EPSON
EXCEED YOUR VISION

S1F78B17 Series Technical Manual

SEIKO EPSON CORPORATION

Rev.1.0

Table of Contents

1. DESCRIPTION

The S1F78B17 is a positive-voltage CMOS regulator IC. This IC provides the low output noise, high-speed load transient response, high-load stability, and high accuracy mechanisms.

The output voltage is fixed in the IC, and its allowance is between 1.5 to 4.0 V based on the laser trimming technique.

This IC consists of the reference voltage supply, output voltage setting resistor, overcurrent protection circuit, output voltage drop correction circuit, phase compensation circuit, chip enable circuit, pulse response circuit, and other components.

There are two kinds of packages provided: SOT23 and WCSP (size: 0.92 [mm] × 0.92 [mm]).

1.1 Features

● Low consumption current	At no-load operation [Typ.] 30μA, In standby [Max.] 0.1μA
● Output voltage	DC 1.5V to 4.0V (Can be set in 0.1V steps.)
● Output current	150mA (V_{DD}=V_{OUT}(S)+1.0V)
● Input-output potential difference	[Typ.] 0.30V (V_{OUT}(S)=3.3V, V_{DD}=4.3V, I_{OUT}=150mA)
● Output voltage accuracy	±2.0%
● Output voltage temperature coefficient	[Typ.] ±100ppm/°C
● Ripple rejection	[Typ.]60dB (f=1kHz)
● Overcurrent detection current	[Typ.]350mA
● Short-circuit holding current	[Typ.]50mA
● Range of ceramic capacitor	Cin=1.0μF, Cout=0.47μF

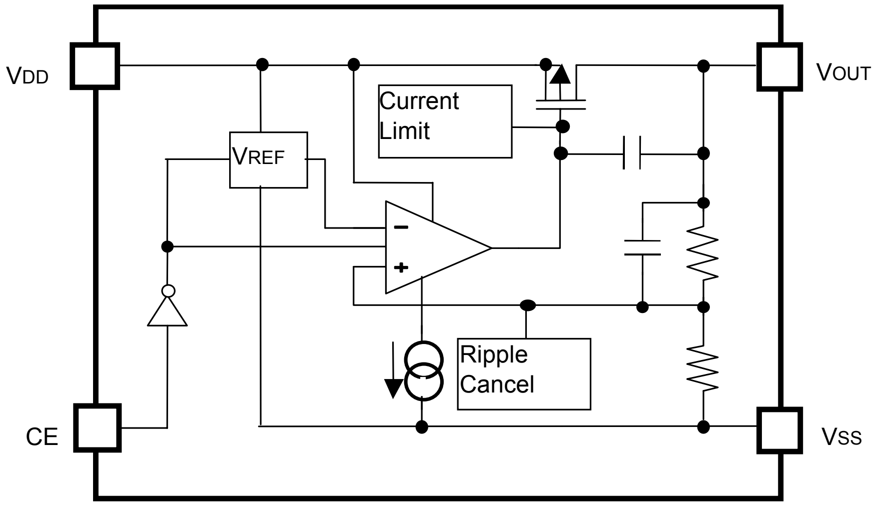
1.2 Package

SOT23	5PIN
WCSP	4PIN

1.3 Application

- Mobile communication equipment (Mobile-phone, cordless phone, radio communication equipment)
- Camera, video equipment
- Mobile AV equipment
- Portable game device
- Home appliance
- Battery equipment

2. BLOCK DIAGRAM



2.1 Selection guide

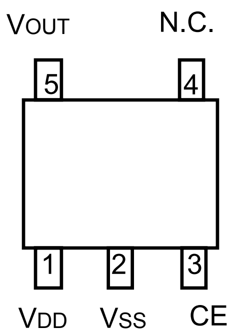
S1F78B17 ＊ ＊＊ 0 0 ＊＊

a b c d e

a	Package type Y SOT23-5pin B WCSP-4pin
b	Indicates the output voltage with a 2-digit value by decoupling the value.
c	Fixed to “0” in this IC.
d	Fixed to “0” in this IC.
e	Taping form (See the packing specifications.) 0R TR type

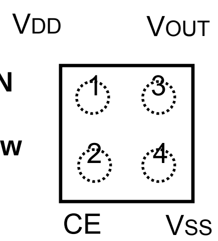
2.2 Pin assignment

SOT23 5PIN



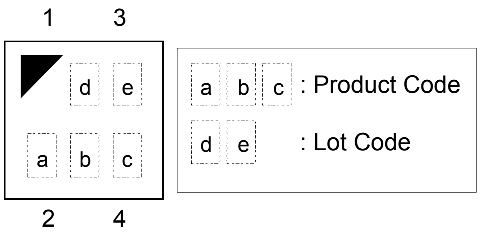
WCSP 4PIN

Top View

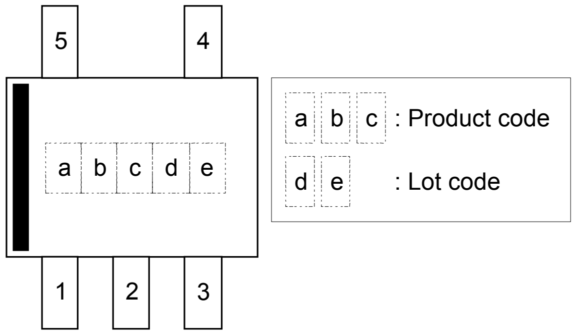


2.3 Marking

WCSP-4pin

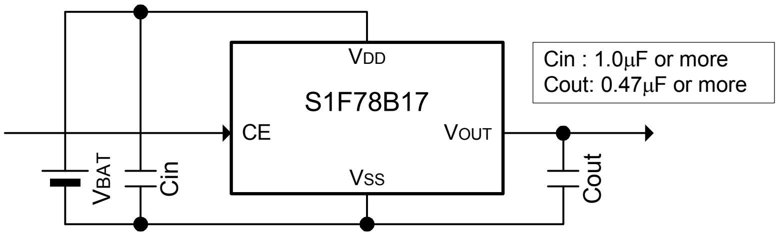


SOT23-5pin



VOUT option	a	b	c	VOUT option	a	b	c	VOUT option	a	b	c
—	—	—	—	2.6V	C	0	G	—	—	—	—
—	—	—	—	2.7V	C	0	H	—	—	—	—
—	—	—	—	2.8V	C	0	J	—	—	—	—
—	—	—	—	2.9V	C	0	K	—	—	—	—
1.5V	C	0	5	3.0V	C	P	0	—	—	—	—
1.6V	C	0	6	3.1V	C	P	1	—	—	—	—
1.7V	C	0	7	3.2V	C	P	2	—	—	—	—
1.8V	C	0	8	3.3V	C	P	3	—	—	—	—
1.9V	C	0	9	3.4V	C	P	4	—	—	—	—
2.0V	C	0	A	3.5V	C	P	5	—	—	—	—
2.1V	C	0	B	3.6V	C	P	6	—	—	—	—
2.2V	C	0	C	3.7V	C	P	7	—	—	—	—
2.3V	C	0	D	3.8V	C	P	8	—	—	—	—
2.4V	C	0	E	3.9V	C	P	9	—	—	—	—
2.5V	C	0	F	4.0V	C	P	A	—	—	—	—

2.4 Recommended circuit diagram



3. PIN DESCRIPTION

SOT23-5pin

Pin No.	Pin Name	Function
1	V_{DD}	Power input pin
2	V_{SS}	GND pin
3	CE	Chip enable pin (H:Enable / L:Disable)
4	N.C.	No connection
5	V_{OUT}	Voltage output pin

WCSP-4pin

Pin No.	Pin Name	Function
1	V_{DD}	Power input pin
2	CE	Chip enable pin (H:Enable / L:Disable)
3	V_{OUT}	Voltage output pin
4	V_{SS}	GND pin

4. ABSOLUTE MAXIMUM RATINGS

(Unless otherwise specified: T_a=25°C)

Item	Symbol	Rating	Unit
Power voltage	V_{DD}	V_{SS}-0.3 to V_{SS}+7.0	V
Output voltage	V_{OUT}	V_{SS}-0.3 to V_{DD}+0.3	V
Output current	I_{OUT}	150	mA
CE input voltage	V_{CE}	V_{SS}-0.3 to V_{DD}+0.3	V
Allowable dissipation	PD	SOT23WCSP 300T.B.D.	mW
Operating ambient temperature	Topr	-40 to +85	°C
Storage ambient temperature	Tstg	-55 to +125	°C

(Note) To stabilize the IC, insert the decoupling capacitor between V_{DD} and V_{SS}.

*1) Installation conditions at measurement of SOT23 allowable dissipation (Board specifications)
Glass epoxy, 40 × 40 × 1.6, FR-4 (2-layer board), wiring: 50%, wind speed: 0m/s

5. ELECTRICAL CHARACTERISTICS

● DC Characteristics

(Unless otherwise specified: Ta=25°C, Cin=Cout=1μF/Ceramics)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit	Measuring circuit
Output voltage	VOUT	VDD=VCE=VOUT(S)+1.0V, IOUT=50mA		VOUT(S) ×0.98	—	VOUT(S) ×1.02	V	Fig.1
Output current	IOUT	VDD=VCE=VOUT(S)+1.0V		150	—	—	mA	Fig.1
Input voltage	VDD	—		—	—	5.5	V	Fig.1
Input stability	dVOUT / dVDD•VOUT	VOUT(S)+0.5V≤VDD≤5.5V, VCE=VDD IOUT=50mA		—	0.05	0.2	%/V	Fig.2
Input-output potential difference	Vdiff	Vdiff=VDDA-VOUT,*) VDDA: VDD value with VOUT set to 98%	3.2V<VOUT(S)<=4.0V	—	0.25	0.35	V	Fig.2
			2.6V<VOUT(S)<=3.2V	—	0.30	0.45	V	
			2.0V<VOUT(S)<=2.6V	—	0.40	0.55	V	
			1.5V<=VOUT(S)<=2.0V	—	0.50	0.65	V	
Load stability	dVOUT / dIOUT	VDD=VCE=VOUT(S)+1.0V 1mA≤IOUT≤150mA		—	20	40	mV	Fig.1
Current consumption (no-load operation)	ISS1	VDD=VCE=VOUT(S)+1.0V, IOUT=0mA		—	30	50	μA	Fig.3.1
Current consumption (standby)	ISS0	VDD=VOUT(S)+1.0V, VCE=VSS		—	0.01	1	μA	Fig.3.2
Limited current	ILIM	VDD=VCE=VOUT(S)+1.0V		—	350	—	mA	Fig.1
Short-circuit current	ISHORT	VDD=VCE=VOUT(S)+1.0V, VOUT=VSS		—	50	—	mA	Fig.1
Discharge Tr ON resistance	RDIST	VDD=4.0V, VCE=VSS, VOUT=3.0V		66	110	154	Ω	Fig.7
CE HIGH level input voltage	VCEH	VDD=VOUT(S)+1.0V		1.1	—	VDD	V	Fig.6
CE LOW level input voltage	VCEL	VDD=VOUT(S)+1.0V		VSS	—	0.25	V	Fig.6
CE HIGH level input current	ICEH	VDD=VOUT(S)+1.0V, VCE=1.1V		-1.95	-1	-0.45	μA	Fig.6
CE LOW level input current	ICEL	VDD=VOUT(S)+1.0V, VCE=VSS		-0.1	—	0.1	μA	Fig.6

(Unless otherwise specified: Ta=25°C, Cin=COUT=1μF/Ceramics)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Measuring circuit
Output voltage temperature coefficient	dVOUT / dTa	VDD=VCE=VOUT(S)+1.0V -40°C≤Ta≤85°C, IOUT=50mA	—	±100	—	ppm/°C	Fig.1
Ripple rejection	RR	VDD=VCE=VOUT(S)+1.0V, IOUT=50mA, f=1kHz, Vripple=0.2Vp-pAC	—	60	—	dB	Fig.4

Note 1) VOUT : Actual output voltage value
VOUT(S): Rated output voltage value

5. ELECTRICAL CHARACTERISTICS

■ Electrical characteristics [DC Characteristics]

1. Output voltage (Measuring circuit, Fig.1)

Range of output value when the input voltage is changed in the specified output current and temperature.

V_{OUT}: Actual output voltage value

$V_{OUT}(S)$: Rated output voltage value $V_{OUT}(S)*0.98 \leq V_{OUT} \leq V_{OUT}(S)*1.02$

The output voltage accuracy guarantees +/-2[%].

<Conditions>

Supply output current I_{OUT}=50 [mA], and change the input voltage from V_{OUT} (S)+0.1 [V] to 5.5 [V].

2. Output current (Measuring circuit, Fig.1)

Current that is stably output with normal operation.

Minimum current value when the actual output voltage V_{OUT} become less than 95% of the rated output value $V_{OUT}(S)$ by increasing the output current by degrees.

<Conditions>

Apply the input voltage of $V_{OUT}(S)$+1.0 [V].

3. Input stability (Measuring circuit, Fig.2)

Maximum value in change of the output voltage that is caused when changing the input voltage while maintaining the output current.

- V_{OUT1}: Changed output voltage
- V_{IN}: Changed input voltage (Rated output voltage +0.5 [V] ≤ V_{IN} ≤ Maximum input voltage)
- V_{OUT}: Rated output voltage

Rated output voltage

$$\text{Input Stability} = \frac{\Delta V_{OUT1}}{\Delta V_{IN} \cdot V_{OUT}}$$

<Conditions>

Supply output current I_{OUT}=50 [mA], and apply the input voltage from $V_{OUT}(S)$+0.5 [V] to rated input voltage 5.5 [V].

4. Load stability (Measuring circuit, Fig.1)

Maximum value in change of the output voltage that is caused when changing the output current while maintaining the input voltage.

<Conditions>

Maximum value in change of the output voltage that is caused when changing the output voltage from 1 [mA] to 150 [mA] while maintaining the input voltage $V_{OUT}(S)$+1.0 [V].

5. Input-output potential difference (Measuring circuit, Fig.2)

Potential difference between input and output voltages when changing the output current as a parameter.

Potential difference between input and output voltages when the output voltage lowers to 98 [%] by reducing the input voltage by degrees while maintaining the output current.

<Conditions>

Specify input-output potential differences Typ. and Max., using output current I_{OUT}=150 [mA] as the reference.

6. Output voltage temperature coefficient (Measuring circuit, Fig.1)

Rate in change of the output voltage that is caused when changing the ambient temperature while maintaining the output current. Obtained from the following formula.

$$\text{Output voltage temperature coefficient [ppm/°C]} = \frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}} \text{[ppm/°C]} = \frac{\Delta V_{OUT}}{\Delta Ta} \text{[mV/°C]} * \frac{1}{V_{OUT}(S)} \text{[V]} * 1000$$

<Conditions>
Rate in change of the output voltage that is caused when changing the rated range from -40 [°C] to +85 [°C] while setting the input voltage to V_{OUT}(S)+1.0 [V] and applying the output current I_{OUT}=50 [mA].

7. Current consumption (no-load operation) (Measuring circuit, Fig.3.1)
CE pin=V_{DD} (IC active state), operating current at a specific input voltage and load current.

<Conditions>
Current value at CE=V_{DD} and I_{OUT}= 0 [mA]; the input voltage is set to V_{OUT} (S)+1.0 [V].

8. Current consumption (standby) (Measuring circuit, Fig.3.2)
Input current value that is obtained when changing the input voltage while setting CE pin=V_{SS} and output open (no connection) state.

<Conditions>
Current value at CE=V_{SS} and I_{OUT}= 0 [mA]; the input voltage is set to V_{OUT}(S)+1.0 [V].

9. Limited current (Measuring circuit, Fig.1)
Output current value required to run the overcurrent protection circuit.
Maximum current value when the output voltage drastically lowers by the overcurrent protection circuit that prevents overcurrent. (Max. IC output current)

<Conditions>
Set the input voltage to V_{OUT}(S)+1.0 [V] and the CE pin voltage to V_{DD}.

10. Short-circuit current (Measuring circuit, Fig.1)
Value of the current that is supplied to the output when the output pin is short-circuited with V_{SS}. Output current value required to run the short-circuit current protection circuit.

<Conditions>
Set the input voltage to V_{OUT}(S)+1.0 [V] and the CE pin voltage to V_{DD}, then connect the output pin to V_{SS}.

11. Ripple rejection (Measuring circuit, Fig.4)
Indicates the ratio with which AC components included in the input voltage appear in the output voltage, by [dB].

<Conditions>
Input voltage=CE pin voltage=V_{OUT}(S)+1.0[V] Output current I_{OUT}=50[mA]
Frequency obtained by superposing the sine wave of 0.2 [Vp-pAC] with the input voltage: 10 [Hz] to 100 [kHz]

12. Discharge Tr ON resistance (Measuring circuit, Fig.7)
ON resistance value of internal transistor that removes (discharges) the Cout charge in the standby state.

<Conditions>
Obtained from the value of the current that is supplied to the V_{OUT} pin when the power is applied externally at input voltage=4.0V, CE=V_{SS}, V_{OUT}=3V.

■ Electrical characteristics [AC Characteristics]

13. Input transient response (Measuring circuit, Fig.2)
Change of the output voltage that is caused when the input voltage is changed instantaneously.

<Conditions>
Response of the output voltage that is caused when the input voltage is changed from V_{OUT}+1.0 [V] to V_{OUT}+2.0 [V] or from V_{OUT}+2.0 [V] to V_{OUT}+1.0 [V] at 5[μs]. Output current I_{OUT}=50 [mA]

14. Load transient response (Measuring circuit, Fig.1)

Change of the output voltage that is caused when the output current is changed at 500 [ns].

<Conditions>

1) Response of the output voltage that is caused when the output current is changed from 1.0 [mA] to 50 [mA] or from 50 [mA] to 1.0 [mA]. Input voltage=V_{OUT}(S)+1.0 [V], Cout=4.7 [μF]
2) Response of the output voltage that is caused when the output current is changed from 1.0 [mA] to 150 [mA] or from 150 [mA] to 1.0 [mA]. Input voltage=V_{OUT}(S)+1.0 [V], Cout=4.7 [μF]

15. CE pin transient response (Measuring circuit, Fig.5)

Change of the output voltage that is caused when the CE pin is changed from OFF to ON or from ON to OFF.

<Conditions>

Output current I_{OUT}=50 [mA], input voltage=V_{OUT}(S)+1.0 [V]

Change of the output voltage that is caused when the CE pin voltage is changed from 0 [V] to more than HIGH level voltage (1.1 [V]) at 1 [μs].

6. MEASURING CIRCUIT

Fig.1

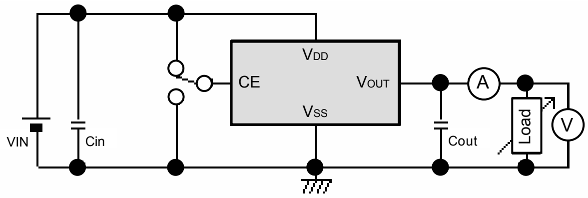


Fig.2

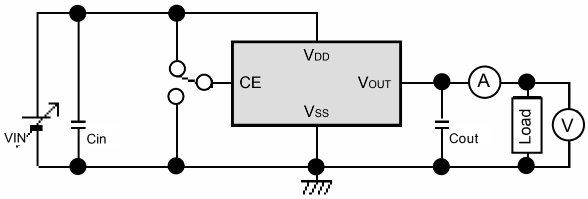


Fig.3.1

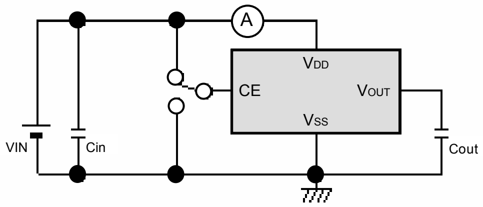


Fig.3.2

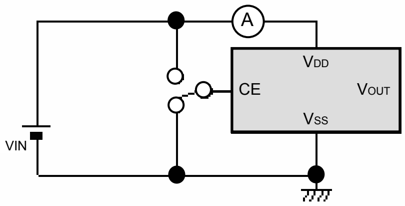


Fig.4

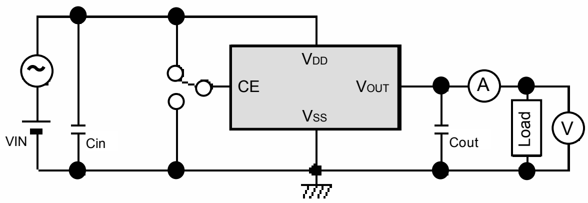


Fig.5

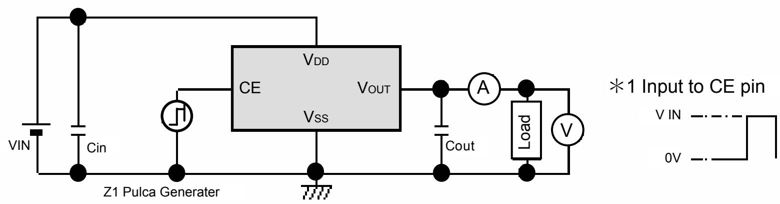


Fig.6

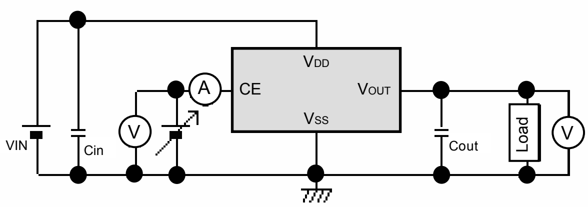
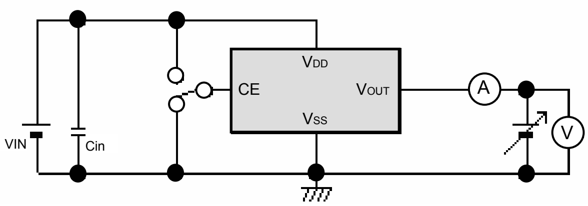
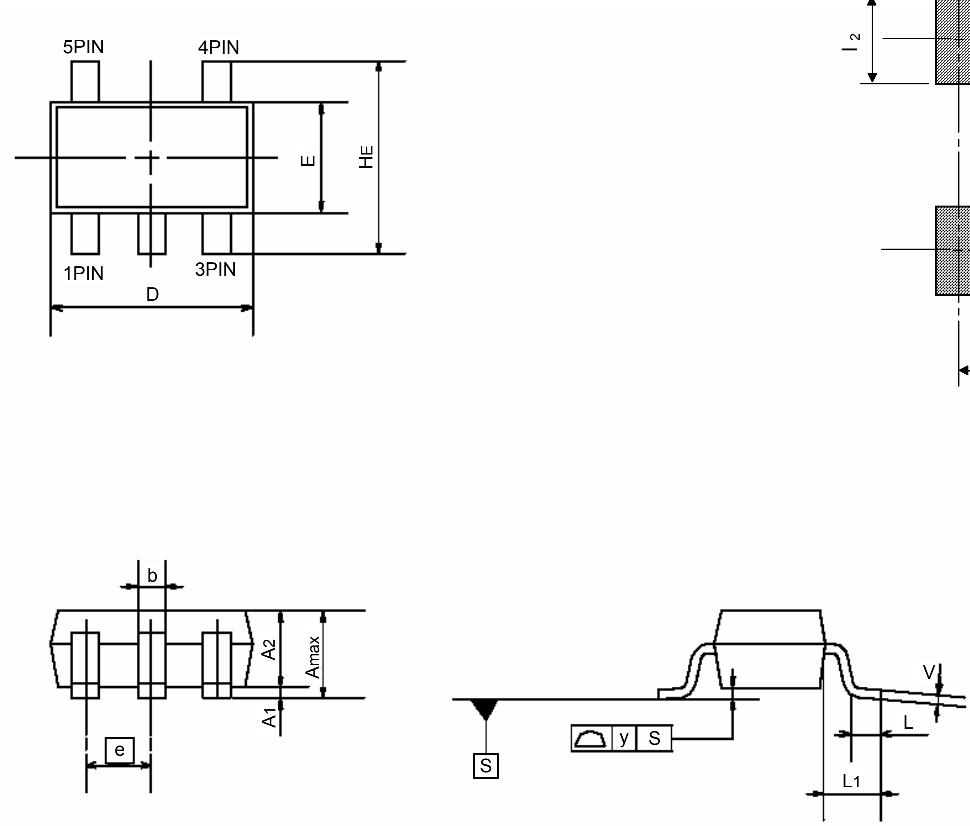


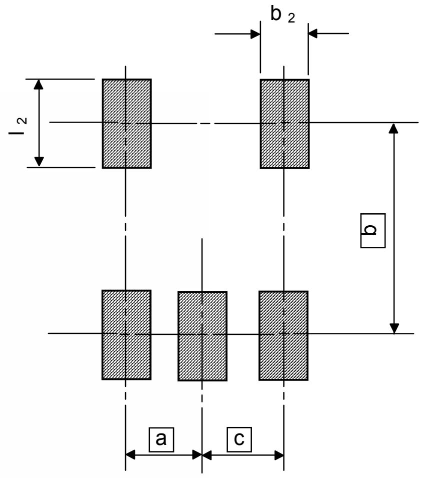
Fig.7



7. DIMENSIONS

・ SOT23-5





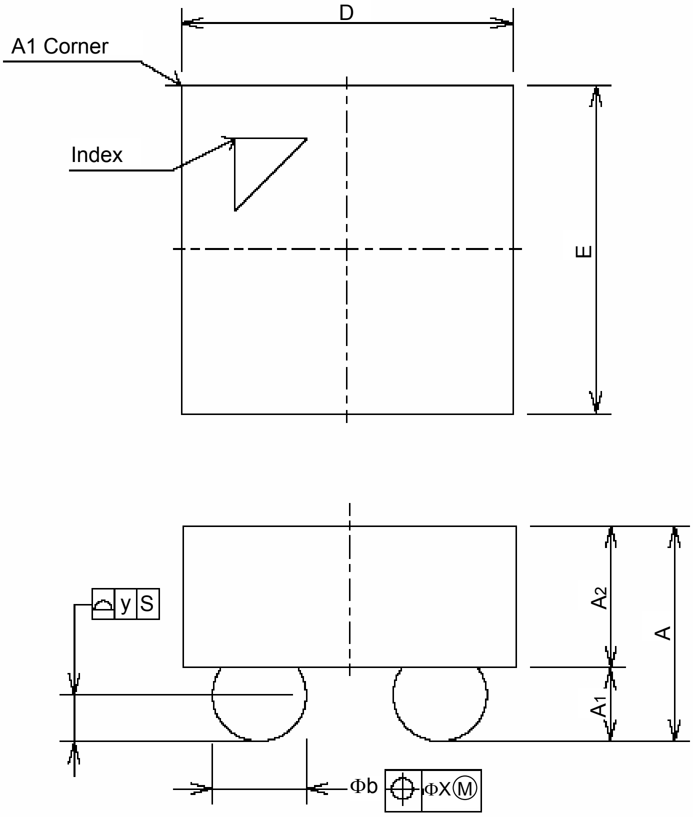
$\boxed{e_1}$	2.40
l_2	1.00
$\boxed{a}$	0.95
b_1	0.60

symbol	Dimension in Millimeters		
	Min.	Nom.	Max.
D	—	2.9	—
E	—	1.6	—
A_{MAX}	—	—	1.40
A_L	0	—	0.15
A_e	—	1.1	—
$\boxed{e}$	—	0.95	—
b	0.3	—	0.5
C	0.1	—	0.26
L	0.2	—	0.6
L1	—	0.6	—
H_E	—	2.8	—
Y	—	—	0.1

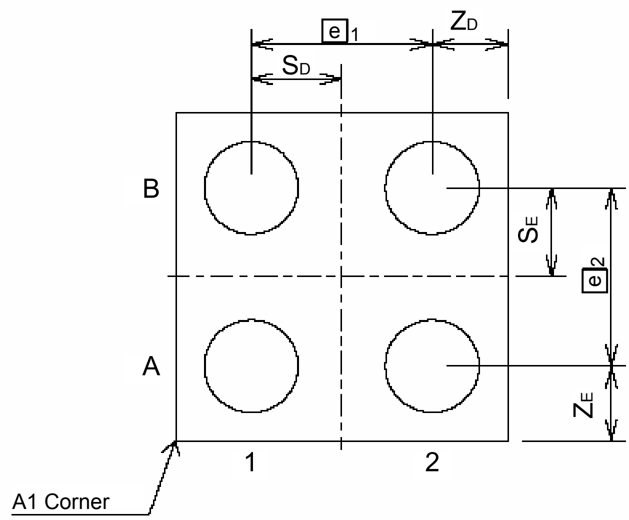
1=1mm

- WCSP-4

Top View



Bottom View



	Dimension in Millimeters		
symbol	**Min.**	**Nom.**	**Max.**
D	—	0.920	—
E	—	0.920	—
A	—	—	0.65
A_1	—	0.21	—
A_2	—	—	—
$\boxed{e}_1$	—	0.50	—
$\boxed{e}_2$	—	0.50	—
b	0.23	0.26	0.29
x	—	—	0.08
y	—	—	0.05
S_D	—	0.25	—
S_E	—	0.25	—
Z_D	—	0.210	—
Z_E	—	0.210	—

8. CHARACTERISTIC EXAMPLES

1) Characteristics examples between output voltage and output current

[Measuring conditions] $V_{DD}=V_{OUT}(S)+1.0V$, $V_{SS}=0.0V$, $CE=V_{DD}$, Topr=25°C, Cin=Cout=1.0μF

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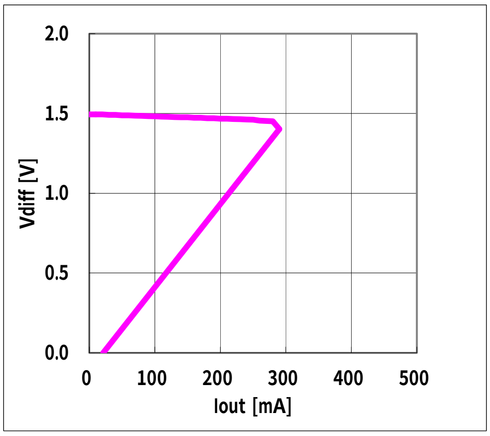

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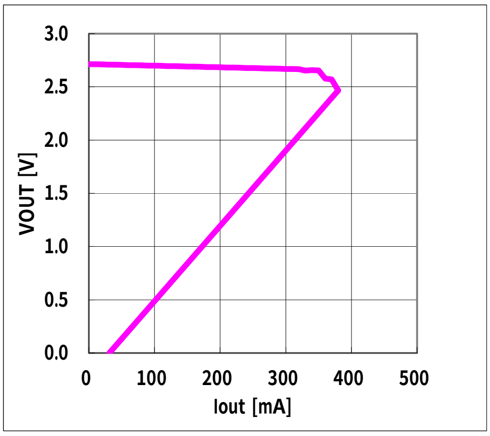

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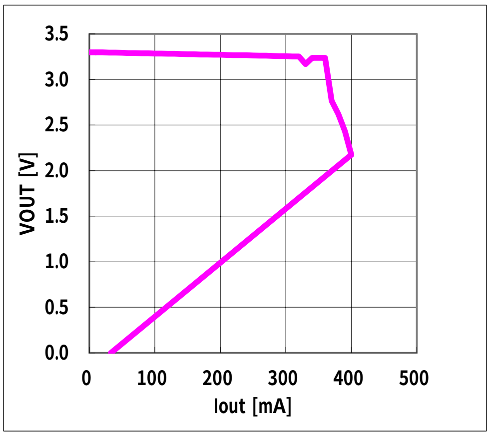
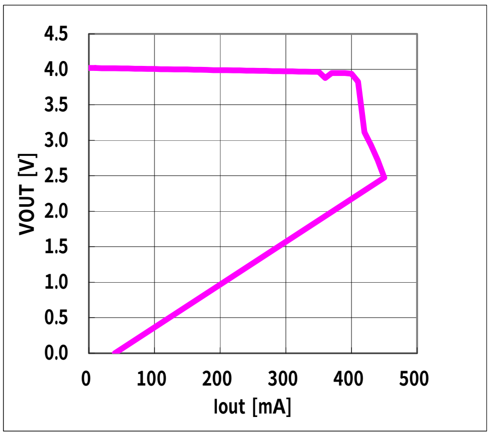


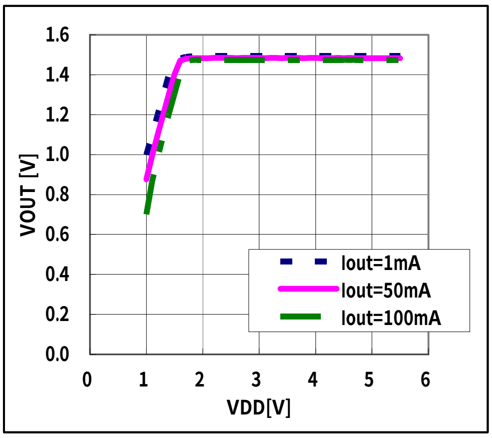
S1F78B17*40000R



2) Characteristics examples between output voltage and input voltage

[Measuring conditions] V_{SS}=0.0V, CE=V_{DD}, Topr=25°C, Cin=Cout=1.0μF

S1F78B17*15000R



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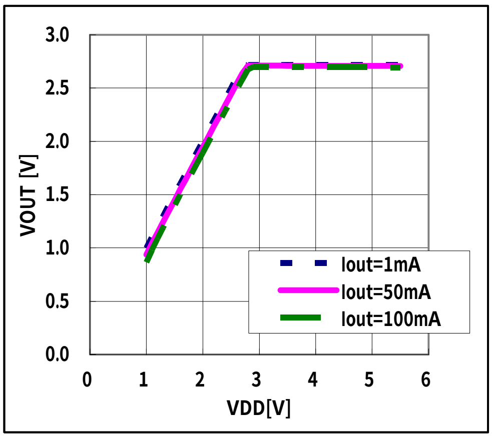
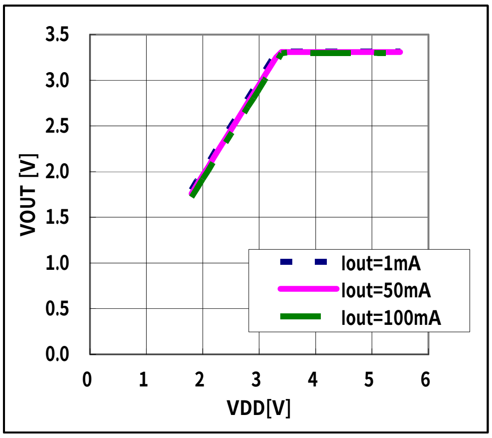


S1F78B17*33000R



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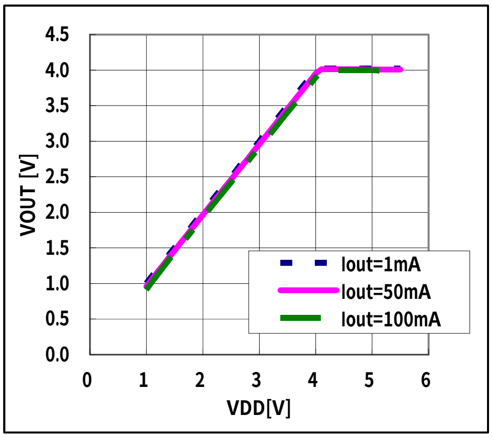
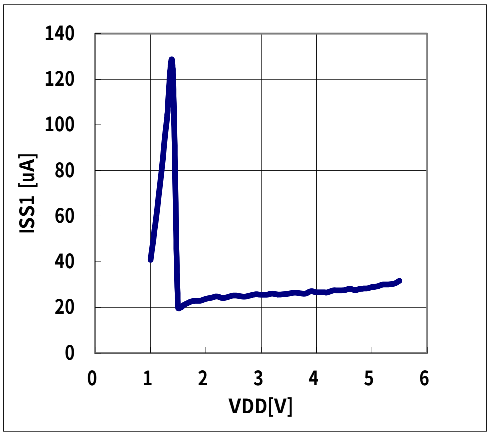


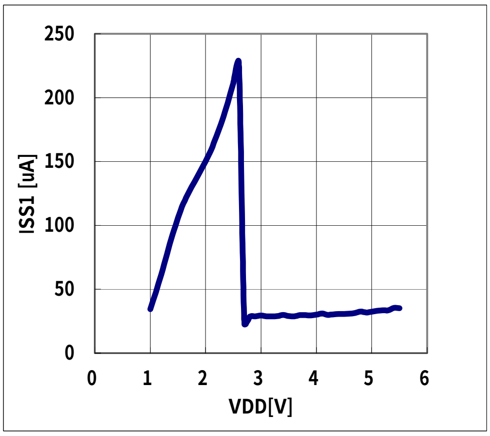
3) Characteristics between consumption current and input voltage

[Measuring conditions] VSS=0.0V, CE=VDD, Topr=25°C, Cin=Cout=1.0μF, Iout=0mA

S1F78B17*15000R



S1F78B17*27000R



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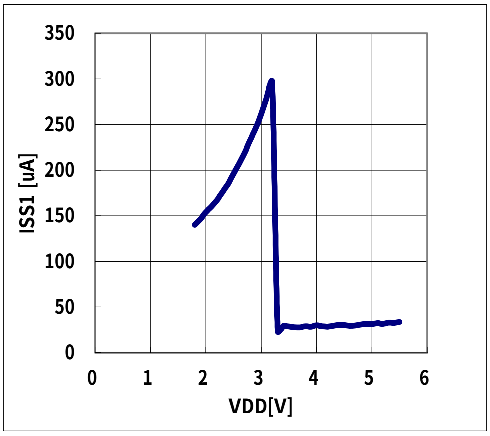
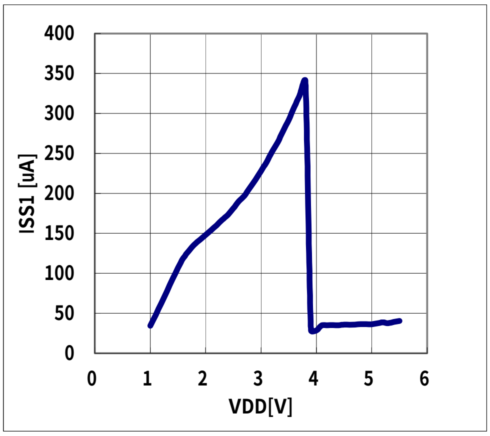
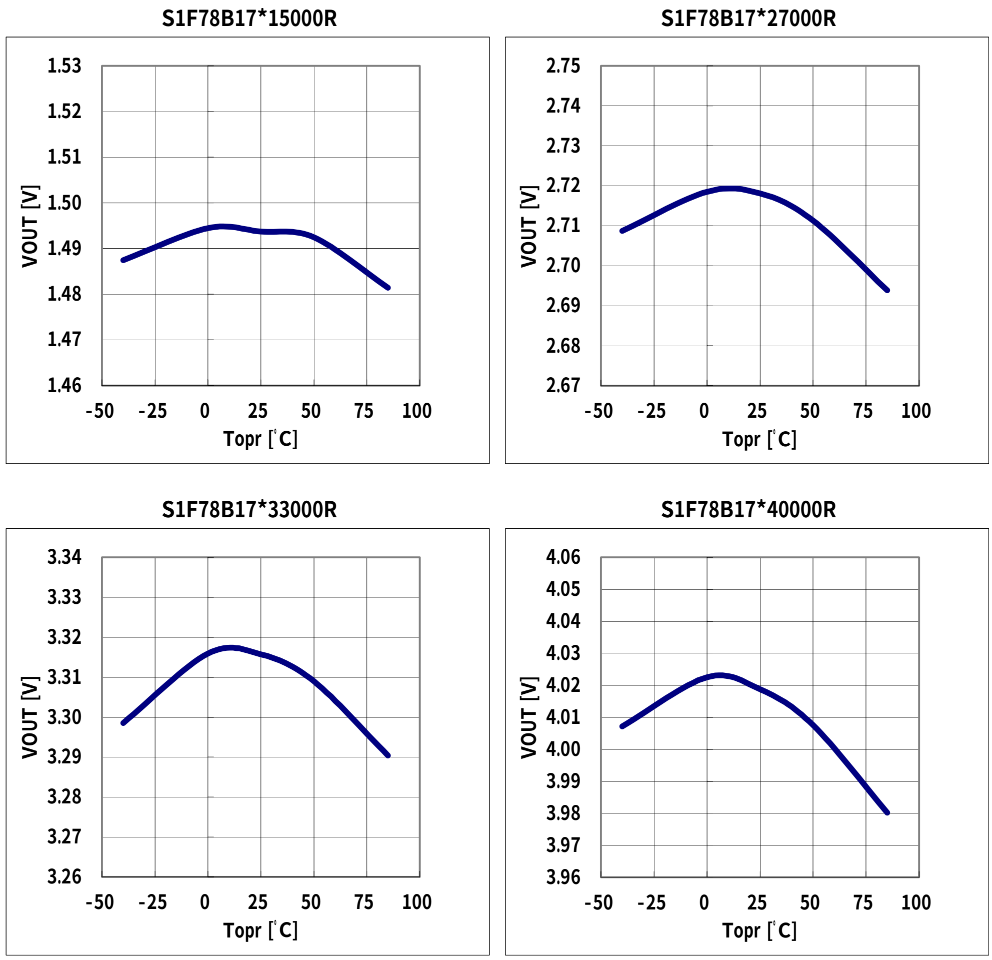


S1F78B17*40000R

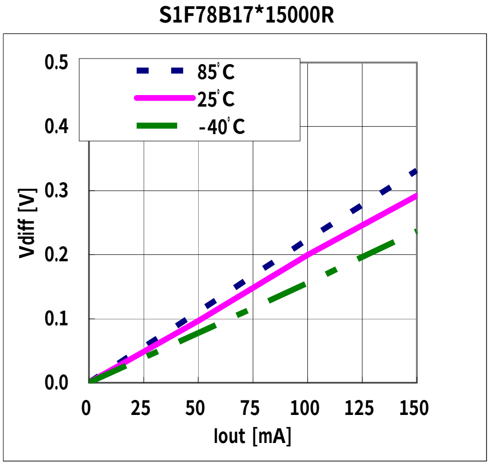


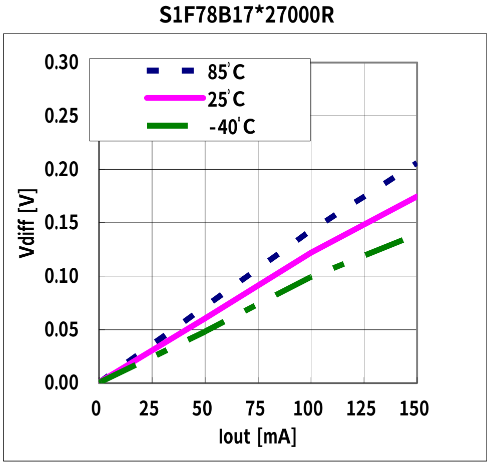
4) Characteristics between output voltage and ambient temperature

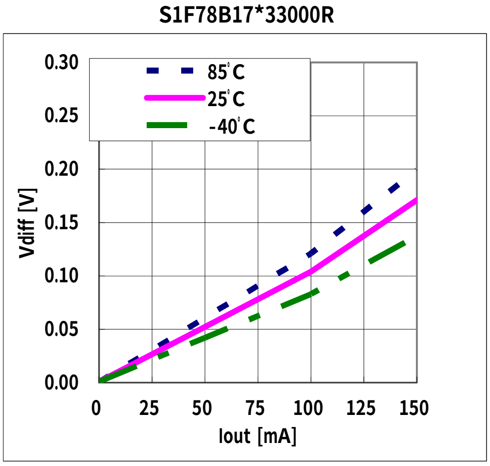
[Measuring conditions] $V_{DD}=V_{OUT}(S)+1.0V$, $V_{SS}=0.0V$, CE=V_{DD}, Cin=Cout=1.0μF, Iout=0mA

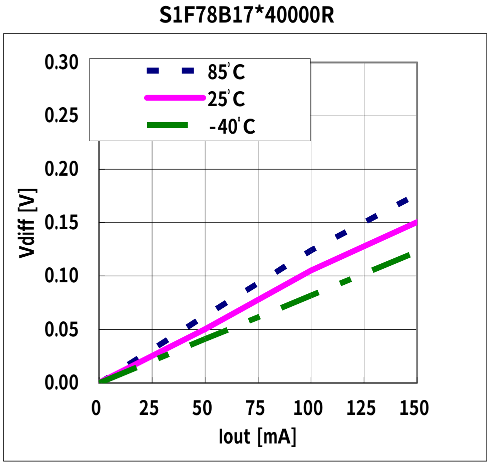


5) Characteristic examples between input-output potential difference and output current

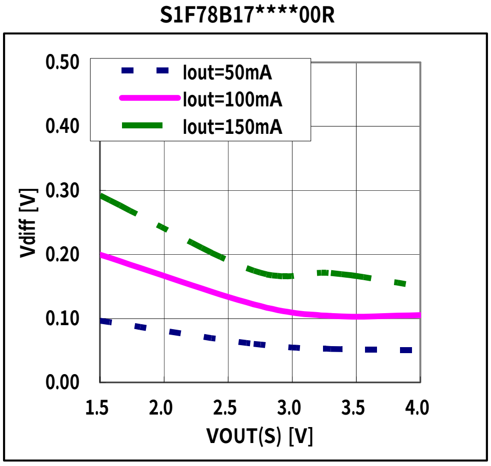








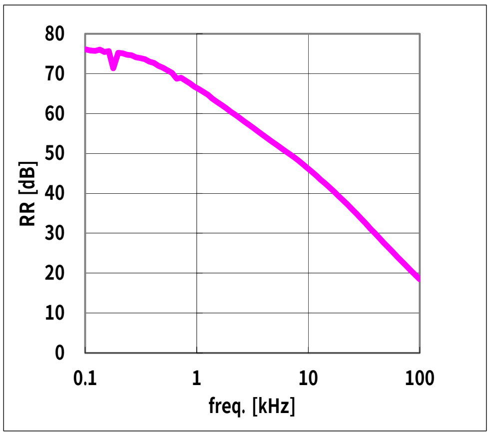
6) Characteristic examples between input-output potential difference and set output voltage



7) Characteristics between ripple rejection and frequency

[Measuring conditions] V_{DD}=V_{OUT}(S)+1.0V+0.2Vp-p, V_{SS}=0.0V, CE=V_{DD}, Topr=25℃, Cin=Cout=1.0μF, Iout=50mA

S1F78B17*15000R



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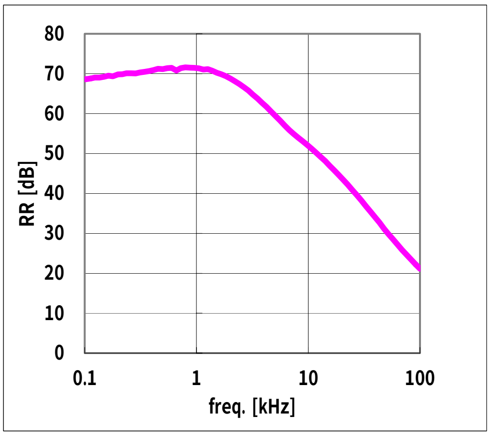
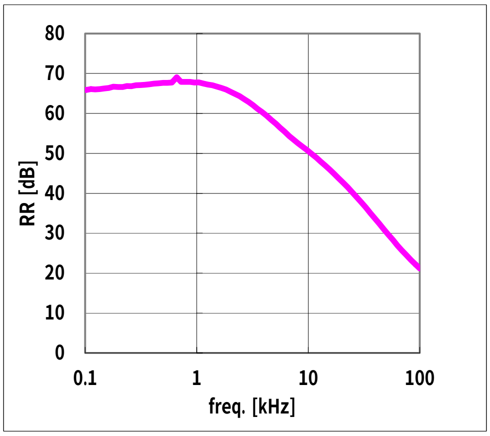
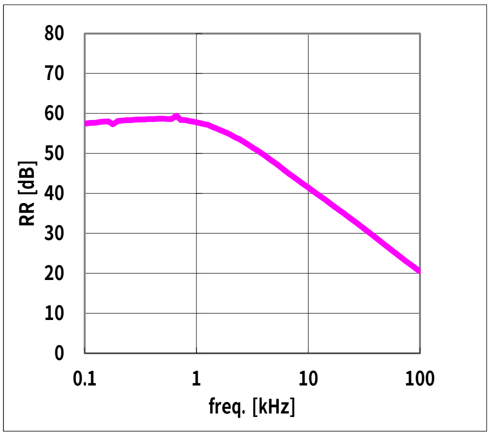


S1F78B17*33000R



S1F78B17*40000R

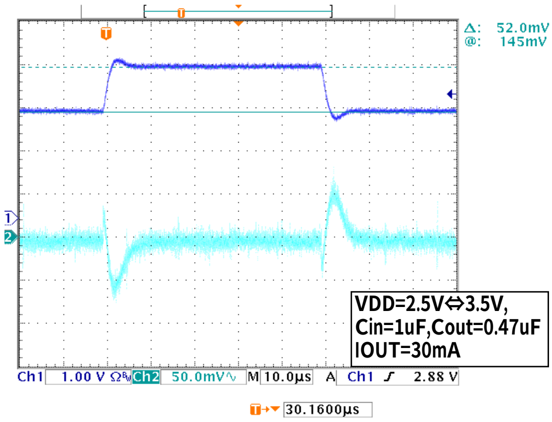


8) Characteristics examples of input transient response

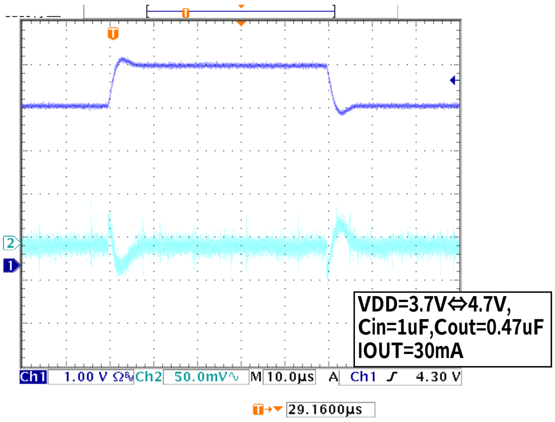
[Measuring conditions] V_{SS}=0.0V, CE=V_{DD}, Topr=25°C

* Upper: V_{DD}, Lower: V_{OUT} in the following waveforms.

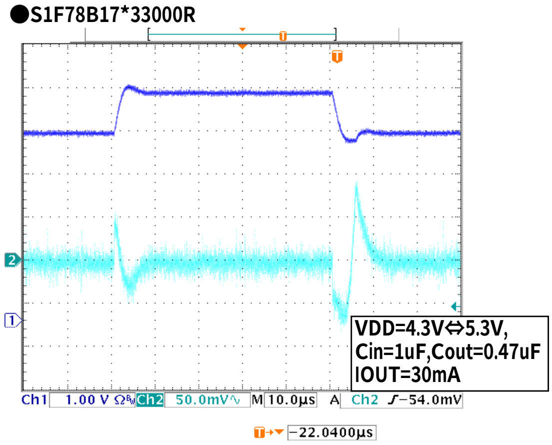
●S1F78B17*15000R



●S1F78B17*27000R



●S1F78B17*33000R

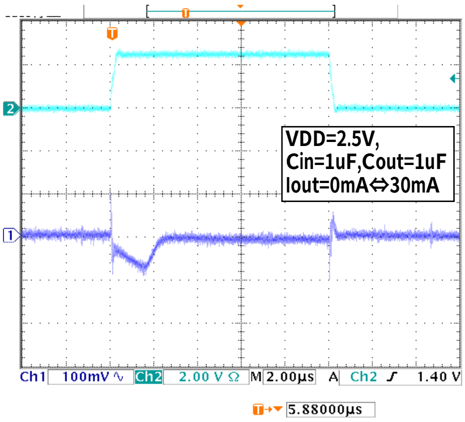


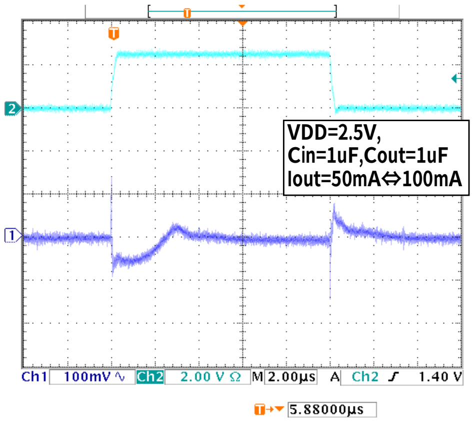
9) Characteristics examples of load transient response

[Measuring conditions] VSS=0.0V, CE=VDD, Topr=25°C

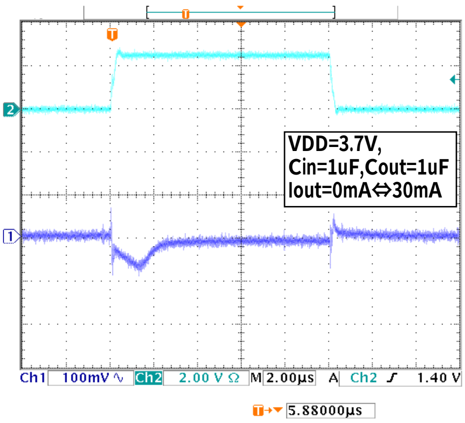
* Upper: VDD, Lower: VOUT in the following waveforms.

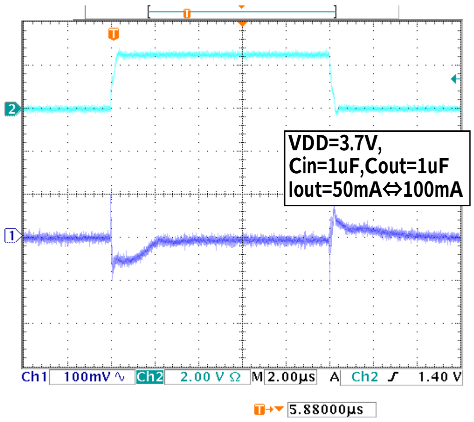
●S1F78B17*15000R



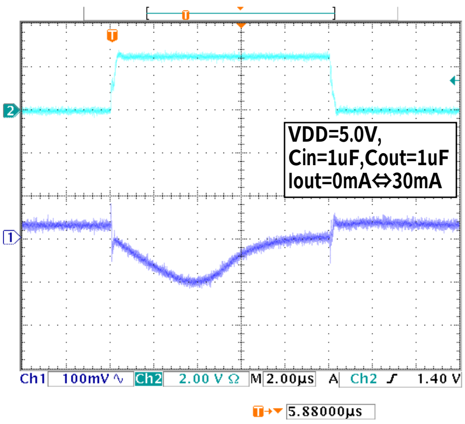


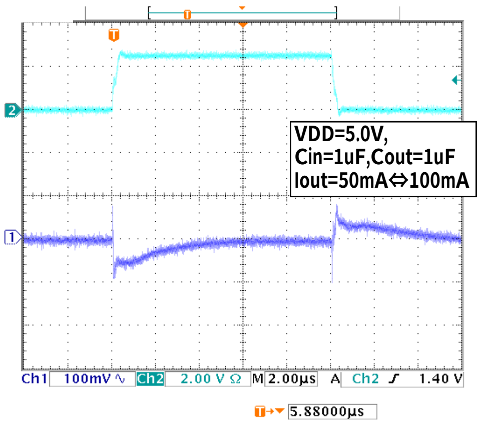
●S1F78B17*27000R





●S1F78B17*40000R



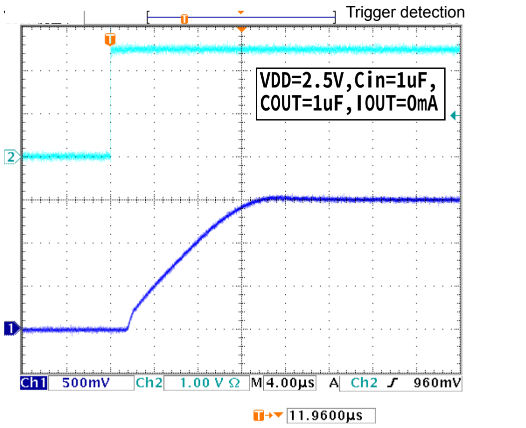


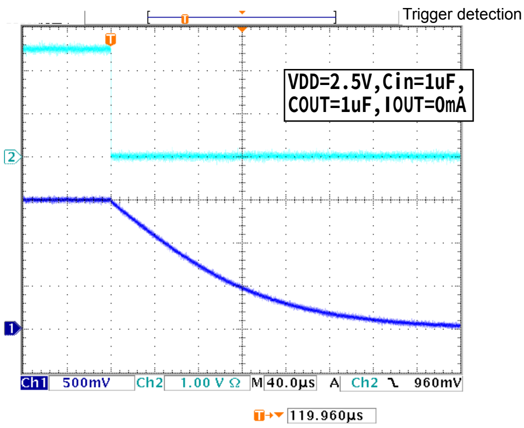
10) Characteristics examples of CE pin transient response

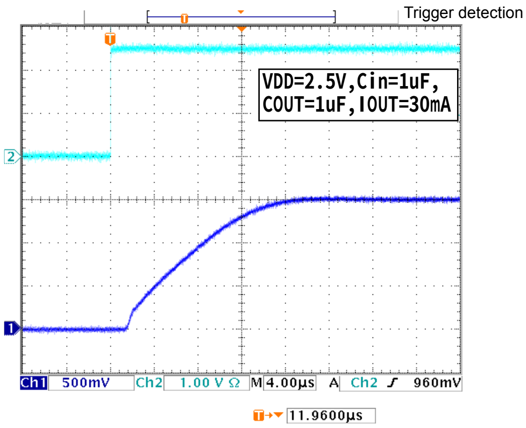
[Measuring conditions] VSS=0.0V, CE=VSS⇔VDD, Topr=25°C

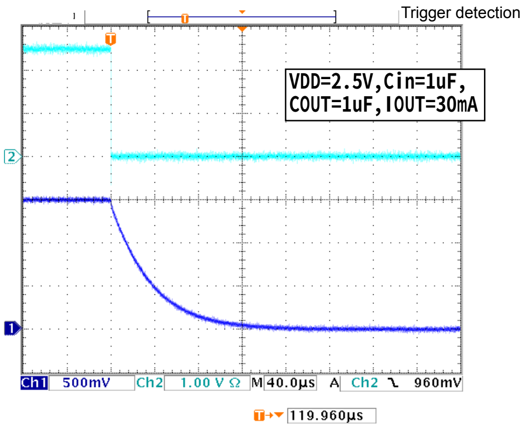
* Upper: CE, Lower: VOUT in the following waveforms.

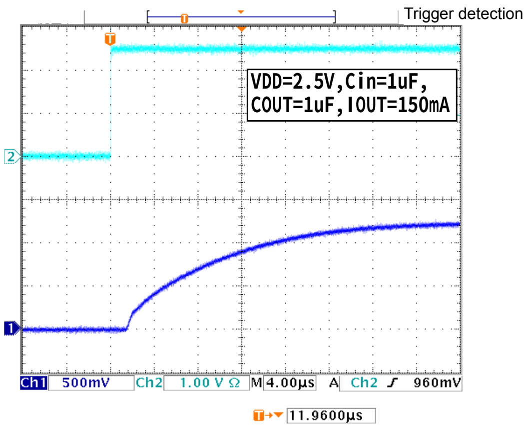
●S1F78B17*15000R

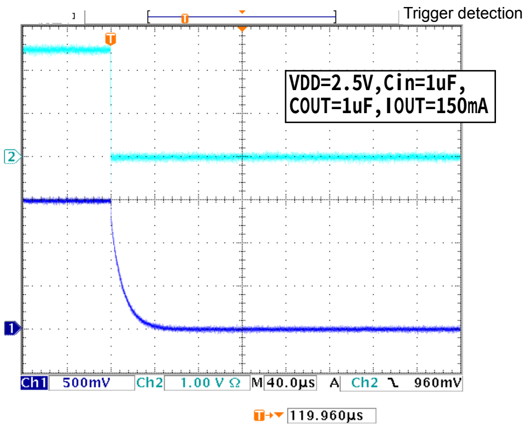












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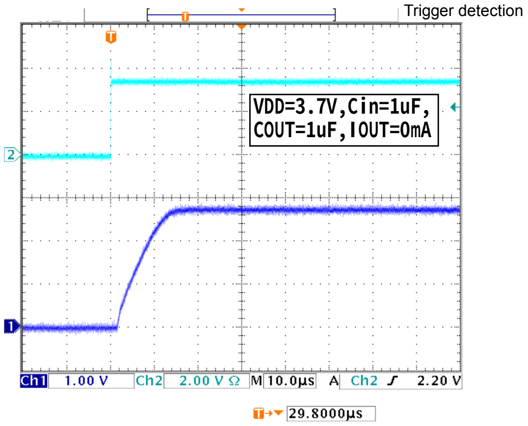
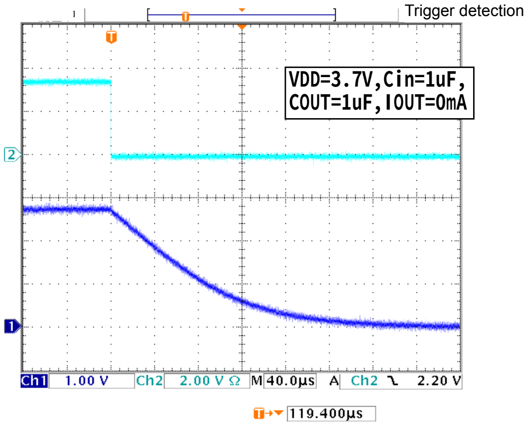
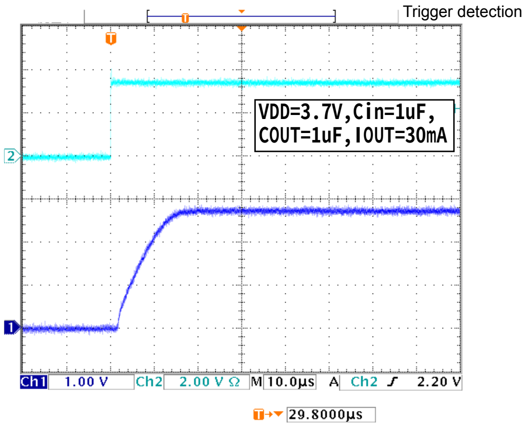
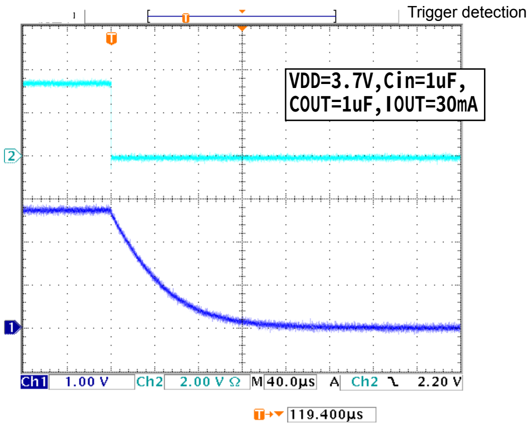
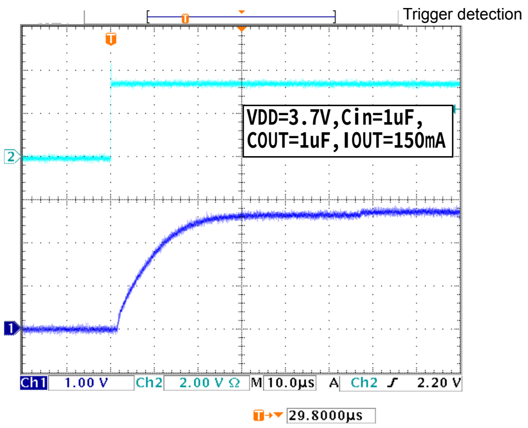
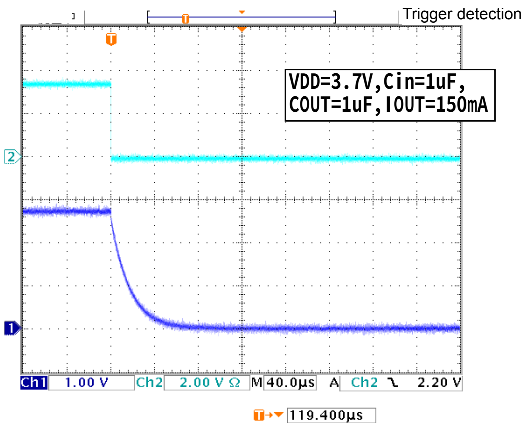




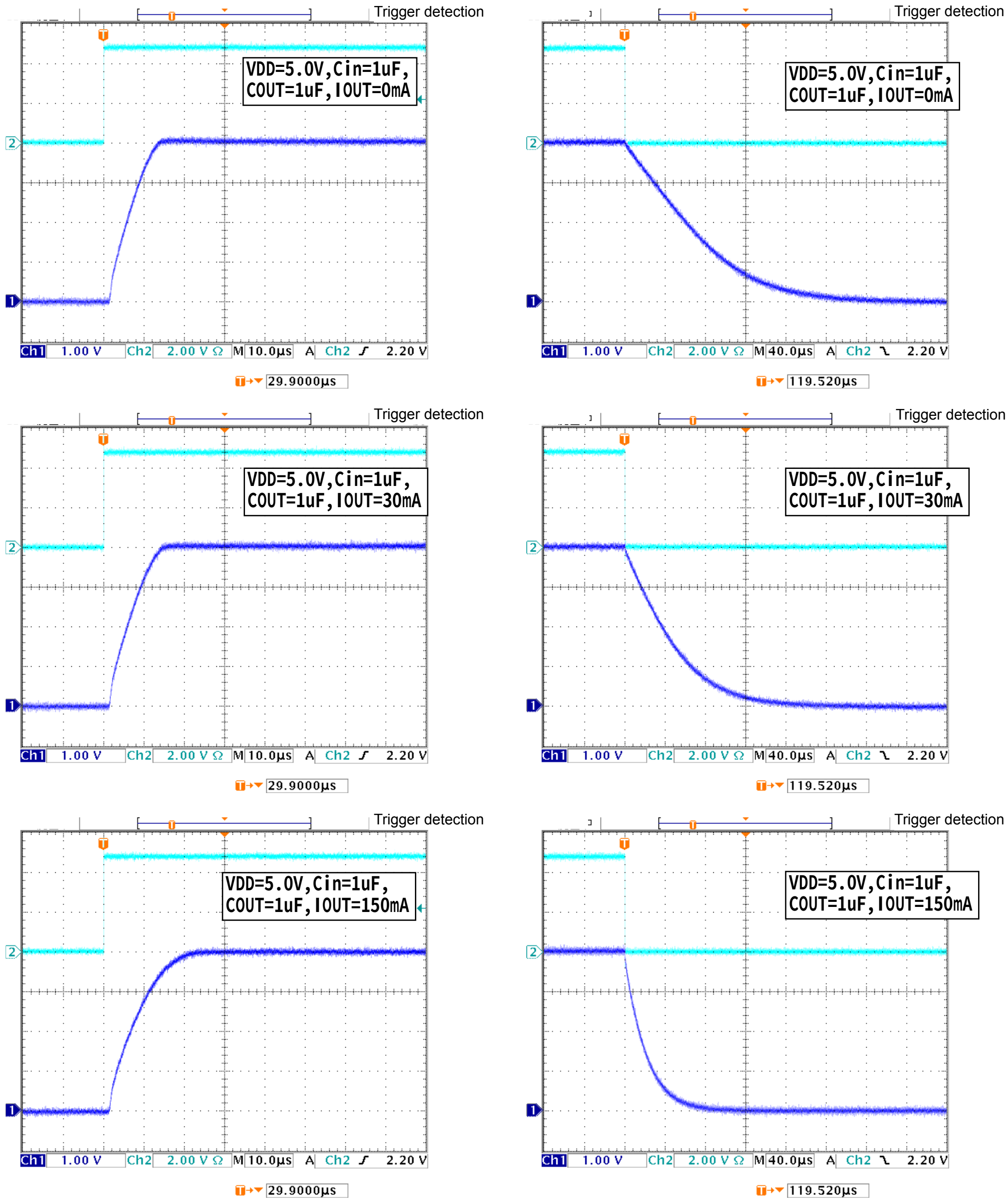








●S1F78B17*40000R



9. PRECAUTIONS ON EXTERNAL PARTS

- Always add an input capacitor (Cin) and output capacitor (Cout) to stabilize this IC.
- For VDD and VSS circuit, provide enough noise suppression on the board.
- Keep the distance from this IC to Cin and Cout as short as possible.

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