
			S-875061C to S-875037C, S-875037G	—	±0.5	±2.0		
Detection voltage	$-V_{DET}$	S-8750B0C		10.736	11.00	11.264	V	
		S-875077C		7.515	7.70	7.885		
		S-875061C		5.953	6.10	6.247		
		S-875045C		4.392	4.50	4.608		
		S-875043C		4.196	4.30	4.404		
		S-875041C		4.001	4.10	4.199		
		S-875039C		3.806	3.90	3.994		
		S-875037C/S-875037G		3.611	3.70	3.789		
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V	V_{IN}=10 V S-875077C to S-875037C, S-875037G	—	—	0.1	μA	
			V_{IN}=15 V S-8750B0C					
Hysteresis width	V_{HYS}	S-875045C		$-V_{DET}$ ×0.01	—	$-V_{DET}$ ×0.025	V	2
		S-8750B0C to S-875061C, S-875043C to S-875037C, S-875037G		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08		

Table 10 (2/2)

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Total								
Current consumption	I_{SS}	V_{IN}=7 V, Unloaded	S-8750B0C to S-875061C	—	4	8	μA	5
			S-875045C to S-875037C, S-875037G	—	3	8		
	I_{of}	$\overline{V_{PF}}$ ="L", Shutdown, V_{IN}=7 V		—	1.5	3.5		
Shutdown input voltage	V_{IL}	$\overline{V_{PF}}$ ="L", Shutdown, V_{IN}=7 V		—	—	0.4	V	6
	V_{IH}	$\overline{V_{PF}}$ ="H", Power on, V_{IN}=7 V		2.0	—	—		

6. S-8730xxC Series

Table 11

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=4 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5 V, I_{OUT}=50 μA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=5 V, I_{OUT}=30 mA, Ta=−40°C to +85°C		—	±0.23	±0.92	mV /°C	
Shutdown output voltage	V_{OUTOFF}	V_{IN}=5V, $\overline{V_{PF}}$="L", R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of $-V_{DET}$	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C	S-873069C	—	±0.5	±2.0	mV /°C	
			S-873025C to S-873021C	—	±0.3	±1.2		
Detection voltage	$-V_{DET}$	S-873069C		6.734	6.900	7.066	V	
		S-873025C		2.440	2.500	2.560		
		S-873024C		2.342	2.400	2.458		
		S-873023C		2.244	2.300	2.356		
		S-873022C		2.147	2.200	2.253		
		S-873021C		2.049	2.100	2.151		
Sink current	I_{DOUT}	Nch, V_{DS}=0.5 V	V_{IN}=1.3 V Other than below	0.25	0.60	—	mA	4
			V_{IN}=2.4 V S-873069C, S-873025C	1.50	2.60	—		
			V_{IN}=3.6 V S-873069C	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V		—	—	0.1	μA	
Hysteresis width	V_{HYS}	—		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=5 V, Unloaded		—	3	8	μA	5
	I_{of}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=5 V		—	1.5	3.5		
Shutdown input voltage	V_{IL}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=5 V		—	—	0.4	V	6
	V_{IH}	$\overline{V_{PF}}$="H", Power on, V_{IN}=5 V		2.0	—	—		

7. S-875271C, S-875255C

Table 12

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=6.2 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7.2 V, I_{OUT}=50 µA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7.2 V, I_{OUT}=30 mA, Ta=−40°C to +85°C		—	±0.40	±1.60	mV /°C	
Shutdown output voltage	V_{OUTOFF}	V_{IN}=7.2V, $\overline{V_{PF}}$="L", R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of $-V_{DET}$	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C	S-875271C	—	±0.5	±2.0	mV /°C	
			S-875255C	—	±0.4	±1.6		
Detection voltage	$-V_{DET}$	S-875271C		6.929	7.10	7.271	V	
		S-875255C		5.368	5.50	5.632		
Sink current	I_{DOUT}	Nch, V_{DS}=0.5 V	V_{IN}=1.3V	0.25	0.60	—	mA	4
			V_{IN}=2.4V	1.50	2.60	—		
			V_{IN}=3.6V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V		—	—	0.1	µA	
Hysteresis width	V_{HYS}	—		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=7.2 V, Unloaded		—	4	8	µA	5
	I_{of}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=7.2 V		—	1.5	3.5		
Shutdown input voltage	V_{IL}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=7.2 V		—	—	0.4	V	6
	V_{IH}	$\overline{V_{PF}}$="H", Power on, V_{IN}=7.2 V		2.0	—	—		

8. S-875294C

Table 13

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Voltage Regulator								
Output voltage	V_{OUT}	V_{IN}=14.4 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		
Line regulation	ΔV_{OUT1}	V_{IN}=6.2 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=14.4 V, I_{OUT}=50 µA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=14.4 V, I_{OUT}=30 mA, Ta=−40°C to +85°C		—	±0.40	±1.60	mV /°C	
Shutdown output voltage	V_{OUTOFF}	V_{IN}=14.4 V, $\overline{V_{PF}}$="L", R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of $-V_{DET}$	$\frac{\Delta -V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C		—	±0.7	±2.8	mV /°C	
Detection voltage	$-V_{DET}$	—		9.174	9.40	9.626	V	
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V		—	—	0.1	µA	
Hysteresis width	V_{HYS}	—		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=14.4 V, Unloaded		—	4	9	µA	5
	I_{of}	$\overline{V_{PF}}$="L", Shutdown,, V_{IN}=14.4 V		—	2.1	4.7		
Shutdown input voltage	V_{IL}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=14.4 V		—	—	0.4	V	6
	V_{IH}	$\overline{V_{PF}}$="H", Power on, V_{IN}=14.4 V		2.6	—	—		

9. S-873361C

Table 14

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=4.3 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5.3 V, I_{OUT}=50 µA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature 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		—	±0.25	±1.00	mV /°C	
Shutdown output voltage	V_{OUTOFF}	V_{IN}=5.3 V, $\overline{V_{PF}}$="L", R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of $-V_{DET}$	$\frac{\Delta -V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C		—	±0.5	±2.0	mV /°C	
Detection voltage	$-V_{DET}$	—		5.953	6.100	6.247	V	
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=10 V		—	—	0.1	µA	
Hysteresis width	V_{HYS}	—		$-V_{DET}$ ×0.03	—	$-V_{DET}$ ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=5.3 V, Unloaded		—	4	8	µA	5
	I_{of}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=5.3 V		—	1.5	3.5		
Shutdown input voltage	V_{IL}	$\overline{V_{PF}}$="L", Shutdown, V_{IN}=5.3 V		—	—	0.4	V	6
	V_{IH}	$\overline{V_{PF}}$="H", Power on, V_{IN}=5.3 V		2.0	—	—		

10. S-8750xxE Series

Table 15

(Unless otherwise specified: Ta=25°C, Connect the SENSE pin to the VIN pin.)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Voltage Regulator								
Output voltage	V_{OUT}	V_{IN}=7 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		4.88	5.00	5.12	V	1
I/O voltage difference	V_{dif}	I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	0.15	0.40		
Line regulation	ΔV_{OUT1}	V_{IN}=6 to 24 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7 V, I_{OUT}=50 µA to 40 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7 V, I_{OUT}=30 mA, Ta=−40°C to +85°C, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	±0.38	±1.52	mV /°C	
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_{opr}	—		1.3	—	24	V	2
Temperature characteristic of −V_{DET}	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C	S-875077E	—	±0.6	±2.4	mV /°C	
			S-875061E		±0.5	±2.0		
Detection voltage	−V_{DET}	S-875077E		7.515	7.70	7.885	V	
		S-875061E		5.953	6.10	6.247		
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=−$V_{DET\ (Typ.)}$ +2 V		—	—	0.1	µA	
SENSE pin input current	I_{SENSE}	V_{IN}=7 V, V_{SENSE}=−$V_{DET\ (Typ.)}$ +2 V	S-875077E	—	0.6	1.7		7
			S-875061E	—	0.7	1.8		
Hysteresis width	V_{HYS}	—		−V_{DET} ×0.03	—	−V_{DET} ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=−$V_{DET\ (Typ.)}$+2 V, Unloaded	S-875077E	—	4	8	µA	5
			S-875061E	—	4	9		
	I_{of}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, Shutdown		—	1.5	3.5		

11. S-8730xxE Series

Table 16

(Unless otherwise specified: Ta=25°C, Connect the SENSE pin to the VIN pin.)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Voltage Regulator								
Output voltage	V_{OUT}	V_{IN}=5 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		2.928	3.000	3.072	V	1
I/O voltage difference	V_{dif}	I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	0.45	0.70		
Line regulation	ΔV_{OUT1}	V_{IN}=4 to 24 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5 V, I_{OUT}=50 μA to 40 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=5 V, I_{OUT}=30 mA, Ta=−40°C to +85°C, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	±0.23	±0.92	mV /°C	
Output voltage during voltage detection	V_{OUTOFF}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of −V_{DET}	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C	S-873082E	—	±0.6	±2.4	mV /°C	
			S-873062E	—	±0.5	±2.0		
Detection voltage	−V_{DET}	S-873082E		8.003	8.200	8.397	V	
		S-873062E		6.051	6.200	6.349		
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=−$V_{DET\ (Typ.)}$+2 V		—	—	0.1	μA	
SENSE pin input current	I_{SENSE}	V_{IN}=5 V, V_{SENSE}=−$V_{DET\ (Typ.)}$+ 2 V	S-873082E	—	0.6	1.7		7
			S-873062E	—	0.6	1.8		
Hysteresis width	V_{HYS}	—		−V_{DET} ×0.03	—	−V_{DET} ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=−$V_{DET\ (Typ.)}$+2 V, Unloaded		—	4	8	μA	5
	I_{of}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, Shutdown		—	1.5	3.5		

12. S-873330E

Table 17

(Unless otherwise specified: Ta=25°C, Connect the SENSE pin to the VIN pin.)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Voltage Regulator								
Output voltage	V_{OUT}	V_{IN}=5.3 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		3.220	3.300	3.380	V	1
I/O voltage difference	V_{dif}	I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	0.45	0.70		
Line regulation	ΔV_{OUT1}	V_{IN}=4.3 to 24 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=5.3 V, I_{OUT}=50 µA to 40 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature 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, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	±0.25	±1.00	mV /°C	
Output voltage during voltage detection	V_{OUTOFF}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of −V_{DET}	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C		—	±0.2	±0.8	mV /°C	
Detection voltage	−V_{DET}	—		2.928	3.000	3.072	V	
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	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=−$V_{DET\ (Typ.)}$+2 V		—	—	0.1	µA	
SENSE pin input current	I_{SENSE}	V_{IN}=5.3 V, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	0.5	1.3		7
Hysteresis width	V_{HYS}	—		−V_{DET} ×0.03	—	−V_{DET} ×0.08	V	2
Total								
Current consumption	I_{SS}	V_{IN}=−$V_{DET\ (Typ.)}$+2 V, Unloaded		—	4	8	µA	5
	I_{of}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, Shutdown		—	1.5	3.5		

13. S-8725xxE Series

Table 18

(Unless otherwise specified: Ta=25°C, Connect the SENSE pin to the VIN pin.)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Voltage Regulator								
Output voltage	V_{OUT}	V_{IN}=4.5 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		2.440	2.500	2.560	V	1
I/O voltage difference	V_{dif}	I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	0.65	1.00		
Line regulation	ΔV_{OUT1}	V_{IN}=4.5 to 24 V, I_{OUT}=30 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=4.5 V, I_{OUT}=50 μA to 40 mA, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=4.5 V, I_{OUT}=30 mA, Ta=−40°C to +85°C, V_{SENSE}=−$V_{DET\ (Typ.)}$+2 V		—	±0.23	±0.92	mV /°C	
Output voltage during voltage detection	V_{OUTOFF}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, R_L=1 MΩ		—	—	0.1	V	6
Voltage Detector								
Operating voltage	V_{opr}	—		1.3	—	24	V	2
Temperature characteristic of −V_{DET}	$\frac{\Delta - V_{DET}}{\Delta Ta}$	Ta=−40°C to +85°C	S-872548E	—	±0.5	±2.0	mV /°C	
			S-872530E to S-872526E	—	±0.2	±0.8		
Detection voltage	−V_{DET}	S-872548E		4.685	4.800	4.915	V	
		S-872530E		2.928	3.000	3.072		
		S-872526E		2.538	2.600	2.662		
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=−$V_{DET\ (Typ.)}$+2 V		—	—	0.1	μA	
SENSE pin input current	I_{SENSE}	V_{IN}=4.5V, V_{SENSE}=−$V_{DET\ (Typ.)}$ +2 V	S-872548E to S-872526E	—	0.5	1.3		7
Hysteresis width	V_{HYS}	S-872548E to S-872530E		−V_{DET} ×0.03	—	−V_{DET} ×0.08	V	2
		S-872526E		−V_{DET} ×0.02	—	−V_{DET} ×0.05		
Total								
Current consumption	I_{SS}	V_{IN}=−$V_{DET\ (Typ.)}$+2 V, Unloaded		—	4	8	μA	5
	I_{of}	V_{IN}=−$V_{DET\ (Typ.)}$−1 V, Shutdown		—	1.5	3.5		

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Table 19

(Unless otherwise specified: Ta=25°C)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
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		
Line regulation	ΔV_{OUT1}	V_{IN}=6 to 24 V, I_{OUT}=30 mA		—	15	50	mV	
Load regulation	ΔV_{OUT2}	V_{IN}=7 V, I_{OUT}=50 µA to 40 mA		—	15	50		
Input voltage	V_{IN}	—		—	—	24	V	
Temperature coefficient of V_{OUT}	$\frac{\Delta V_{OUT}}{\Delta Ta}$	V_{IN}=7 V, I_{OUT}=30 mA, Ta=–40°C to +85°C		—	±0.38	±1.52	mV /°C	
Voltage Detector								
Operating voltage	V_{opr}	—		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	
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	—		
			V_{IN}=3.6 V	3.00	4.50	—		
Leakage current	I_{LEAK}	Nch, V_{DS}=24 V, V_{IN}=15 V		—	—	0.1	µA	
Hysteresis width	V_{HYS}	—		0.085	—	0.215	V	2
Total								
Current consumption[*2]	I_{SS}	V_{IN}=7 V, Unloaded		—	4	8	µA	5

***1.** t_{pd} (ms)=(3.18min., 5.74typ., 8.73max.)×C_D(nF)
***2.** Excluding the charging current of C_D.

■ Measurement Circuits

1.

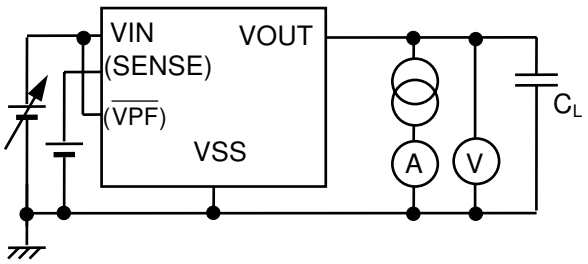

Figure 8

2.

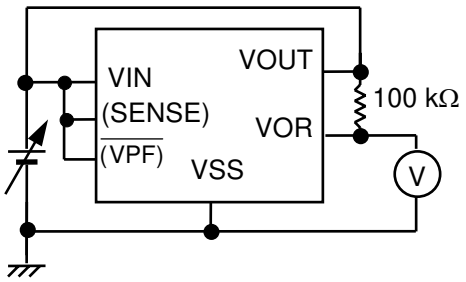

Figure 9

3.

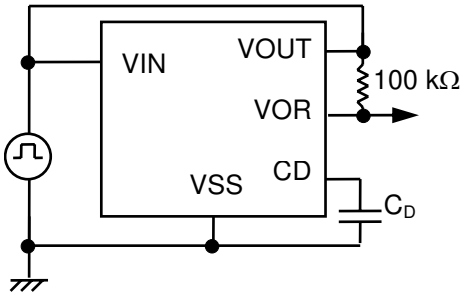

Figure 10

4.

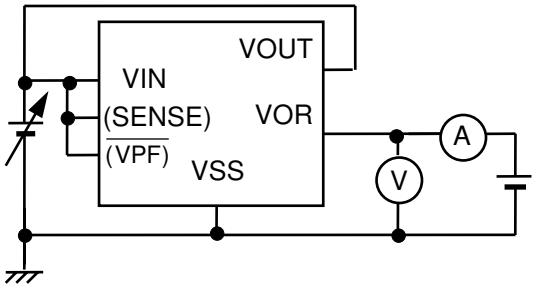

Figure 11

5.

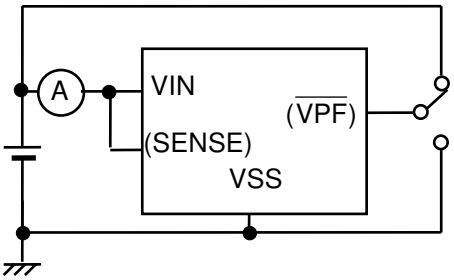

Figure 12

6.

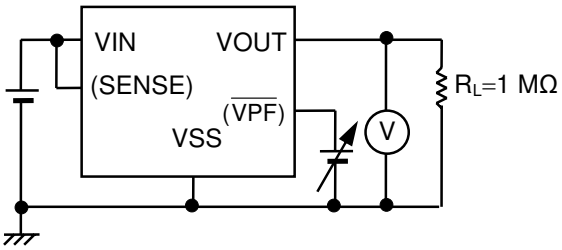

Figure 13

7.

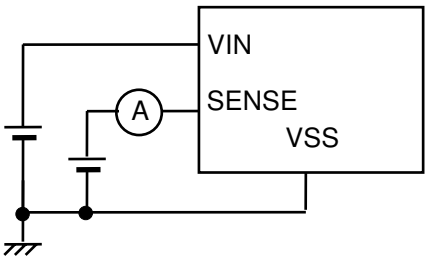

Figure 14