

Negative output 200mA LDO

Monolithic IC MM1898 Series

Outline

This IC is a low noise negative output 200mA LDO by bipolar process. The target applications by noise reduction pin are for a power supply of highly sensitive image sensor. The output range is from -0.9V to -5.0V (0.1V steps), it can use to the negative power supply of CMOS image sensor.

Features

- | | |
|----------------------------|---|
| 1. Input voltage range | -2V to -10V |
| 2. Output voltage range | -0.9V to -5.0V |
| 3. Output voltage accuracy | $V_{OUT} \pm 1\%$ ($V_O < -1.5V$)
$V_{OUT} \pm 15mV$ ($-1.5V \leq V_O \leq -0.9V$) |
| 4. Maximum output current | 200mA |
| 5. Current consumption | 3 μ A typ. (OFF)
160 μ A typ. (No-Load) |
| 6. Dropout voltage | 0.5V typ. / 0.8V max. ($I_O = 200mA$) |
| 7. Line regulation | 0.01%/V typ.
0.10%/V max. |
| 8. Load regulation | 15mV typ. / 100mV max. ($I_O = 1mA$ to 200mA) |
| 9. Ripple rejection | 70dB typ. ($f = 1kHz$) |
| 10. Output noise voltage | 30 μ Vrms typ. ($V_O = -1.4V$, $C_n = 0.01\mu F$) |
| 11. Output rise time | 5ms typ. ($C_n = 0.01\mu F$, $I_{OUT} = 0mA$) |

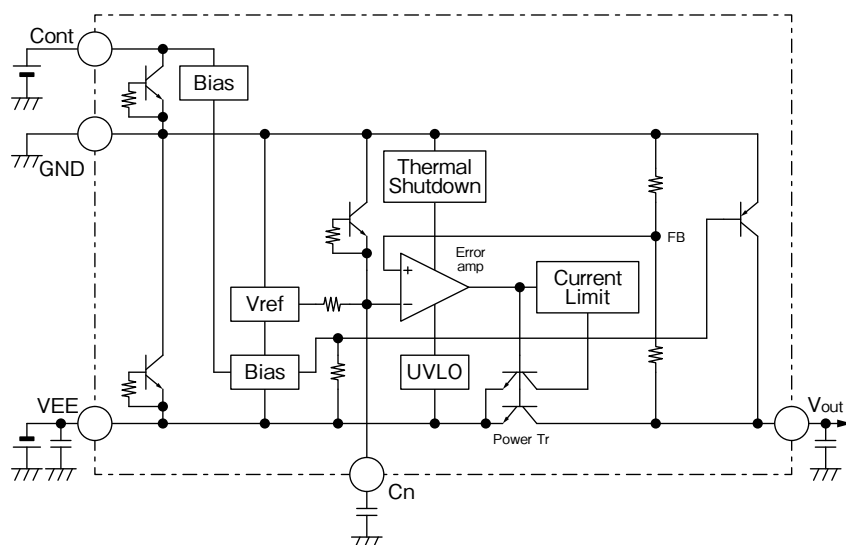
Package

SOT-25A
SSON-6A

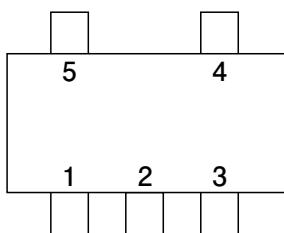
Applications

1. Image sensor
2. LCD

Block Diagram

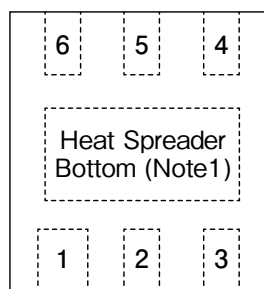


Pin Assignment



SOT-25A
(TOP VIEW)

1	GND
2	VEE
3	Cont
4	Cn
5	VOUT



SSON-6A
(TOP VIEW)

1	Cont
2	GND
3	VEE
4	VOUT
5	NC
6	Cn

Note1 : Heat Spreader Bottom with VEE.
 Don't connect with GND.

Pin Description

SOT-25A

Pin No.	Pin name	Functions
1	GND	Ground pin
2	VEE	Negative voltage input pin
3	Cont	Control pin Vcont=H : Output ON Vcont=L : Output OFF
4	Cn	Reducing noise pin with capacitor pin
5	VOUT	Negative voltage output pin

SSON-6A

Pin No.	Pin name	Functions
1	Cont	Control pin Vcont=H : Output ON Vcont=L : Output OFF
2	GND	Ground pin
3	VEE	Negative voltage input pin
4	VOUT	Negative voltage output pin
5	NC	No connection
6	Cn	Reducing noise pin with capacitor pin

Absolute Maximum Ratings (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
Supply voltage	VEE	-12 to +0.3	V
Control voltage	Vcont	-0.3 to +5.0	
Output current	Iout	0 to 400	mA
Junction Temperature	TjMAX	125	°C
Storage Temperature	Tstg	-55 to +125	
Power Dissipation	Pd	SOT-25A	560(Note2)
		SSON-6A	1000(Note2)
			mW

Note2 : JEDEC51-7 Standard 114.3mm×76.2mm, t=1.6mm

Recommended Operating Conditions (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
Operating Ambient temperature	Topr	-40 to +85	°C
Operating Voltage	Vop	-10 to -2	V
Output Current	Iop	0 to 200	mA

Electrical Characteristics 1 (Except where noted otherwise VEE=V_{OUT}(typ.)-1V, I_{out}=1mA, V_{cont}=1.6V, T_a=25°C)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Input current consumption (OFF)	IEEOFF	VEE=-5V, V _{cont} =0V		3	8	μA
No-Load input current consumption	IEE	I _{out} =0mA		160	240	
Output voltage (Note3)	V _{OUT}	V _{OUT} ≤-1.5V	×1.01		×0.99	V
		V _{OUT} >-1.5V	-0.015		+0.015	
Dropout voltage	V _{io}	VEE=V _O +0.2V, I _{out} =200mA		0.5	0.8	
Line regulation	V _{line}	V _{OUT} ≤-1.0V, VEE=V _{OUT} -1 to -10V		0.01	0.10	% / V
		V _{OUT} =-0.9V, VEE=-2 to -10V				
Load regulation	V _{load}	I _{out} =1m to 200mA		15	100	mV
V _{out} temperature coefficient (Note4)	ΔV _{OUT} / ΔT	T _a =-40 to +85°C		±100		ppm / °C
Ripple rejection (Note4)	RR	f=1kHz, V _{ripple} =0.5A, I _{out} =10mA, C _n =0.01μA		70		dB
Output noise voltage (Note4)	V _n	V _{OUT} =-1.4V, f _{BW} =10k to 100kHz, I _{out} =10mA, C _n =0.01μA		30		μV _{rms}
Cont pin input current	I _{cont}	V _{cont} =1.6V		4	12	μA
Cont pin High Threshold level	V _{contH}	V _{OUT} : ON	1.2			V
Cont pin Low Threshold level	V _{contL}	V _{OUT} : OFF			0.3	
Output rise time	T _r	C _n =0.01μF, I _{out} =0mA (Note5)		5		ms
UVLO detective voltage	V _{UVLO}		-1.85	-1.75	-1.65	V
UVLO hysteresis voltage	ΔV _{UVLO}			0.15		
Discharge current	I _{dis}	VEE=-5V, V _{cont} =0V		4		mA

Note3 : Please refer to another page.

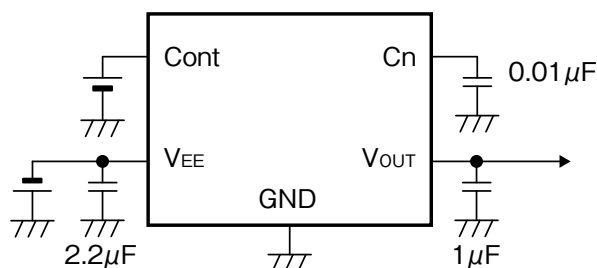
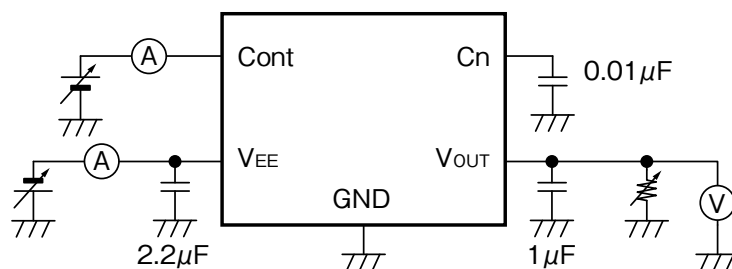
Note4 : The parameter is guaranteed by design.

Note5 : V_{cont}=H to 90% of V_{out} (Typ.)

Electrical Characteristics 2 (Except where noted otherwise VEE=V_{OUT}(typ.)-1V, I_{out}=1mA, V_{cont}=1.6V, T_a=25°C)

Output voltage	Measurement Conditions	Output Voltage (V)		
		Min.	Typ.	Max.
-0.9	I _{out} =1mA	-0.915	-0.900	-0.885
-1.0		-1.015	-1.000	-0.985
-1.1		-1.115	-1.100	-1.085
-1.2		-1.215	-1.200	-1.185
-1.3		-1.315	-1.300	-1.285
-1.4		-1.415	-1.400	-1.385
-1.5		-1.515	-1.500	-1.485
-1.6		-1.616	-1.600	-1.584
-1.7		-1.717	-1.700	-1.683
-1.8		-1.818	-1.800	-1.782
-1.9		-1.919	-1.900	-1.881
-2.0		-2.020	-2.000	-1.980
-2.1		-2.121	-2.100	-2.079
-2.2		-2.222	-2.200	-2.178
-2.3		-2.323	-2.300	-2.277
-2.4		-2.424	-2.400	-2.376
-2.5		-2.525	-2.500	-2.475
-2.6		-2.626	-2.600	-2.574
-2.7		-2.727	-2.700	-2.673
-2.8		-2.828	-2.800	-2.772
-2.9		-2.929	-2.900	-2.871
-3.0		-3.030	-3.000	-2.970
-3.1		-3.131	-3.100	-3.069
-3.2		-3.232	-3.200	-3.168
-3.3		-3.333	-3.300	-3.267
-3.4		-3.434	-3.400	-3.366
-3.5		-3.535	-3.500	-3.465
-3.6		-3.636	-3.600	-3.564
-3.7		-3.737	-3.700	-3.663
-3.8		-3.838	-3.800	-3.762
-3.9		-3.939	-3.900	-3.861
-4.0		-4.040	-4.000	-3.960
-4.1		-4.141	-4.100	-4.059
-4.2		-4.242	-4.200	-4.158
-4.3		-4.343	-4.300	-4.257
-4.4		-4.444	-4.400	-4.356
-4.5		-4.545	-4.500	-4.455
-4.6		-4.646	-4.600	-4.554
-4.7		-4.747	-4.700	-4.653
-4.8		-4.848	-4.800	-4.752
-4.9		-4.949	-4.900	-4.851
-5.0		-5.050	-5.000	-4.950

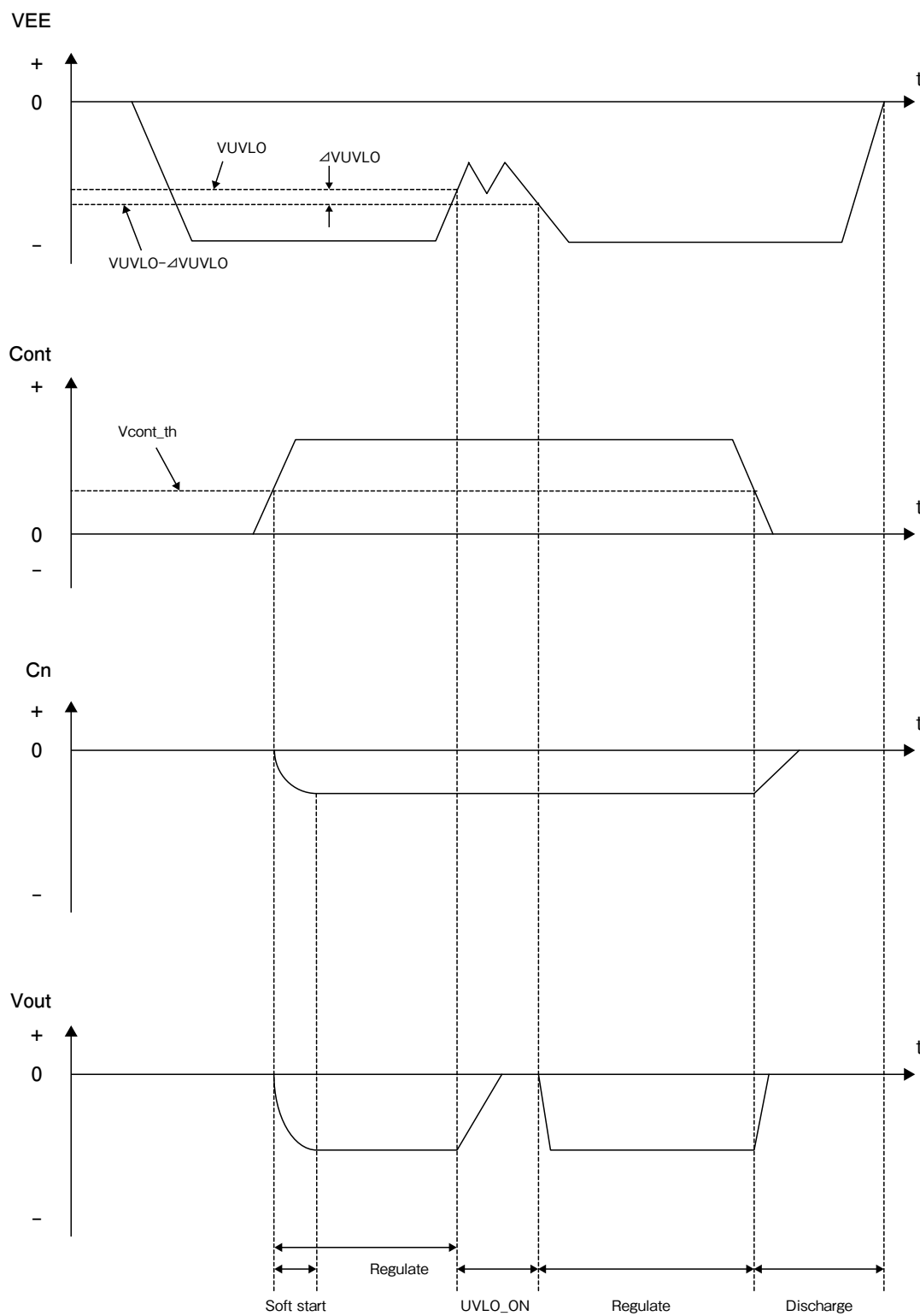
Application Circuit



· Output capacitor	Ceramic capacitor	1.0 μ F (2.2 μ F for Vo $\geq$ -1.1V)	*Temperature Characteristics : B
· Input capacitor	Ceramic capacitor	2.2 μ F	*Temperature Characteristics : B

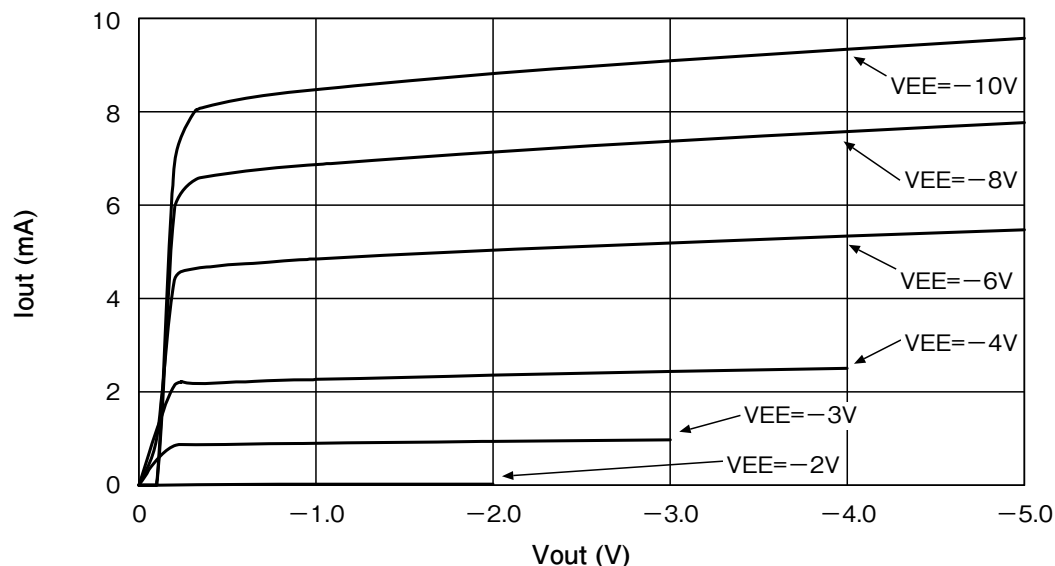
· In the event a problem which may affect industrial property or any other rights of us or a third party is encountered during the use of information described in these circuit, we shall not be liable for any such problem, nor grant a license therefore.

Timing Chart



Discharge Current Depending on Power Supply

Discharge current depend on power supply VEE.
 Reference to Below current characteristics.
 In case of discharge current being low, contact us.



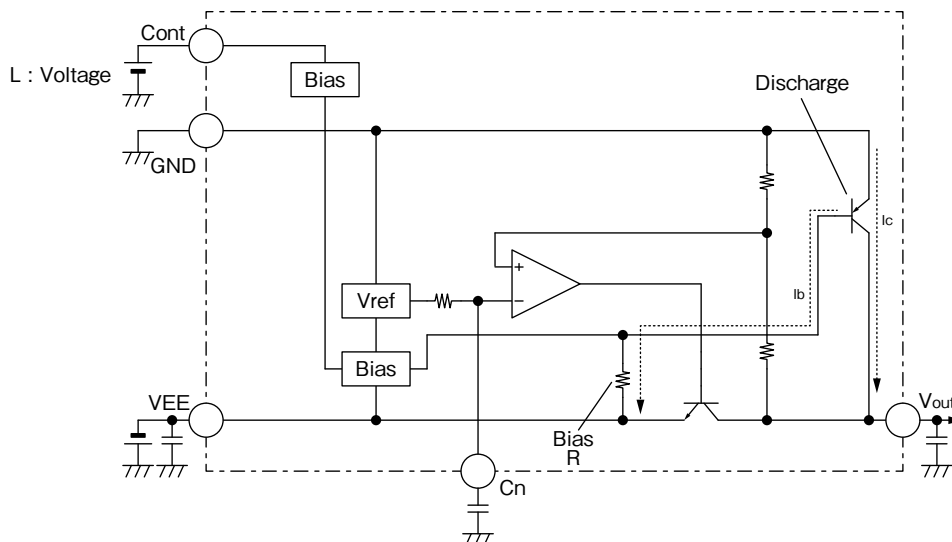
Discharge Circuit Current

Discharge current is collector current of discharge element in IC.
 Collector current I_c is h_{fe} times as many as base current I_b , equation (1).
 Base current I_b depend on bias resistance R , equation (2).
 Collector current express equation (3).
 Discharge current (collector current) depend on VEE voltage.
 And base current is input current (OFF).

$$I_c = h_{fe} \times I_b \quad \dots (1)$$

$$I_b = (V_{EE} - 0.7) \div R \quad \dots (2)$$

$$I_c = h_{fe} \times (V_{EE} - 0.7) \div R \quad \dots (3)$$



Cn Pin

Cn pin is connected with resistance 176kΩ in IC.

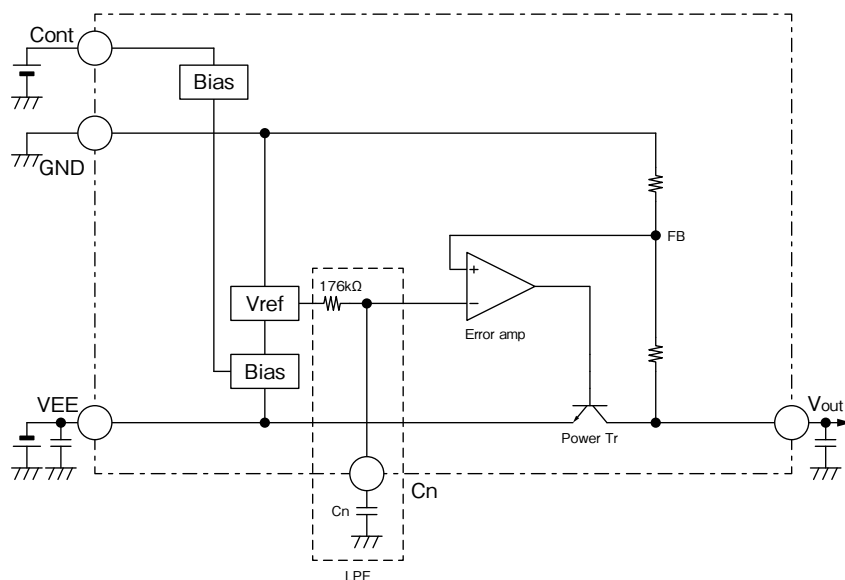
LPF is composed of capacitor, Cn noise is reduced and V_{OUT} noise is reduced too.

This IC feedback FB that is divided from V_{OUT} by resistance equal with Cn voltage.

Noise of FB is feedbacked equal with noise of Cn too.

So noise of V_{OUT} depend on noise of Cn. The capacitor of Cn pin more than 0.01μF is recommended.

If Cn pin influence by noise for outside, noise of V_{OUT} pin is bad characteristics.



Output rise time

MM1898 starting soft start in cause of outside capacitor connected with Cn pin.

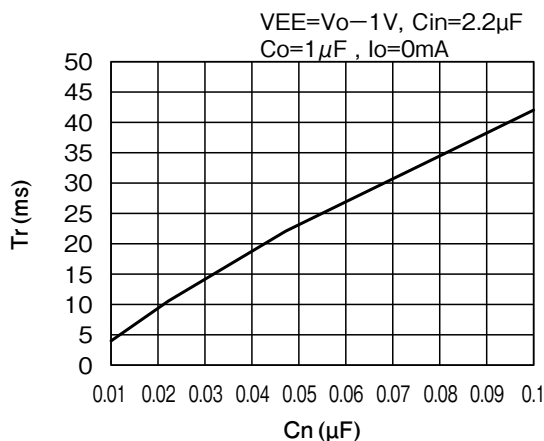
Cn voltage start slowly in course of LPF.

FB voltage is feedback equal to Cn voltage, therefore FB and V_{OUT} voltage start slowly.

Output rise time Tr depend on capacitor Cn that is connected with Cn pin.

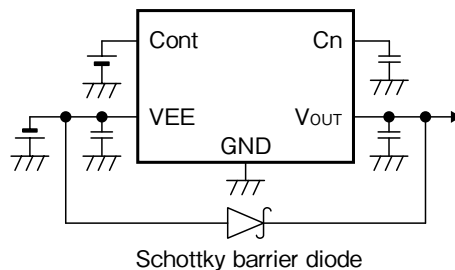
About output rise time, refer to below equation and characteristics.

$$Tr [ms] \div 405 \times Cn [\mu F]$$



NOTE

1. There is a possibility with deterioration and destruction of IC when using it exceeding the absolute maximum rating. The absolute maximum rating, Never exceed it.
The functional operation is not assured.
2. There is a possibility that it becomes impossible to maintain this performance and reliability IC original when using it exceeding recommended operation voltage.
Please use it in recommended operation voltage.
3. Due to restrictions on the package power dissipation, the output current value may not be satisfied.
Attention should be paid to the power dissipation of the package when the output current is large or the voltage between Input and Output is high.
4. The output capacitor is required between output and GND to prevent oscillation.
5. The ESR of capacitor must be defined in ESR stability area.
It is possible to use a ceramic capacitor without ESR resistance for output.
The ceramic capacitor must be used more than $1.0\mu\text{F}$ and B temperature characteristics.
The ceramic capacitor must be used more than $2.2\mu\text{F}$ and B temperature characteristics for $V_o \geq 1.1\text{V}$.
6. The wire of VEE and GND is required to print full ground plane for noise and stability.
7. The input capacitor must be connected a distance of less than 1 cm from input pin.
8. In case the output voltage is above the input voltage, the overcurrent flow by internal parasitic diode from output to input.
In such application, the external bypass diode must be connected between output and input pin.

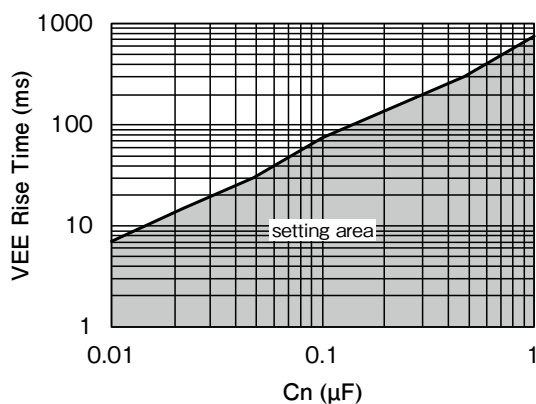


9. It is able to an unstable operation when you use the capacitor with intense capacitance change.
The capacitor has the dependency at the power-supply voltage and the temperature.
The capacity value changes by the environment used. Please evaluate IC in the set.
10. The IC has the thermal shutdown protection.
11. This IC will limit the output current with the overcurrent protection circuit when the overcurrent and the output do short-circuit. However, IC generates heat because of the substrate and use conditions and there is a possibility of destroying it exceeding a permissible loss.
The characteristic changes depending on the substrate condition.
Please evaluate IC in the set.
12. Cont pin control ON/OFF of this IC. Cont pin is used to input plus voltage.
If this pin is open, this IC is OFF.
 ON : $1.2\text{V} \leq V_{\text{cont}} \leq 5.0\text{V}$
 OFF : $0\text{V} \leq V_{\text{cont}} \leq +0.3\text{V}$

13. The overshoot might be generated in UVLO releasing for low output voltage rank.

It is above function When VEE rise time is late and strating by not Cont but VEE So set the setting area in below graf.

Condition : VEE=0→-2V, Vcont=1.6V, Ta=-40°C to +85°C

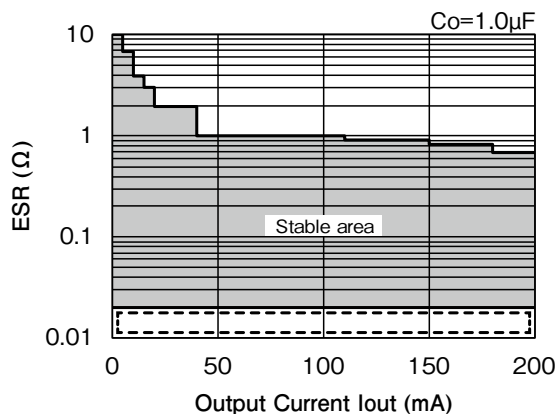


14. It is no data in under 0.02Ω of ESR characteristics. (dotted line area)

Don't be measured in this area because ceramic capacitor contain 0.02Ω in parts self.

Ceramic capacitor only can be used without ESR resistance parts.

Please evaluate IC in the set if the capacitor that is low resistance used.



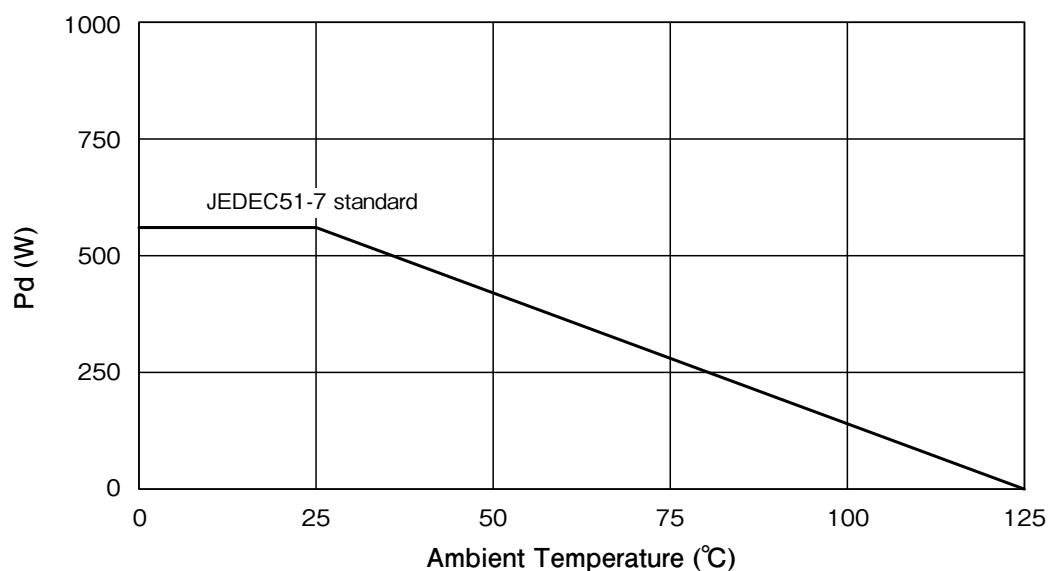
About Power Dissipation

The Power dissipation change if board to mount IC change because radiative heat fix at board. It is reference data below, Evaluate IC in the set.

1. JEDEC51-7 standard

Board size 114.3mm×76.2mm t=1.6mm Copper foil area 80%

Power dissipation 560mW $T_a=25^{\circ}\text{C}$ (It is reference value measured by JEDEC51-7 standard.)



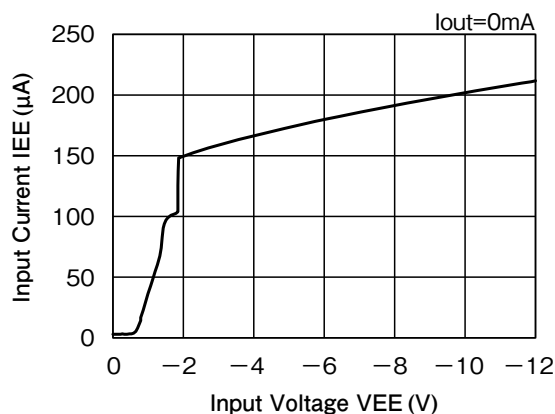
It is recommended to layout the VIA for heat radiation in the GND pattern of reverse (of IC) when there is the GND pattern in the inner layer (in using multiplayer substrate).

By increasing these copper foil pattern area of PCB, Power dissipation improves.

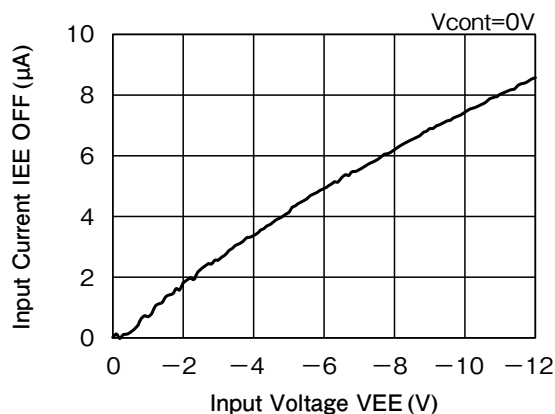
Characteristics (−0.9V)

(Except where noted otherwise $V_{EE}=V_{OUT(Typ.)}-1V$, $I_{out}=1mA$, $V_{cont}=1.6V$, $T_a=25^{\circ}C$, $V_{EE}=-2V$ at $V_{OUT}=-0.9V$)

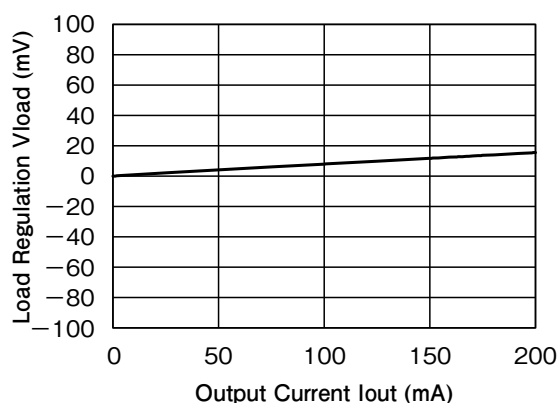
Input voltage – Input current



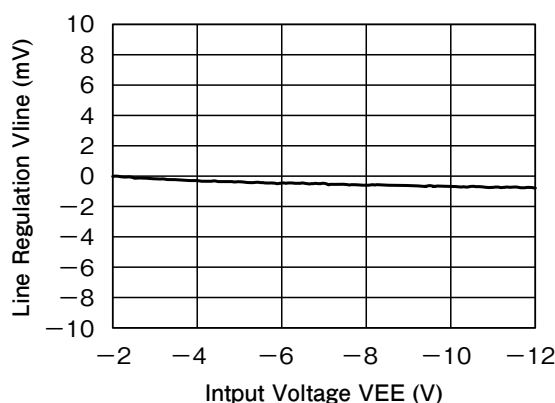
Input voltage – Input current



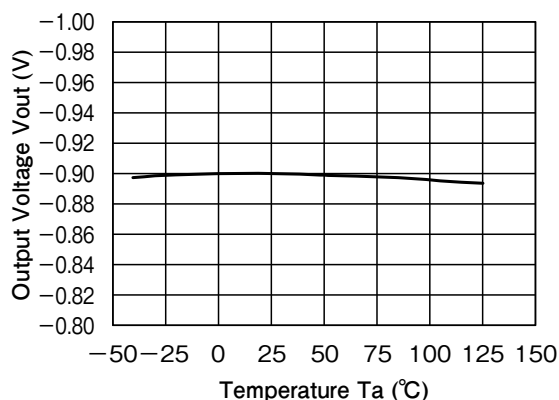
Load regulation



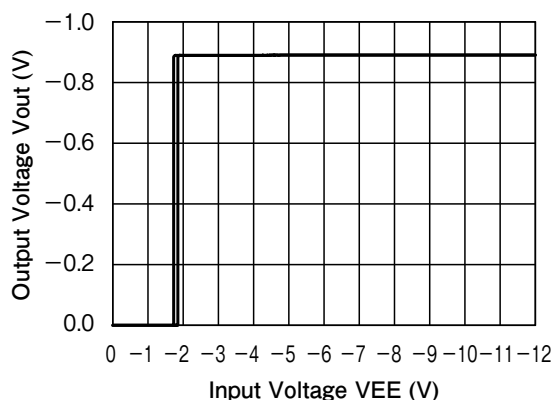
Line regulation



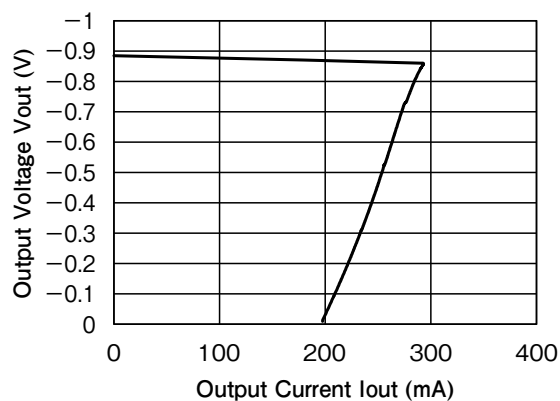
Output Voltage Temperature Coefficient



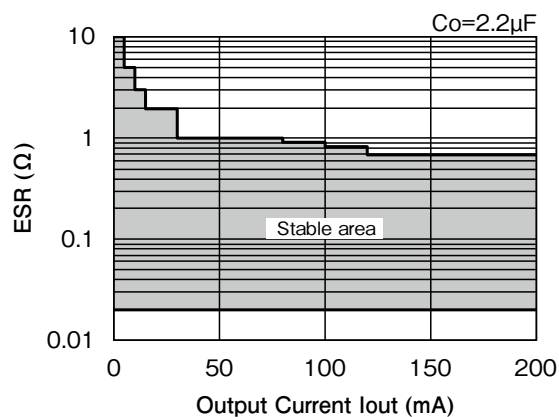
Input voltage – Output voltage



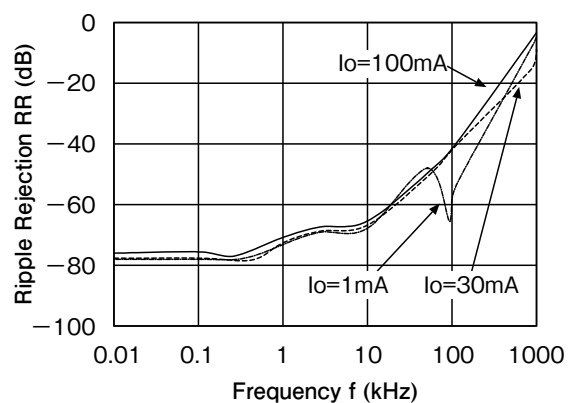
■ Output current – Output voltage



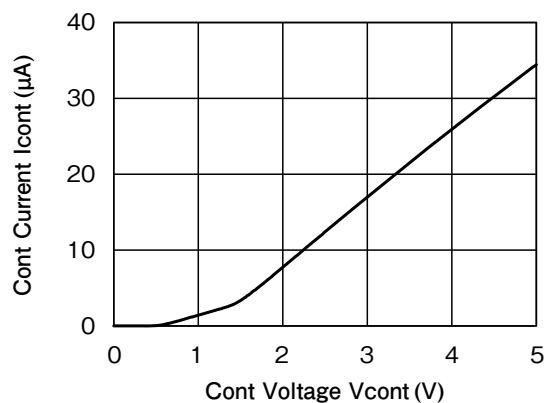
■ ESR stable area



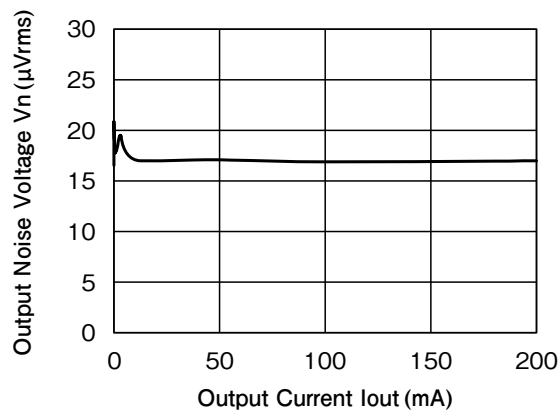
■ Ripple Rejection



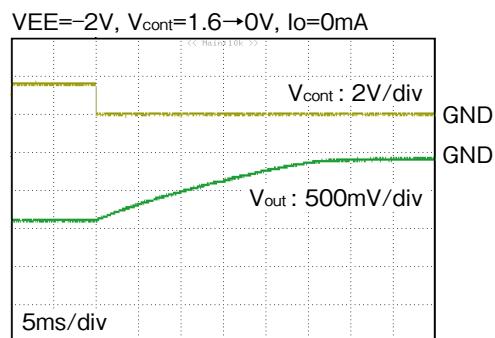
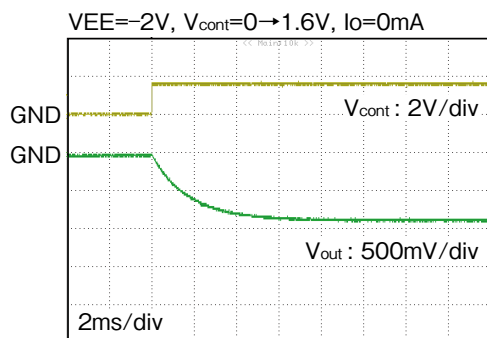
■ Cont voltage – Cont current



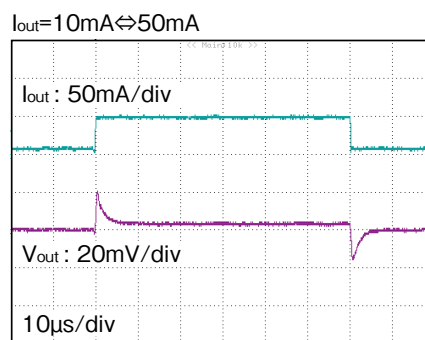
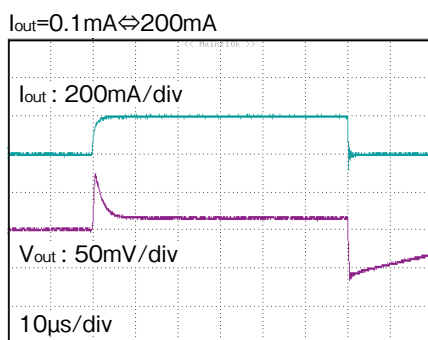
■ Cont voltage – Cont current



Cont rise characteristics



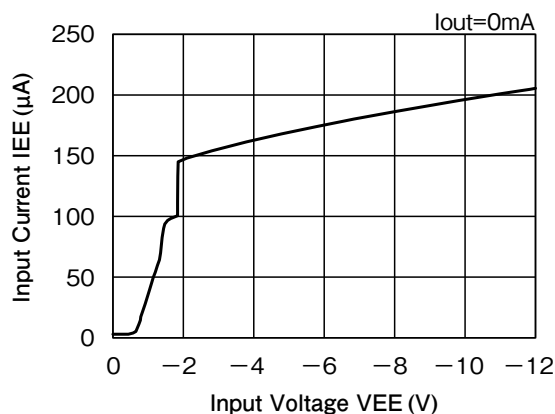
Load transient characteristics



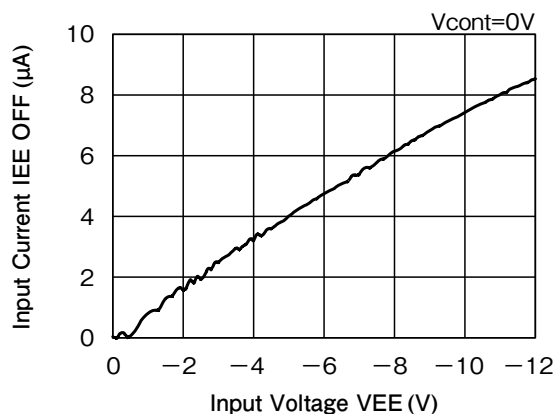
Characteristics (-1.4V)

(Except where noted otherwise $V_{EE}=V_{OUT(Typ.)}-1V$, $I_{out}=1mA$, $V_{cont}=1.6V$, $T_a=25^{\circ}C$, $V_{EE}=-2V$ at $V_{OUT}=-0.9V$)

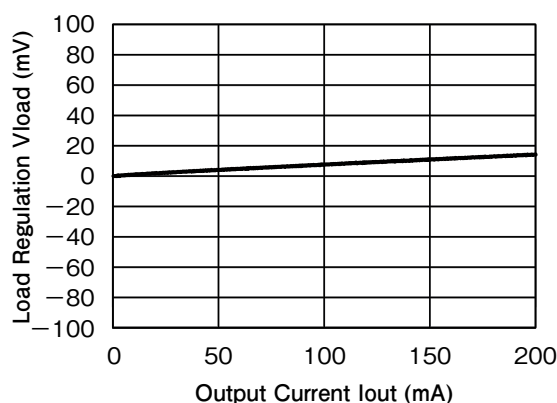
Input voltage - Input current



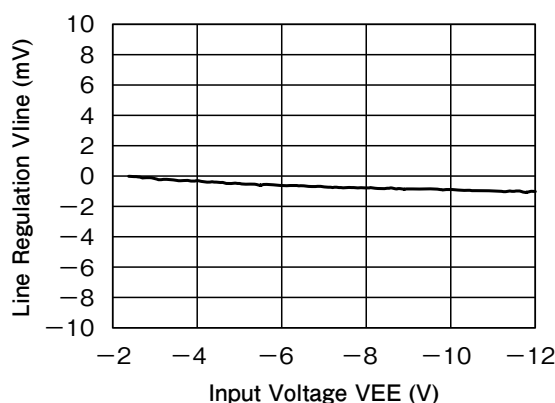
Input voltage - Input current



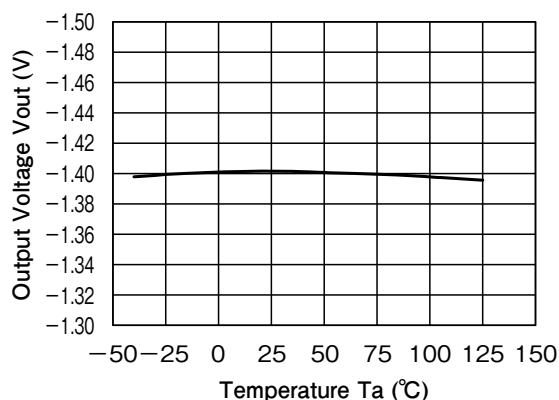
Load regulation



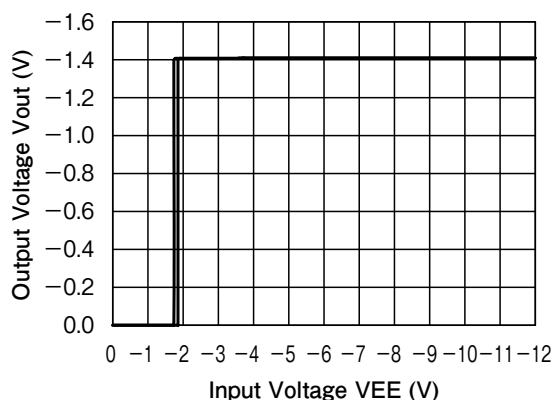
Line regulation



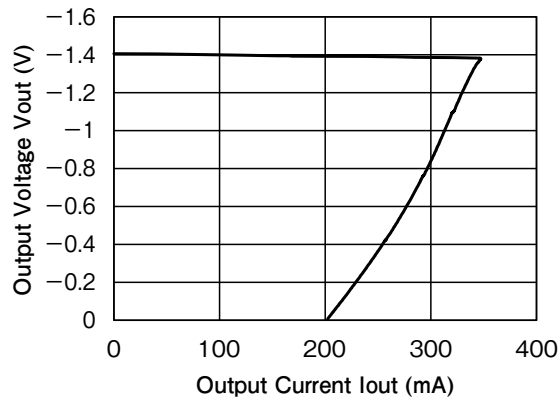
Output Voltage Temperature Coefficient



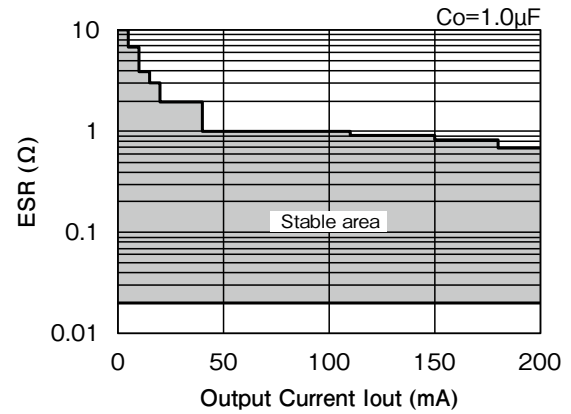
Input voltage - Output voltage



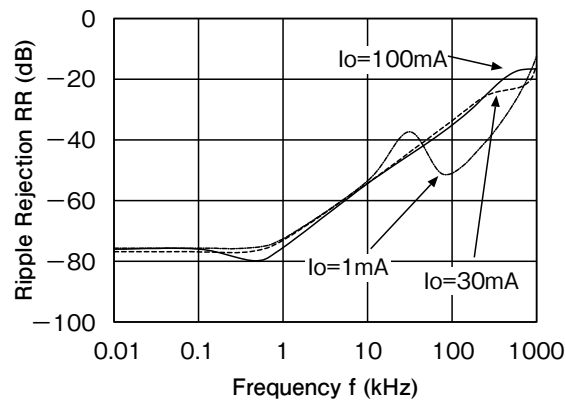
■ Output current – Output voltage



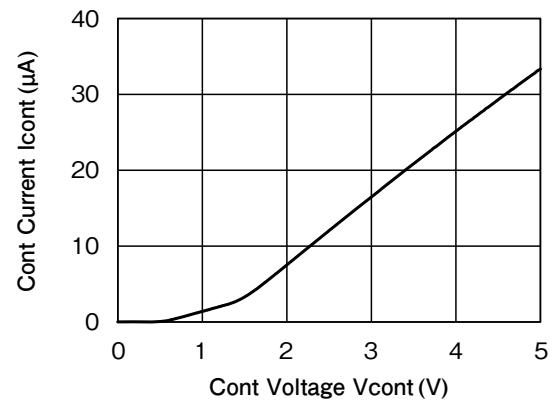
■ ESR stable area



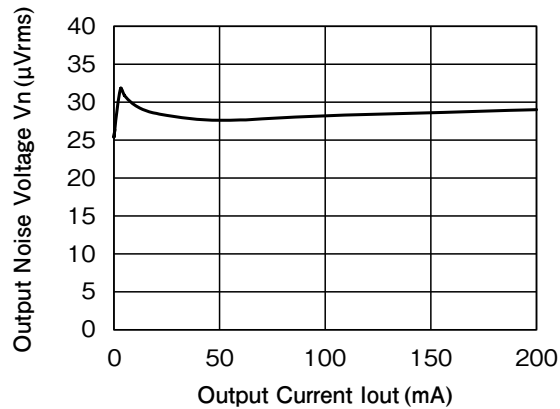
■ Ripple Rejection



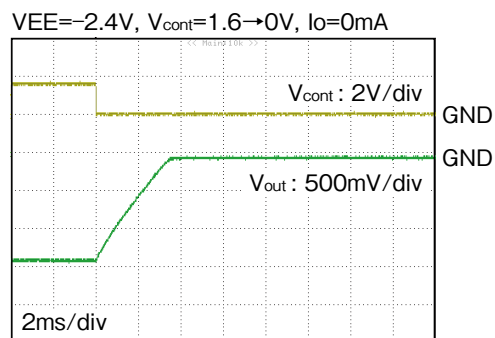
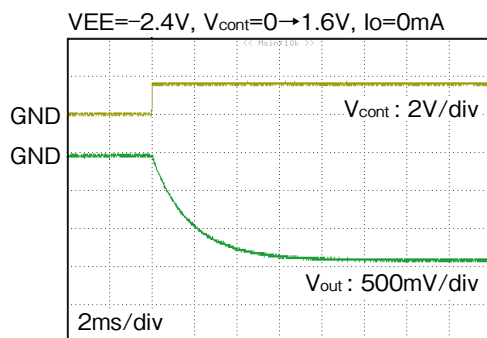
■ Cont voltage – Cont current



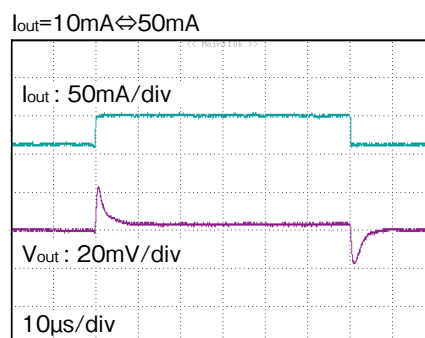
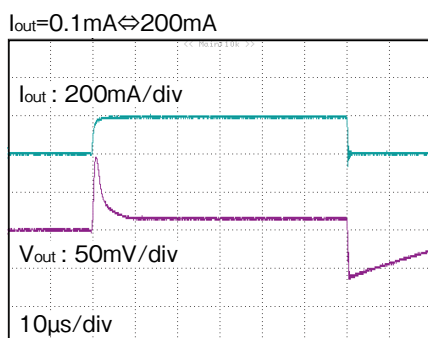
■ Cont voltage – Cont current



Cont rise characteristics



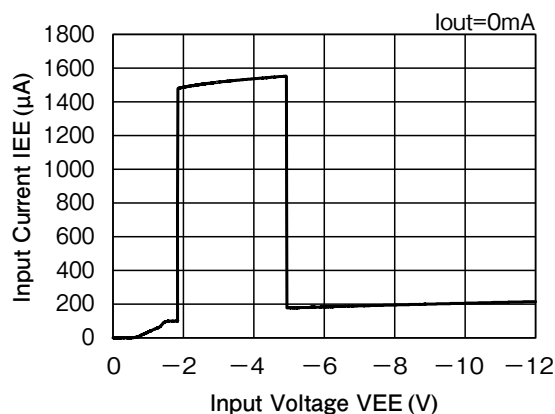
Load transient characteristics



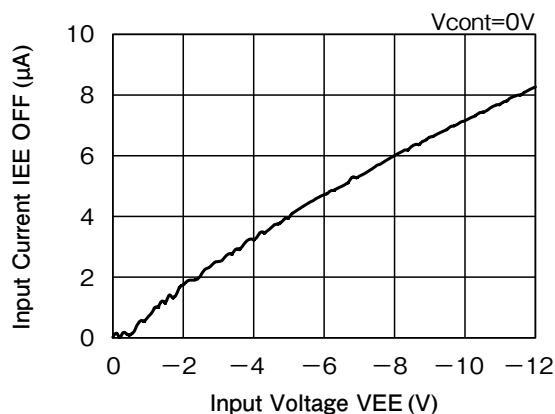
Characteristics (-5.0V)

(Except where noted otherwise $V_{EE}=V_{OUT(Typ.)}-1V$, $I_{out}=1mA$, $V_{cont}=1.6V$, $T_a=25^{\circ}C$, $V_{EE}=-2V$ at $V_{OUT}=-0.9V$)

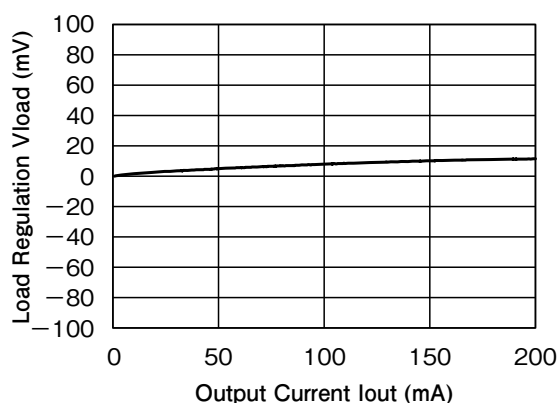
Input voltage - Input current



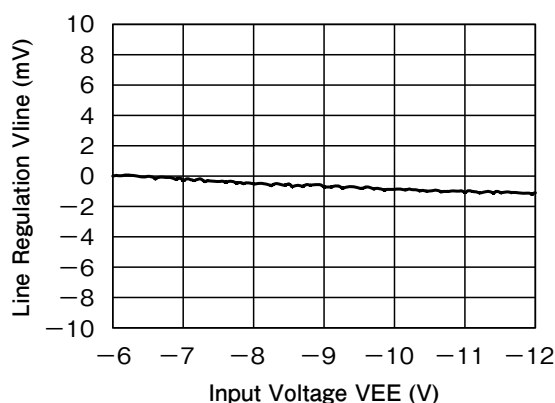
Input voltage - Input current



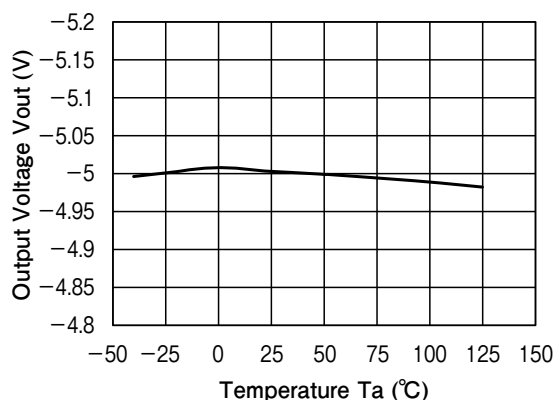
Load regulation



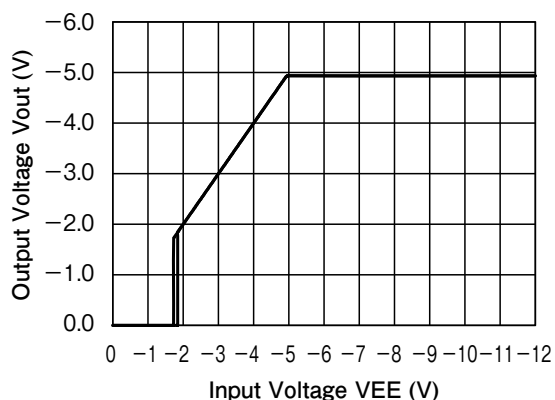
Line regulation



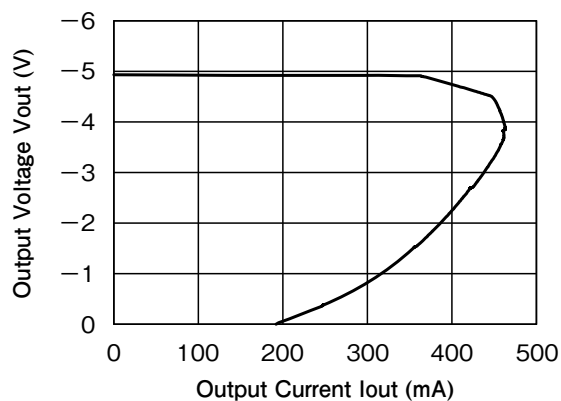
Output Voltage Temperature Coefficient



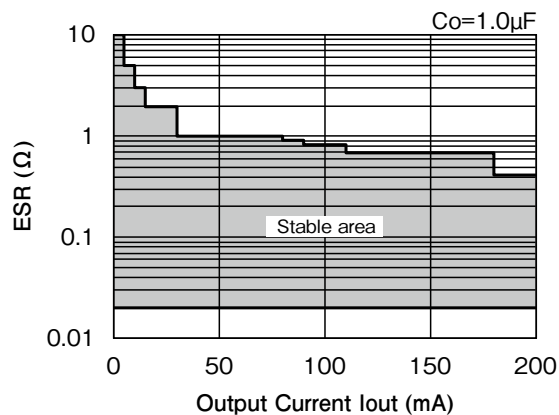
Input voltage - Output voltage



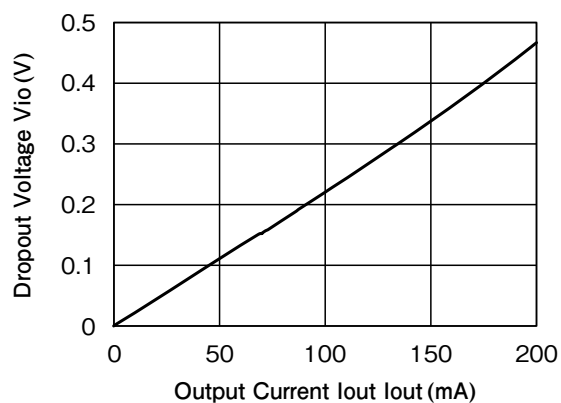
■ Output current – Output voltage



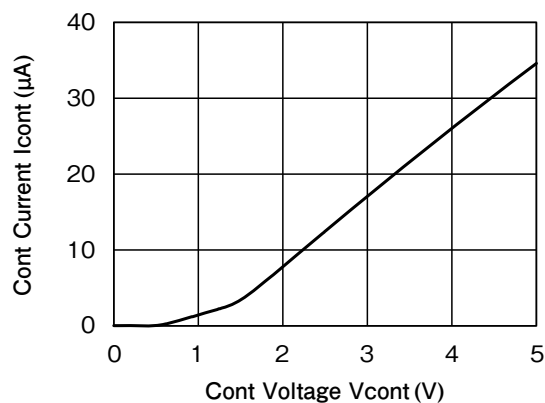
■ ESR stable area



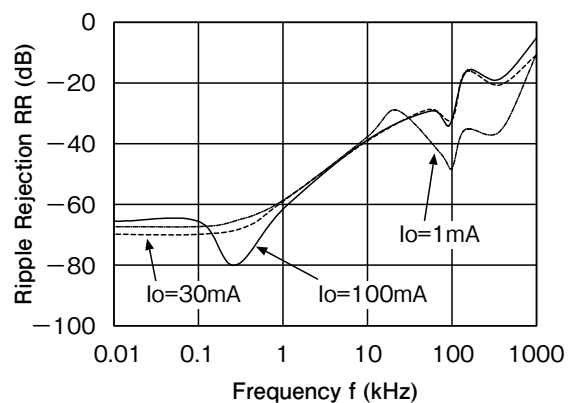
■ Output current – Dropout voltage



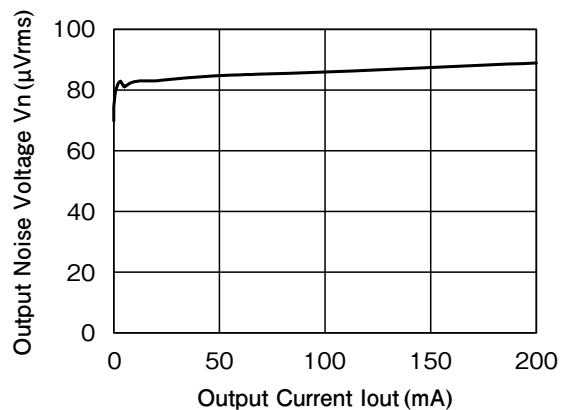
■ Cont voltage – Cont current



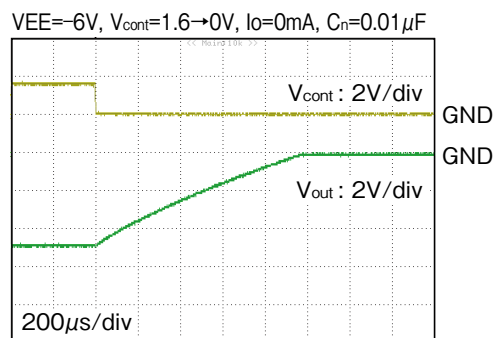
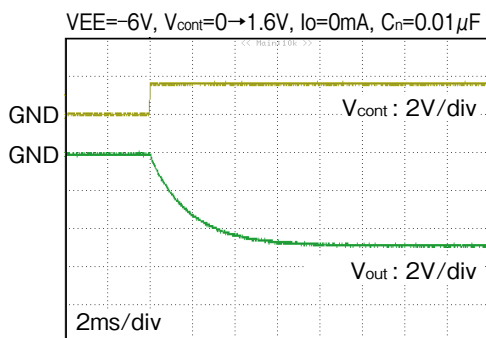
■ Ripple Rejection



■ Cont voltage – Cont current



Cont rise characteristics



Load transient characteristics

