EPSON
EXCEED YOUR VISION

Power Supply IC

S1F78B20

Technical Manual

SEIKO EPSON CORPORATION

Rev.1.1

NOTICE

Configuration of product number

●DEVICES

S1 F 78B20 M 0C00 00

- 00 — Packing specifications
- 0C00 — Specifications
- M — Shape
  (M:VSON, Y:SOT)
- 78B20 — Model number
- F — Model name
  (F : Power Supply)
- S1 — Product classification
  (S1:Semiconductors)

CONTENTS

1. DESCRIPTION

The S1F78B20 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, ensuring 50μA, which is lower than the conventional consumption current.
The output voltage is fixed in the IC, and its allowable range is between 1.8 to 4.0V 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.
It is ideal for the power supply of the high-frequency circuit, realizing low output noises with low operating current.

2. FEATURES

- Low consumption current: At operating: [Typ.] 50μA (V_{OUT}(S)=3.0V, at no-load),
  In standby: [Max.] 0.1μA
- Output noise voltage: 30μVrms (V_{OUT}(S) = 3.0V, Cout=1.0μF, 10 to 100kHz)
- Output voltage: 1.8 to 4.0V DC (Can be set in 0.1V steps.)
- Output current: 150mA (V_{DD}=V_{OUT}(S)+1.0V)
- Output voltage accuracy: ±2.0% (Iout=50mA)
- Input-output potential difference: [Typ.] 0.30V (V_{OUT}(S) = 3.0V, I_{OUT}=150 mA)
- Ripple rejection: [Typ.] 80 dB (V_{OUT}(S)=3.0V, V_{DD}=V_{OUT}(S)+1.0V, f=1kHz, Vripple=0.2Vp-pAC)
- Overcurrent detection current: [Typ.]350mA
- Short-circuit holding current: [Typ.]30mA
- Range of capacitor: Cin=1.0 to 10μF, Cout=1.0 to 10μF, ESR=1m to 6.8Ω

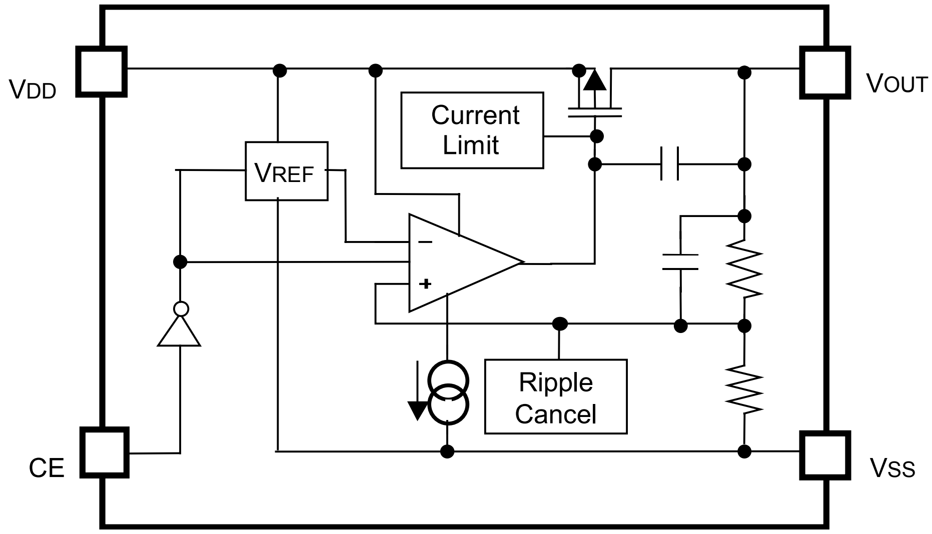
3. PACKAGE

VSON-6pin
SOT23-5pin

4. APPLICATION

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

5. BLOCK DIAGRAM



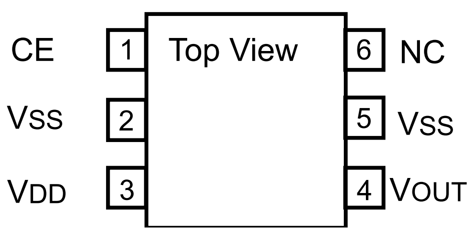
6. SELECTION GUIDE

S1F78B20 * * * 0 0 * *
a b c d e

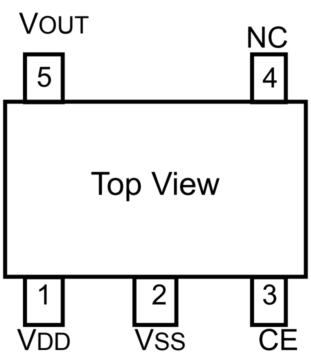
a	Package type M VSON-6pin Y SOT23-5pin
b	Indicates a 2-digit value that is ten times the output voltage value.
c	Fixed to “0” in this IC.
d	Fixed to “0” in this IC.
e	Taping form (See the Packing Specifications.) 0R TR type

7. PIN ASSIGNMENT

VSON-6pin

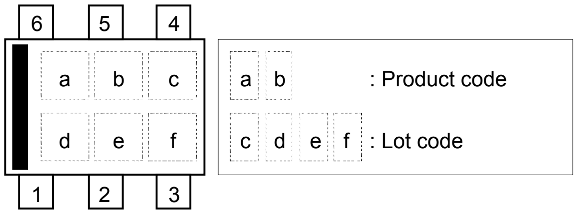


SOT23-5pin

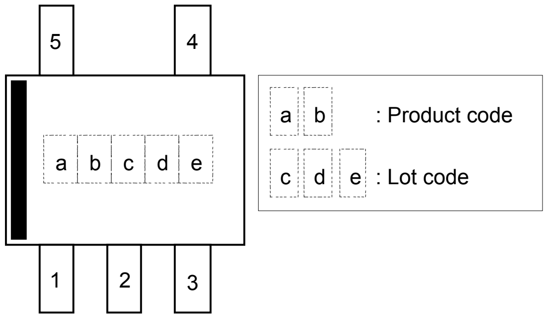


8. MARKING

VSON-6pin



SOT23-5pin



VOUT option	a	b	VOUT option	a	b	VOUT option	a	b
—	—	—	2.6V	A	G	—	—	—
—	—	—	2.7V	A	H	—	—	—
—	—	—	2.8V	A	J	—	—	—
—	—	—	2.9V	A	K	—	—	—
—	—	—	3.0V	A	L	—	—	—
—	—	—	3.1V	A	M	—	—	—
—	—	—	3.2V	A	N	—	—	—
1.8V	A	8	3.3V	A	P	—	—	—
1.9V	A	9	3.4V	A	R	—	—	—
2.0V	A	A	3.5V	A	S	—	—	—
2.1V	A	B	3.6V	A	T	—	—	—
2.2V	A	C	3.7V	A	U	—	—	—
2.3V	A	D	3.8V	A	V	—	—	—
2.4V	A	E	3.9V	A	W	—	—	—
2.5V	A	F	4.0V	A	X	—	—	—

9. PIN DESCRIPTION

For VSON-6pin

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

For 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	NC	No connection
5	V_{OUT}	Voltage output pin

10. 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	VCE	V_{SS}-0.3 to V_{DD}+0.3		V
Allowable dissipation	PD	VSON SOT23	500 *1 300	mW
Operating ambient temperature	T_{opr}	-40 to +85		°C
Storage ambient temperature	T_{stg}	-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 VSON allowable dissipation (Board specifications)
Glass epoxy, 40 × 40 × 1.6, FR-4 (2-layer board), Wiring 50%, wind speed: 0m/s

11. ELECTRICAL CHARACTERISTICS

● DC Characteristics

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

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	ΔVOUT / ΔVDD・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%	3.3V<VOUT(S)<=4.0V	—	0.25	0.35	V	Fig.2
			2.4V<VOUT(S)<=3.3V	—	0.30	0.45	V	
			1.8V<VOUT(S)<=2.4V	—	0.40	0.55	V	
			VOUT(S)=1.8V	—	0.50	0.65	V	
Load stability	ΔVOUT / ΔIOUT	VDD=VCE=VOUT(S)+1.0V 1mA≤IOUT≤150mA		—	20	40	mV	Fig.1
Consumption current (With no load)	ISS1	VDD=VCE=VOUT(S)+1.0V, IOUT=0mA		—	50	80	μA	Fig.3.1
Consumption current (Standby)	ISS0	VDD=VOUT(S)+1.0V, VCE=VSS		—	—	0.1	μA	Fig.3.3
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		—	30	—	mA	Fig.1
Discharge Tr ON resistance	RDIST	VDD=4.0V, VCE=VSS, VOUT=3.0V		80	110	140	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		-1.75	-1.25	-0.75	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/Ceramic)

Item	Symbol	Conditions		Min	Typ	Max	Unit	Measuring circuit
Output voltage temperature coefficient	ΔVOUT / ΔTa	VDD=VCE=VOUT(S)+1.0V -40°CTa≤85≤, IOUT=50mA		—	±100	—	ppm/°C	Fig.1
Ripple rejection	RR	VDD=VCE=VOUT(S)+1.0V, IOUT=50mA, f=1kHz, Vripple=0.2Vp-pAC	VOUT(S)=3.3V	—	80	—	dB	Fig.4
			VOUT(S)=2.7V	—	70	—	dB	
			VOUT(S)=2.6V	—	80	—	dB	
			VOUT(S)=1.8V	—	70	—	dB	
Output noise	Von	VDD=VCE=VOUT(S)+1.0V, IOUT=50mA	VOUT(S)=3.0V	—	30	—	uVrms	Fig.1

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

12. CHARACTERISTICS

1. Output Voltage (Measuring circuit, Fig.1)
   Range of output voltage value when the input voltage is changed in the specified conditions such as the output current and temperature
   V_{OUT}: Actual output voltage value
   $V_{OUT}(S)$: Rated output voltage value $V_{OUT}(S)*0.98 \le V_{OUT} \le V_{OUT}(S)*1.02$
   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} became less than 96% of the rated output voltage $V_{OUT}(S)$ 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)
   Max. value in change of the output voltage that is caused when changing the input voltage while maintaining the output current
   ΔV_{OUT1}: Changed output voltage
   ΔV_{IN}: Changed input voltage (Rated output voltage + 0.5V ≤ V_{IN} ≤ Max. input voltage)
   V_{OUT}: Rated output voltage
   Obtained from the following formula:

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

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

   <Conditions>
   Max. value in change of the output voltage that is caused when changing the output current from 1[mA] to 200[mA] while setting the input voltage to $V_{OUT}(S)$+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 up 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:

$$\text{Output Voltage Temperature Coefficient}[\text{ppm}/℃] = \frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}[\text{ppm}/℃] = \frac{\Delta V_{OUT}}{\Delta Ta}[\text{mV}/℃] * \frac{1}{V_{OUT}(S)}[\text{V}] * 1000$$

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

7. Consumption Current (At Operation with No Load) (Measuring circuit, Fig.3.1)
CE pin = V_{DD} (IC active state), operating current at a specific input voltage and load current
ISS1: No load, ISS2: I_{OUT}=50[mA]
<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. Consumption Current (Standby) (Measuring circuit, Fig.3.3)
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.
Max. 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. Input Transient Response (Measuring circuit, Fig.2)
Change of the output voltage that is caused when the input voltage is changed instantaneously.
<Conditions>
Change 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]

13. 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) Change of the output voltage that is caused when the output current is changed from 0.1[mA] to 50[mA] or 50[mA] to 0.1[mA]. Input voltage = V_{OUT}(S)+1.0[V], Cout=4.7[μF]
2) Change of the output voltage that is caused when the output current is changed from 0.1[mA] to 150[mA] or 150[mA] to 0.1[mA]. Input voltage = V_{OUT}(S)+1.0[V], Cout=4.7[μF]

14. CE Pin Transient Response (Measuring circuit, Fig.5)
Time required until the output voltage reaches the specified value when the CE pin is switched from OFF to ON or ON to OFF.
<Conditions>
Output current: I_{OUT}=50[mA], Input voltage: V_{OUT}(S)+1.0[V]
Time required until the output voltage reaches 90% of V_{OUT}(S) when the CE pin voltage exceeds the H level voltage (1.1[V]), changing the CE pin voltage from 0[V] to V_{OUT}(S)+1.0[V] at 1[μs].

15. Output Noise (Measuring circuit, Fig.1)
AC effective value in output voltage.
<Conditions>
Output current: I_{OUT}=50[mA], Input voltage: V_{OUT}(S)+1.0[V] Frequency: 10[Hz] to 100[kHz]

16. Discharge Tr ON Resistance (Measuring circuit, Fig.7)
ON resistance value of internal transistor that removes 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}, and V_{OUT}=3V.

13. MEASURING CIRCUITS

Fig.1

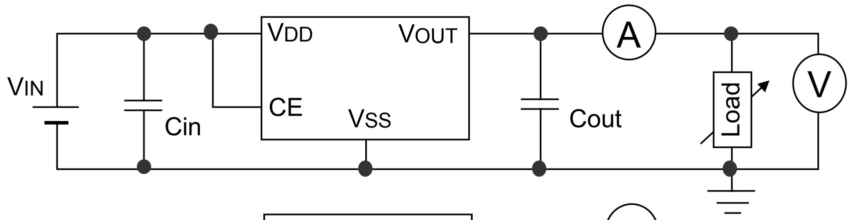


Fig.2

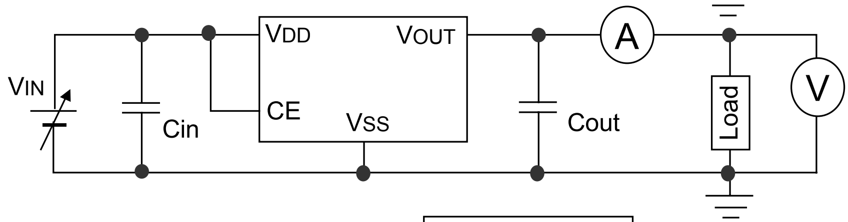


Fig.3.1

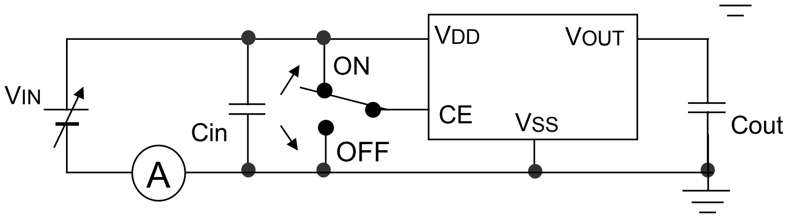


Fig.3.3

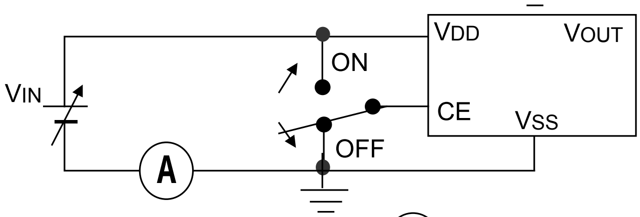


Fig.4

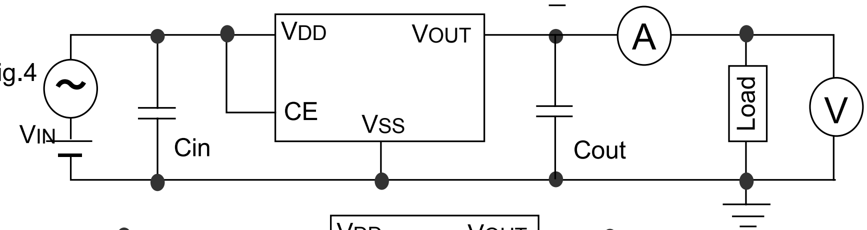


Fig.5

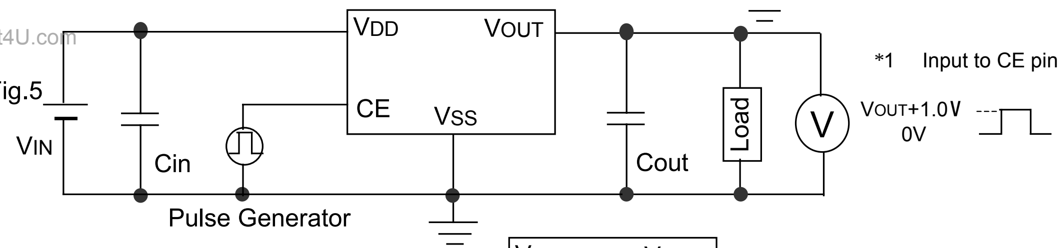


Fig.6

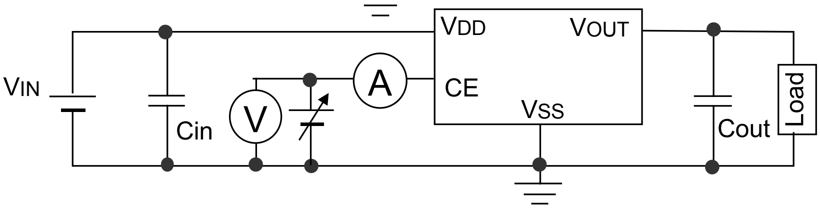
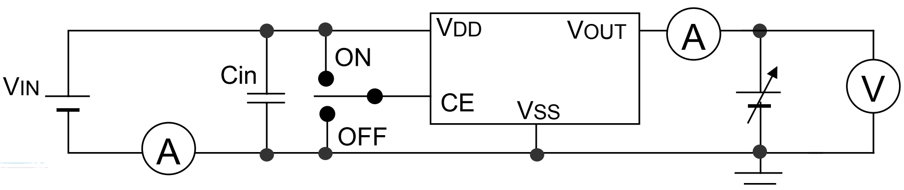
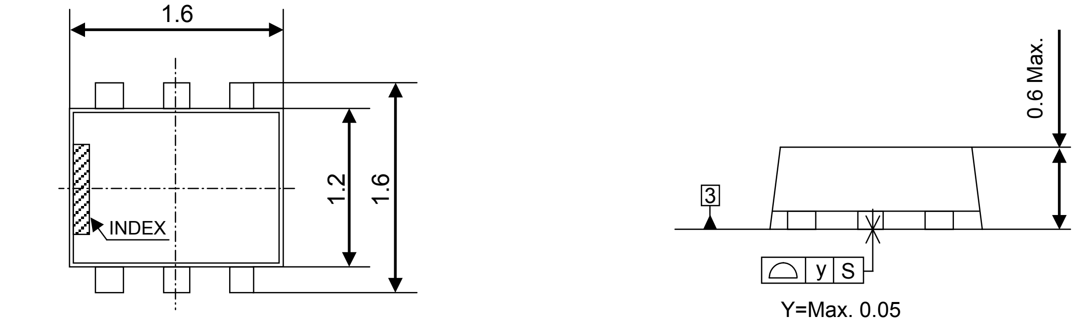


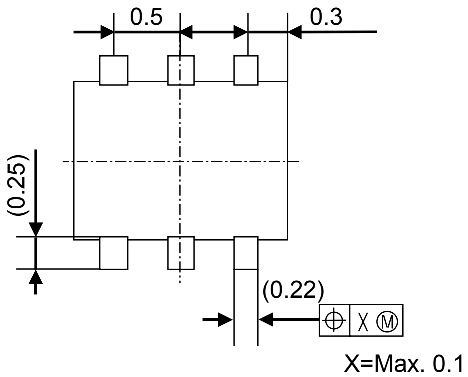
Fig.7



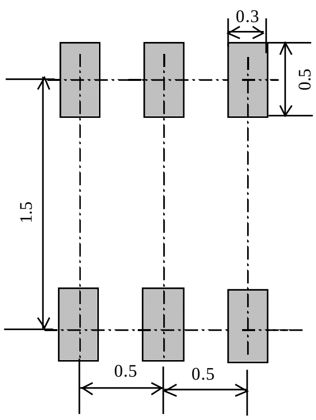
14. DIMENSIONS

VSON-6

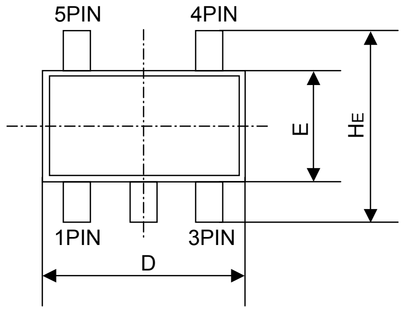


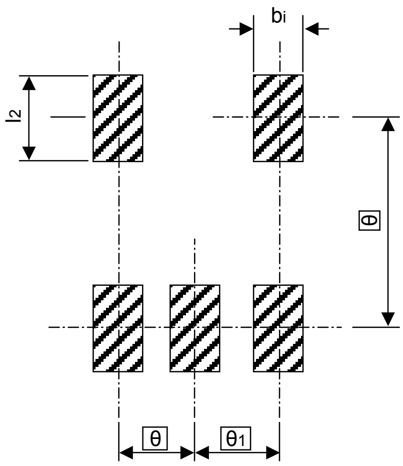


Mount pad design example

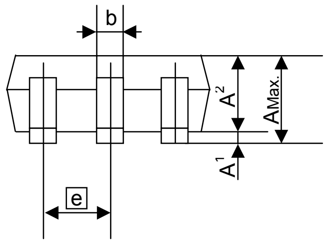


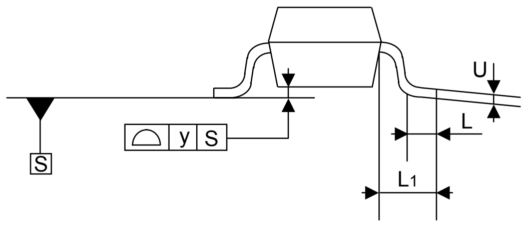
SOT23-5





θ 1	2.40
l2	1.09
θ	0.95
bi	0.80



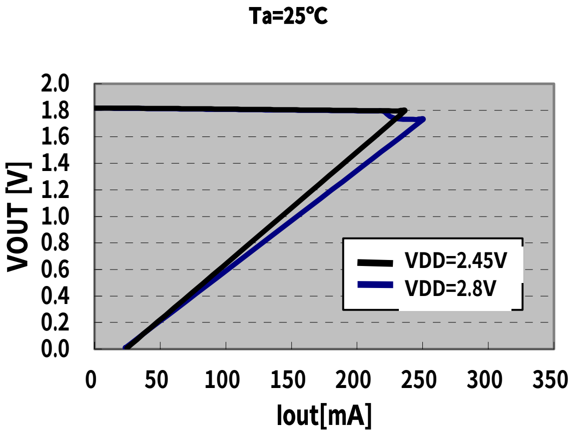


Symbol	Dimention In Millmeters		
	Min.	Nom.	Max.
D	—	2.9	—
E	—	1.6	—
AMax.	—	—	1.40
A_1	0	—	0.15
A_2	—	1.1	—
e	—	0.95	—
lo	0.3	—	0.5
C	0.1	—	0.26
L	0.2	—	0.6
L1	—	0.6	—
H_E	—	2.8	—
y	—	—	0.1

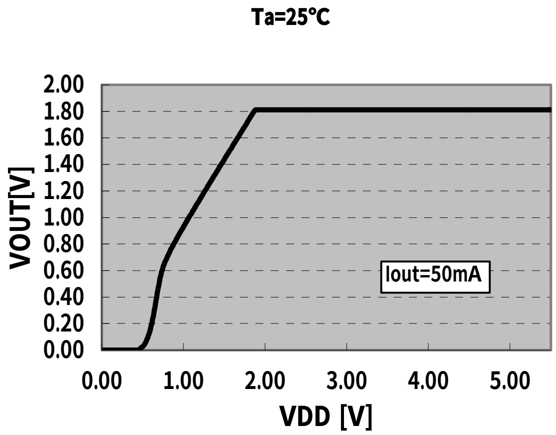
1 = 1mm

15. CHARACTERISTIC EXAMPLES (1.8V OUTPUT PRODUCTS (S1F78B20Y18000R/S1F78B20Y18000R))

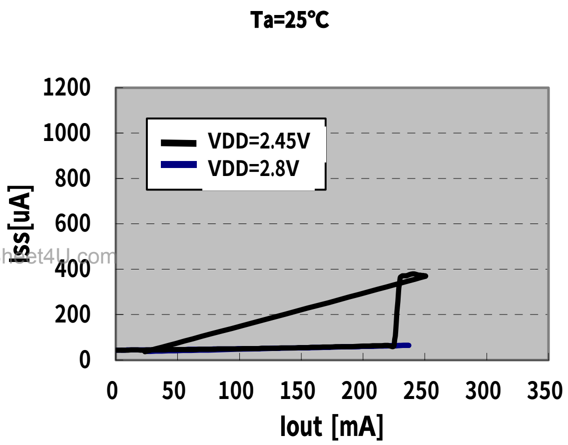
15.1 Characteristics between Output Voltage and Output Current



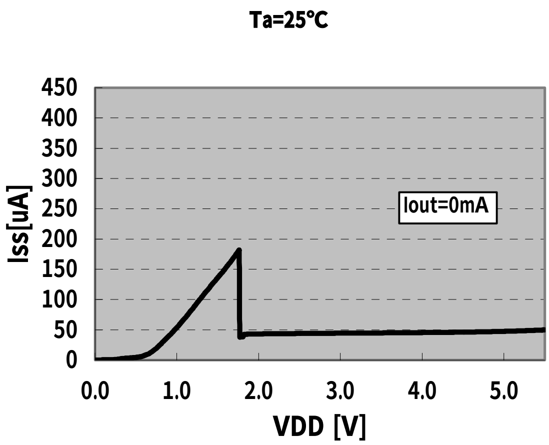
15.2 Characteristics between Output Voltage and Input Voltage



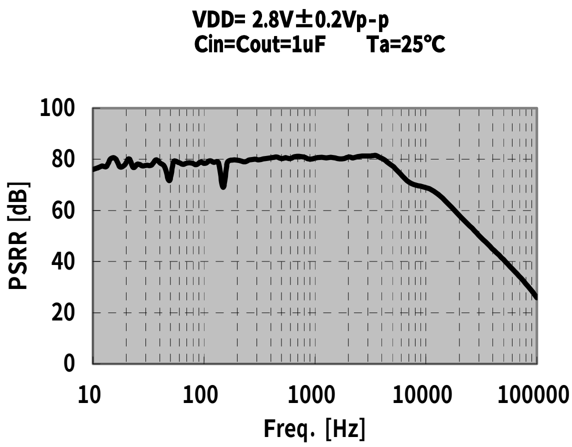
15.3 Characteristics between Consumption Current and Output Current



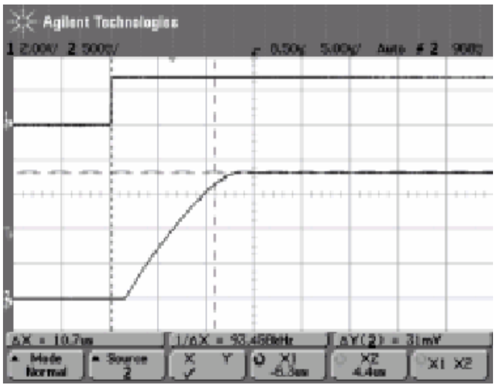
15.4 Characteristics between Consumption Current and Input Voltage



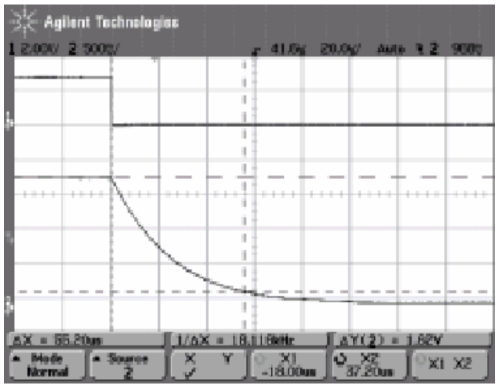
15.5 Characteristics between Ripple Rejection and Frequency



15.6 CE Transient Response IOUT=50mA VCE=0.0V⇔2.8V Cin=COUT=1.0μF VDD=2.8V Ta=25℃

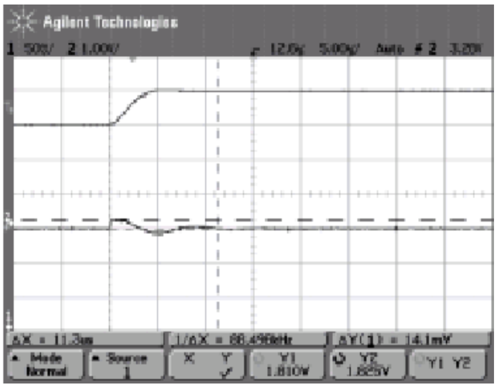


Upper:2.0V/div Lower:500mV/div Time:5μs/div

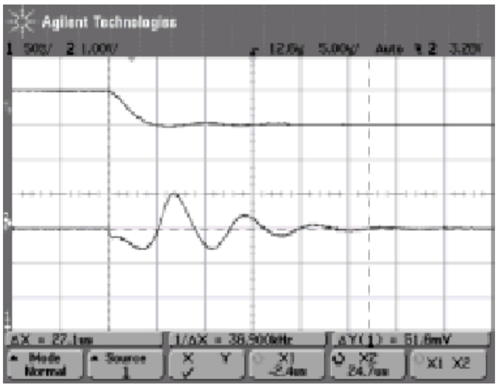


Upper:2.0V/div Lower:500mV/div Time:20μs/div

15.7 Input Transient Response IOUT=50mA VDD=2.8V⇔3.8V Cin=COUT=1.0μF Ta=25℃

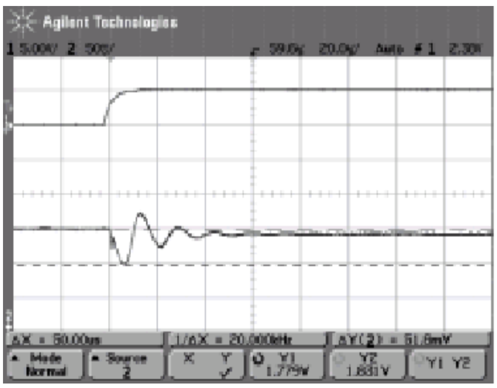


Upper:VDD Lower:VOUT Time:5μs/div

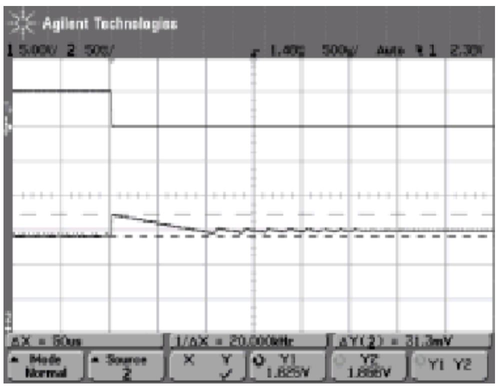


Upper:VDD Lower:VOUT Time:5μs/div

15.8 Load Transient Response VDD=2.8V IOUT=0.1mA⇔50mA Cin=1.0μF COUT=4.7μF Ta=25℃



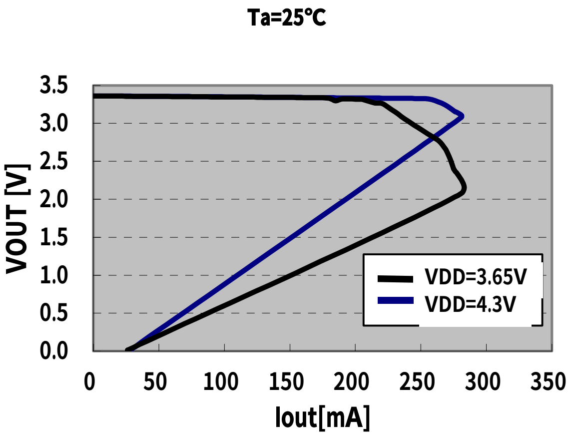
Upper:Iout Lower:VOUT Time:20μs/div



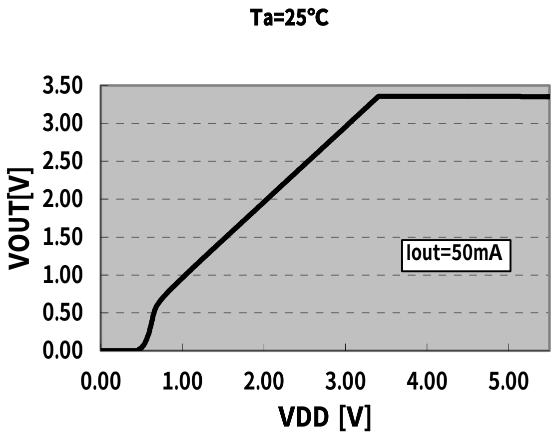
Upper:Iout Lower:VOUT Time:500μs/div

16. CHARACTERISTIC EXAMPLES (3.3V OUTPUT PRODUCTS (S1F78B20Y33000R/S1F78B20Y33000R))

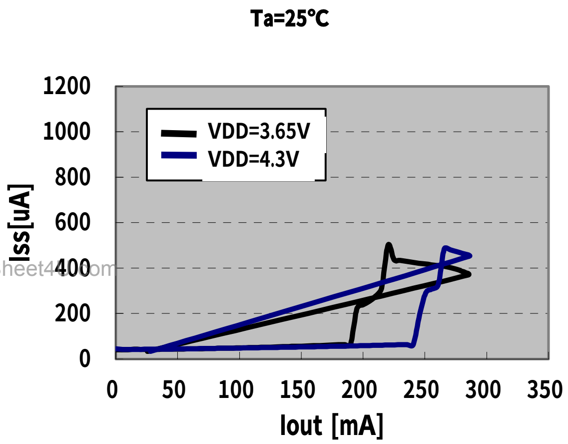
16.1 Characteristics between Output Voltage and Output Current



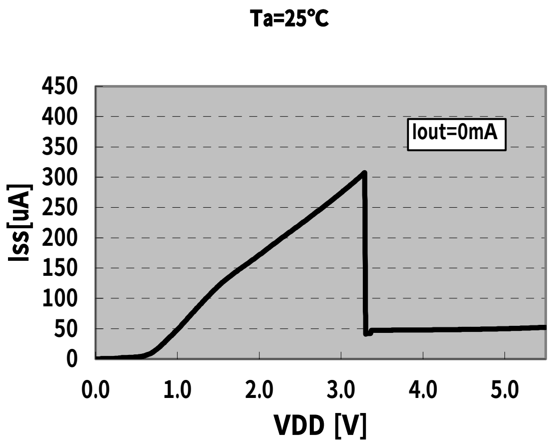
16.2 Characteristics between Output Voltage and Input Voltage



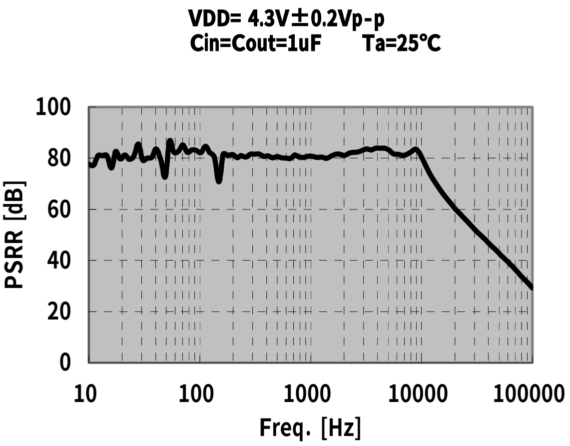
16.3 Characteristics between Consumption Current and Output Current



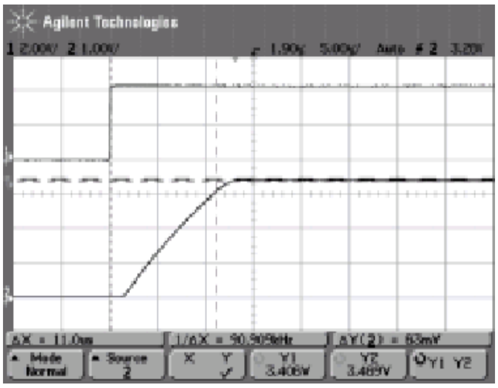
16.4 Characteristics between Consumption Current and Input Voltage



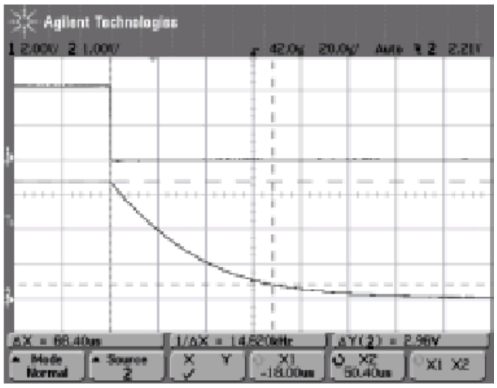
16.5 Characteristics between Ripple Rejection and Frequency



16.6 CE Transient Response I_{OUT}=50mA V_{CE}=0.0V⇔3.3V Cin=C_{OUT}=1.0µF V_{DD}=4.3V Ta=25℃

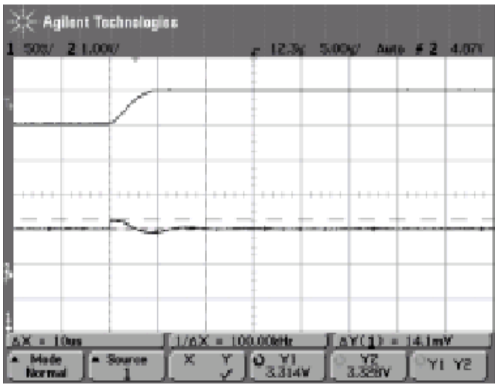


Upper:2.0V/div Lower:500mV/div Time:5µs/div

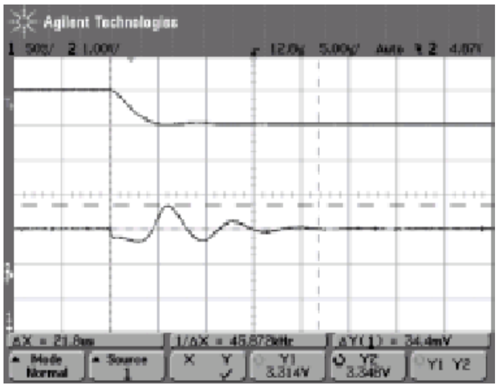


Upper:2.0V/div Lower:500mV/div Time:20µs/div

16.7 Input Transient Response I_{OUT}=50mA V_{DD}=4.3V⇔5.3V Cin=C_{OUT}=1.0µF Ta＝25℃

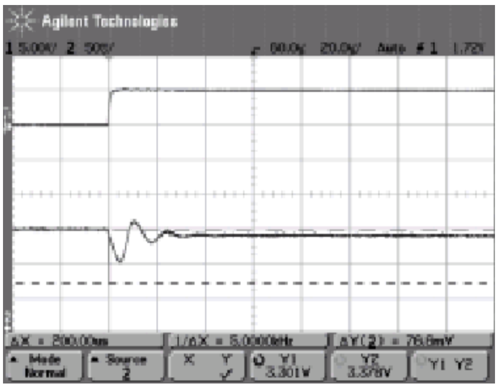


Upper:V_{DD} Lower:V_{OUT} Time:5µs/div

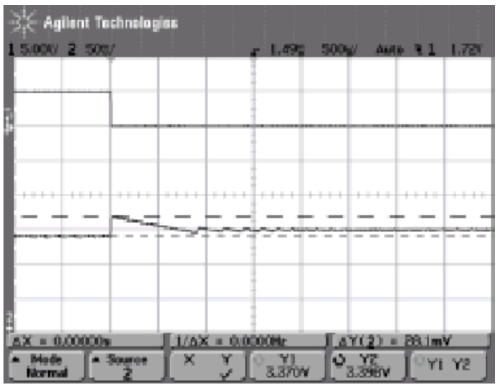


Upper:V_{DD} Lower:V_{OUT} Time:5µs/div

16.8 Load Transient Response V_{DD}=4.3V I_{OUT}=0.1mA⇔50mA Cin=1.0µF C_{OUT}=4.7µF Ta=25℃



Upper:Iout Lower:V_{OUT} Time:20µs/div



Upper:Iout Lower:V_{OUT} Time:500µs/div

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