500mA LDO with soft-start
Monolithic IC MM3526 Series

Outline

This IC is is a 500mA LDO with soft-start.
The soft-start can reduce rush current by the Cs capacitor at start-up.
Package is SOT89-5 which can be the high radiation of heat on small space.

Features

1.	Maximum input voltage	6V
2.	Output current	500mA
3.	No load input current	50μA typ.
4.	Input current (OFF)	1μA max.
5.	Output voltage range	1.2~5.0V
6.	Output voltage accuracy	±1% or ±15mV
7.	Dropout voltage	0.35V max. (Io=500mA, Vo=3V)
8.	Line regulation	0.2%/V max.
9.	Load regulation	80mV max. (Io=1~500mA)
10.	Ripple rejection	70dB typ. (f=1kHz)
11.	Thermal shutdown circuit	Built-in
12.	Output Capacitor	1μF

Package

SSON-6A
SOT89-5A
SOT-25A

Applications

1. Flat-TV
2. Blu-ray/DVD recorder
3. Printer
4. Game equipment

Model Name

M M 3 5 2 6 A □ □ □ □ □

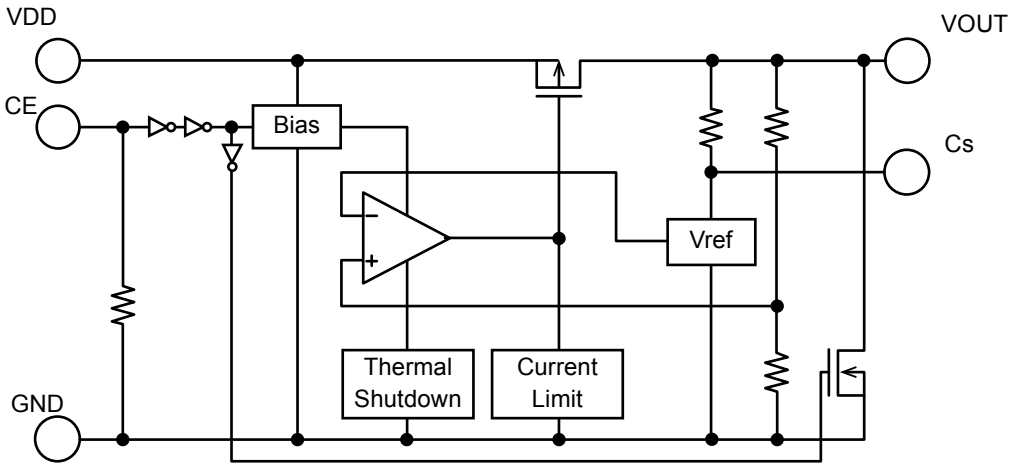
a b c d e

a		b	
Function Type		Voltage Output RANK	
A	CE=H-Active, with Discharge Function	12	The combination of each regulator output voltage is specified by design serial numbers. It is assigned in order from 12. Output voltage can be set in the range.
		~	
		50	

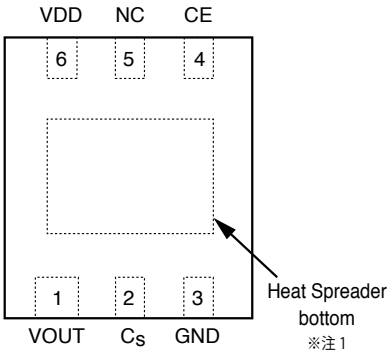
c		d	
Package		Packing Specifications	
P	SOT89-5A	R	R HOUSING (SOT89-5A, SSON-6A, SOT-25A_Standard)
R	SSON-6A	L	L HOUSING
N	SOT-25A	F	F HOUSING
H	HSOP-8C	B	B HOUSING (HSOP-8C_Standard)

e	
E	EMBOSS TAPE

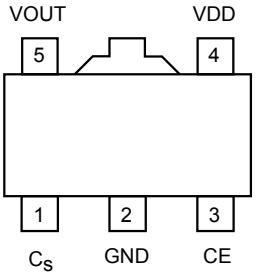
Block Diagram



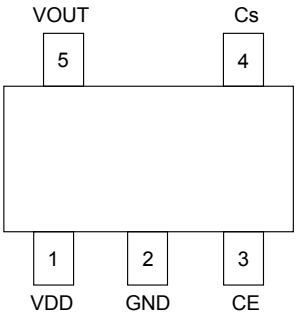
Pin Assignment



SSON-6A
TOP VIEW



SOT89-5A
TOP VIEW



SOT-25A
TOP VIEW

Note1 : Heat Spreader Bottom with GND.

Pin Description

SSON-6A

Pin No.	Pin name	Functions
1	VOUT	Output pin
2	CS	Soft-start pin (Note2)
3	GND	GND pin
4	CE	ON/OFF-Control pin (with CE pull-down resistor) CE: L → OFF, H → ON Connect CE pin with VDD pin, when it is not used.
5	NC	No connection
6	VDD	Voltage-supply pin

SOT89-5A

Pin No.	Pin name	Functions
1	CS	Soft-start pin (Note2)
2	GND	GND pin
3	CE	ON/OFF-Control pin (with CE pull-down resistor) CE: L → OFF, H → ON Connect CE pin with VDD pin, when it is not used.
4	VDD	Voltage-supply pin
5	VOUT	Output pin

SOT-25A

Pin No.	Pin name	Functions
1	VDD	Voltage-supply pin
2	GND	GND pin
3	CE	ON/OFF-Control pin (with CE pull-down resistor) CE: L → OFF, H → ON Connect CE pin with VDD pin, when it is not used.
4	CS	Soft-start pin (Note2)
5	VOUT	Output pin

Note2 : Must be connect capacitor to Soft-Start pin.
Refer to 9 and 19 for details.

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

Item	Symbol	Ratings		Units
Storage Temperature	Tstg	−55~150	SSON-6A	°C
			SOT89-5A	
		−55~125	SOT-25A	
Junction Temperature	T_{jMAX}	150		°C
Supply Voltage	V_{DD}	−0.3~6.5		V
CE Input Voltage	V_{CE}	−0.3~6.5		V
Output Voltage	V_{OUT}	−0.3~V_{DD}+0.3		V
Cs Pin Voltage	V_{CS}	−0.3~V_{DD}+0.3		V
Output Current	I_{OMAX}	600		mA
Power Dissipation (Note3)	Pd	1250	SSON-6A	mW
		1780	SOT89-5A	
		700	SOT-25A	

Note3 : 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~+85	°C
Operating voltage	Vop	1.6~6.0	V
Output Current	I_{OUT}	0~500	mA

Electrical Characteristics 1 (Except where noted otherwise $V_{DD}=V_{OUT}$ (Typ.)+1V, $V_{CE}=V_{DD}$, Ta=25°C)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Input Current (OFF)	I_{DDOFF}	V_{CE}=0V		0.1	1.0	µA
No-Load Input Current	I_{DD}	I_{OUT}=0mA		50	80	µA
Output Voltage	V_{OUT}	I_{OUT}=10mA, 1.5≦V_{OUT}	×0.99		×1.01	V
		I_{OUT}=10mA, V_{OUT} < 1.5V	−0.015		0.015	
Line Regulation	V_{LINE}	V_{OUT} (typ.)+0.5V≦V_{DD}≦6.0V I_{OUT}=100mA, 2.0V≦V_{OUT}		0.05	0.2	%/V
		2.5V≦V_{DD}≦6.0V I_{OUT}=100mA, V_{OUT} < 2.0V				
Load Regulation	V_{LOAD}	1mA≦I_{OUT}≦500mA		40	80	mV
Dropout Voltage	Vio	Please refer to another page				V
Ripple Rejection	RR	f=1kHz, Vripple=0.5V, I_{OUT}=10mA 1.5≦V_{OUT}		70		dB
		f=1kHz, Vripple=0.5V, I_{OUT}=10mA V_{DD}=2.5V, V_{OUT} < 1.5V				
V_{OUT} Temperature Coefficient (Note4)	⊿Vout/⊿T	I_{OUT}=100mA −40≦Top≦85°C		100		ppm/°C
Output Current	I_{OUT}		500			mA
Output Short-Circuit Current (Note4)	I_{short}	V_{OUT}=0V		30		mA
Thermal ShutDown Detect Temperature (Note4)	T_{SD}			150		°C
Thermal ShutDown Release Temperature (Note4)	T_{SR}			125		°C
Output Rise Time (Note4)	tr	C_S=0.1µF		1.5		ms
CE High Threshold Voltage	V_{CEH}		1.2		6.0	V
CE Low Threshold Voltage	V_{CEL}				0.3	V
CE Pin Current	I_{CE}	V_{CE}=2.0V		0.3		µA
Output NMOS ON Resistance (Note4)	R_{DON}	V_{CE}=0V, V_{DD}=4V		30		Ω

Note4 : The parameter is guaranteed by design.

Electrical Characteristics 2 (Except where noted otherwise V_{DD}=V_{OUT} (Typ.)+1V, V_{CE}=V_{DD}, Ta=25°C)

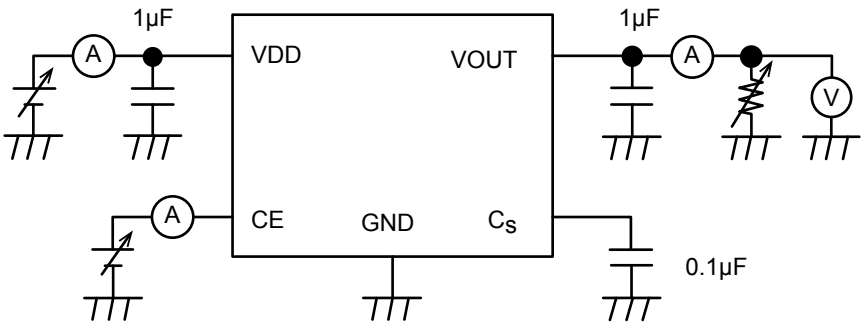
Model No.	Item							
	Output Voltage				Dropout Voltage			
	V_{OUT} (V)				Vio (V)			
	Measurement Conditions	Min.	Typ.	Max.	Measurement Conditions	Min.	Typ.	Max.
MM3526A12	I_{OUT}=10mA	1.185	1.200	1.215	I_{OUT}=200mA, V_{OUT}<2.0V (Note5)		0.30	0.40
MM3526A13		1.285	1.300	1.315				
MM3526A14		1.385	1.400	1.415				
MM3526A15		1.485	1.500	1.515			0.14	0.20
MM3526A16		1.584	1.600	1.616				
MM3526A17		1.683	1.700	1.717				
MM3526A18		1.782	1.800	1.818				
MM3526A19		1.881	1.900	1.919				
MM3526A20		1.980	2.000	2.020	I_{OUT}=200mA, 2.0V≦V_{OUT}, V_{DD}=V_{OUT} (TYP.) –0.2V		0.14	0.20
MM3526A21		2.079	2.100	2.121				
MM3526A22		2.178	2.200	2.222				
MM3526A23		2.277	2.300	2.323				
MM3526A24		2.376	2.400	2.424				
MM3526A25		2.475	2.500	2.525				
MM3526A26		2.574	2.600	2.626				
MM3526A27		2.673	2.700	2.727			0.10	0.14
MM3526A28		2.772	2.800	2.828				
MM3526A29		2.871	2.900	2.929				
MM3526A30		2.970	3.000	3.030				
MM3526A31		3.069	3.100	3.131				
MM3526A32		3.168	3.200	3.232				
MM3526A33		3.267	3.300	3.333				
MM3526A34		3.366	3.400	3.434				
MM3526A35		3.465	3.500	3.535				
MM3526A36		3.564	3.600	3.636				
MM3526A37		3.663	3.700	3.737				
MM3526A38		3.762	3.800	3.838				
MM3526A39		3.861	3.900	3.939				
MM3526A40		3.960	4.000	4.040				
MM3526A41		4.059	4.100	4.141				
MM3526A42		4.158	4.200	4.242				
MM3526A43		4.257	4.300	4.343				
MM3526A44		4.356	4.400	4.444				
MM3526A45		4.455	4.500	4.545				
MM3526A46		4.554	4.600	4.646				
MM3526A47		4.653	4.700	4.747				
MM3526A48		4.752	4.800	4.848				
MM3526A49		4.851	4.900	4.949				
MM3526A50		4.950	5.000	5.050				

Note5 : Dropout voltage maximum value in the input and it is confirmed that there is no output abnormal voltage impression the 200mA in the model less than V_{OUT}<2.0V.

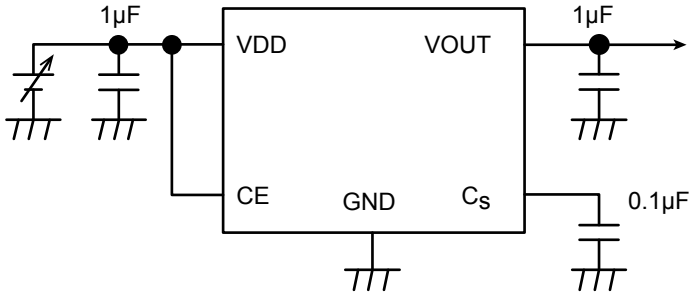
Model No.	Item							
	Output Voltage				Dropout Voltage			
	V_{OUT} (V)				Vio (V)			
	Measurement Conditions	Min.	Typ.	Max.	Measurement Conditions	Min.	Typ.	Max.
MM3526A12	I_{OUT}=10mA	1.185	1.200	1.215	I_{OUT}=500mA, V_{OUT}<2.0V (Note6)		1.00	1.30
MM3526A13		1.285	1.300	1.315				
MM3526A14		1.385	1.400	1.415				
MM3526A15		1.485	1.500	1.515			0.35	0.45
MM3526A16		1.584	1.600	1.616				
MM3526A17		1.683	1.700	1.717				
MM3526A18		1.782	1.800	1.818				
MM3526A19		1.881	1.900	1.919				
MM3526A20		1.980	2.000	2.020	I_{OUT}=500mA, 2.0V≦V_{OUT}, V_{DD}=V_{OUT} (TYP.) −0.2V		0.35	0.45
MM3526A21		2.079	2.100	2.121				
MM3526A22		2.178	2.200	2.222				
MM3526A23		2.277	2.300	2.323				
MM3526A24		2.376	2.400	2.424				
MM3526A25		2.475	2.500	2.525				
MM3526A26		2.574	2.600	2.626				
MM3526A27		2.673	2.700	2.727			0.25	0.35
MM3526A28		2.772	2.800	2.828				
MM3526A29		2.871	2.900	2.929				
MM3526A30		2.970	3.000	3.030				
MM3526A31		3.069	3.100	3.131				
MM3526A32		3.168	3.200	3.232				
MM3526A33		3.267	3.300	3.333				
MM3526A34		3.366	3.400	3.434				
MM3526A35		3.465	3.500	3.535				
MM3526A36		3.564	3.600	3.636				
MM3526A37		3.663	3.700	3.737				
MM3526A38		3.762	3.800	3.838				
MM3526A39		3.861	3.900	3.939				
MM3526A40		3.960	4.000	4.040				
MM3526A41		4.059	4.100	4.141				
MM3526A42		4.158	4.200	4.242				
MM3526A43		4.257	4.300	4.343				
MM3526A44		4.356	4.400	4.444				
MM3526A45		4.455	4.500	4.545				
MM3526A46		4.554	4.600	4.646				
MM3526A47		4.653	4.700	4.747				
MM3526A48		4.752	4.800	4.848				
MM3526A49		4.851	4.900	4.949				
MM3526A50		4.950	5.000	5.050				

Note6 : Dropout voltage maximum value in the input and it is confirmed that there is no output abnormal voltage impression the 500mA in the model less than V_{OUT}< 2.0V.

Test Circuit



Application Circuit



∗ Temperature Characteristics : B

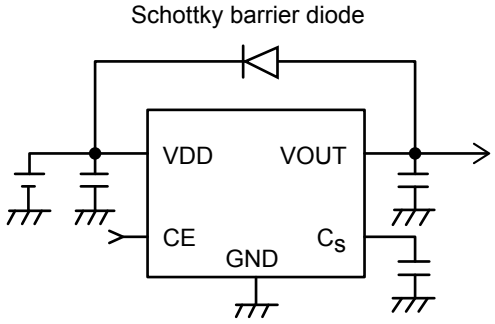
(Reference example of external parts)

· Output capacitor	Ceramic capacitor	1.0μF
· Input capacitor	Ceramic capacitor	1.0μF
· Softstart Capacitor	Ceramic capacitor	0.1μF

· 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.

· 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 1.0μF and B temperature characteristics.
6. The wire of VDD 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 1cm 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. Please connect the soft-start capacitor(Cs) more than 0.01μF with the terminal Cs.
10. The output capacitor and the softstart capacitor must be connected it within the limits a rush current peak level 500mA showed in the typical performance characteristics.
11. When rush current exceeds current limit characteristics, it is restricted with the current limit set up with the chip, an output rise time is uncontrollable by soft-start capacitor.
12. When use connecting VDD and CE, in the case of starting VDD in input rise time longer then the set-up soft-start time, an output rise time is decide by a VDD input rise time.
13. Please do not give the voltage to the terminal Cs.
14. When the voltage of the terminal Cs is higher than the voltage of VDD, it becomes test mode.
    In that case, there is a possibility that the output voltage becomes unstable.
15. 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.
16. The overcurrent protection circuit of foldback current limit type is built into this IC.
17. There is a possibility that IC generates heat when the output terminal is short-circuited. However, the thermal shutdown circuit operates, and it will do operation that protects IC. The thermal shutdown circuit is designed only to shut the IC off to prevent thermal runaway. Do not continue to use the IC in an environment where the operation of this circuit is assumed. The characteristic changes depending on the substrate condition. Please evaluate IC in the set.
18. It returns automatically in temperature returned after it shuts down by self-generation of heat. After it returns, it shuts down again by self-generation of heat. It is necessary to change the environment used (IC consumption, temperature) if it operates in upper cycle.

19. When VDD rise time is longer than Vout rise time, Vout rise time is decided by VDD rise time. At this time, Vout is may rose more than typical voltage.
Please set to soft-start capacitor for the VDD rise time in the slash area shown in Fig. 1.
Fig. 1 is common for all the voltage ranks, because soft start time is decided by soft start capacitor and reference voltage.
Please choose to a capacitor in consideration of the dispersion .
Refer to Fig. 2 for a measurement circuit.

• **Condition VDD=Vout (typ.) +1V, CE=VDD, Ta=-40°C~85°C**

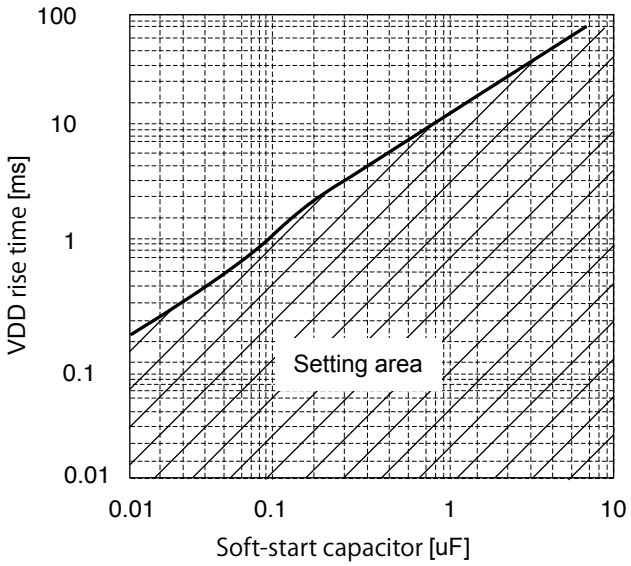
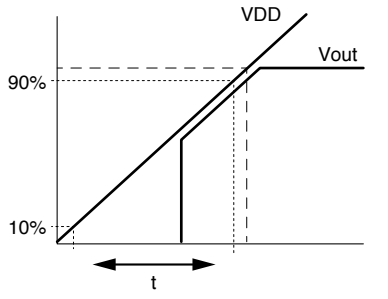
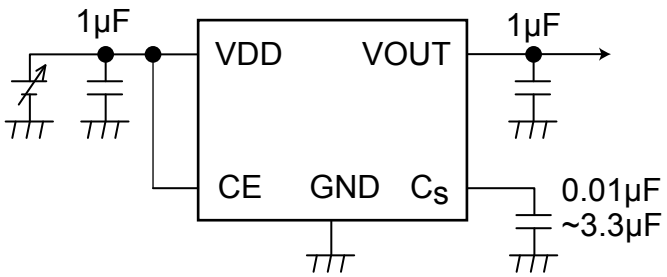


Fig. 1 Soft-start capacitor vs VDD rise time



* VDD rise time (t) of VDD is judged in time (10%-90%) until VDD reaches Vout setting voltage.



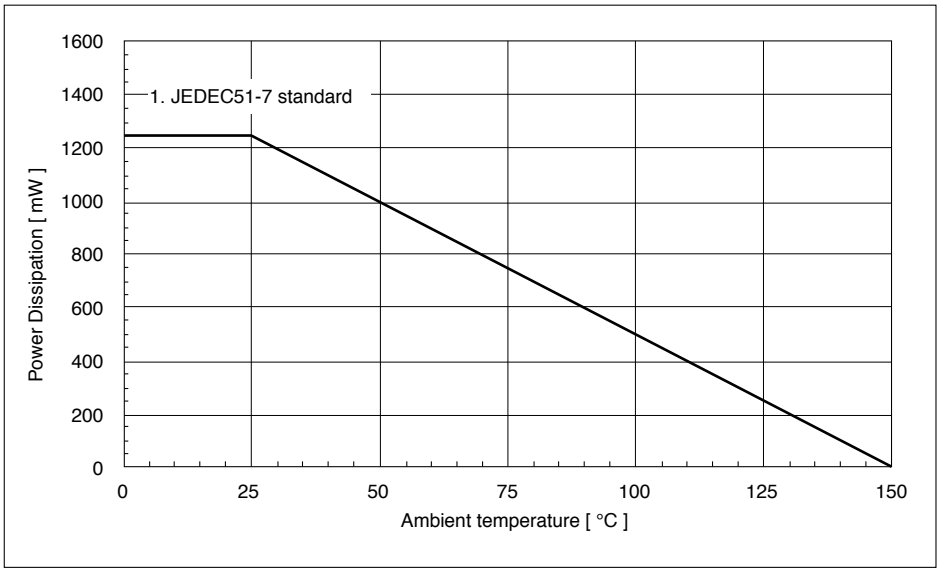
Fig, 2 Test Circuit

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.

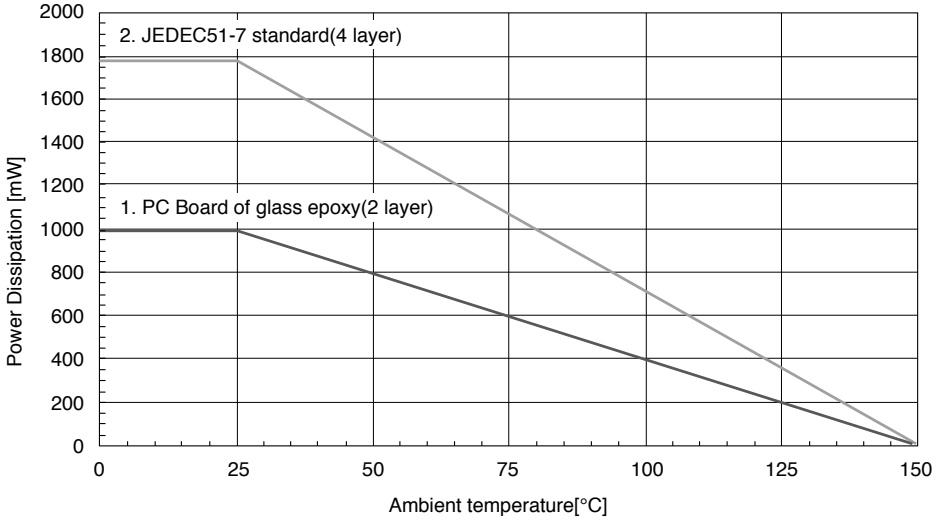
MM3526AxxRRE

1. JEDEC51-7 standard
   Board size 114.3mm×76.2mm t=1.6mm Copper foil area 80%
   Power dissipation 1250mW Ta=25°C (It is reference value measured by JEDEC51-7 standard.)



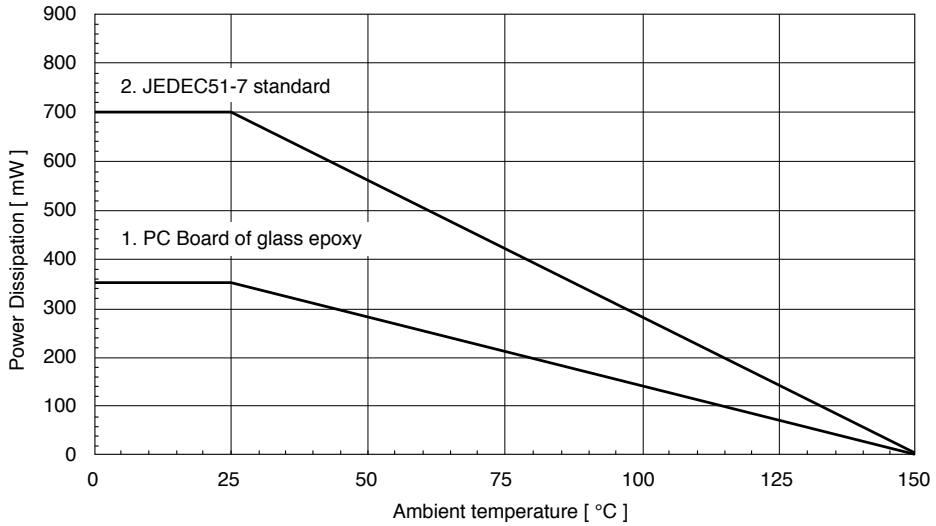
MM3526AxxPRE

1. PC Board of glass epoxy
   Board size 114.3mm×76.2mm t=1.6mm Copper foil area 80%
   Power dissipation 1000mW Ta=25°C
2. JEDEC51-7 standard
   Board size 114.3mm×76.2mm t=1.6mm Copper foil area 80%
   Power dissipation 1780mW Ta=25°C (It is reference value measured by JEDEC51-7 standard.)



MM3526AxxNRE

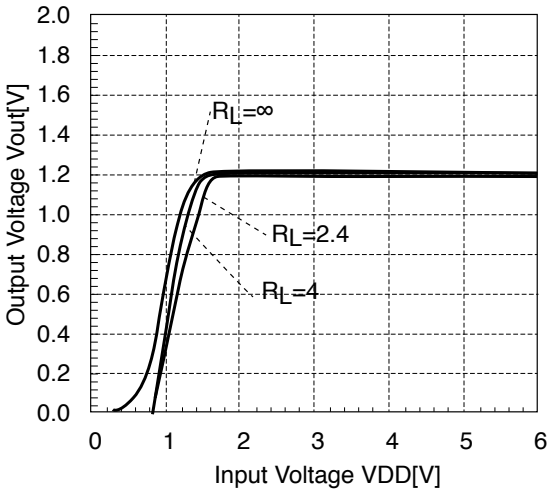
1. PC Board of glass epoxy
   Board size 60mm×40mm t=1.6mm Copper foil area 60%
   Power dissipation 350mW Ta=25°C
2. JEDEC51-7 standard
   Board size 114.3mm×76.2mm t=1.6mm Copper foil area 80%
   Power dissipation 700mW Ta=25°C (It is reference value measured by JEDEC51-7 standard.)



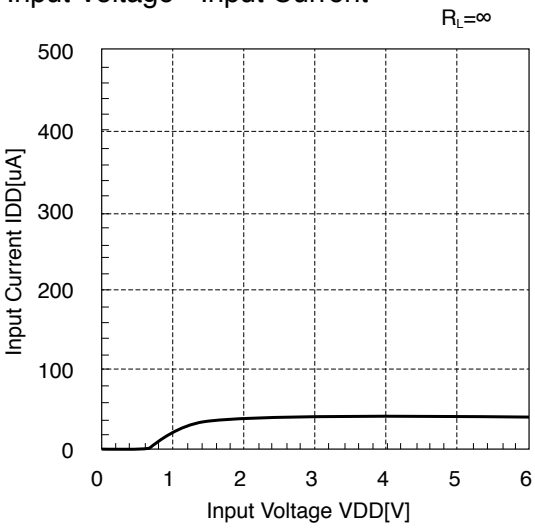
It is recommended to layout the VIA for heat radiation in the GND pattern of reverse (of IC) when there is the GND pattern in the inner layer (in using multiplayer substrate).
By increasing these copper foil pattern area of PCB, Power dissipation improves.

Characteristics (V_O=1.2V) (Except where noted otherwise $V_{DD}=V_{OUT}$(TYP.)+1V, $V_{CE}=V_{DD}$, Ta=25°C)

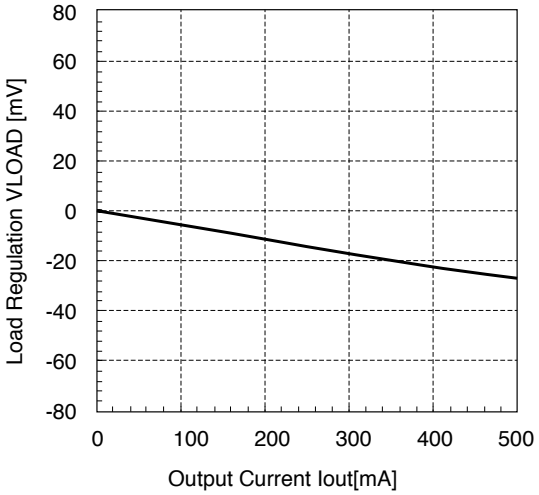
■ Input Voltage - Output Voltage



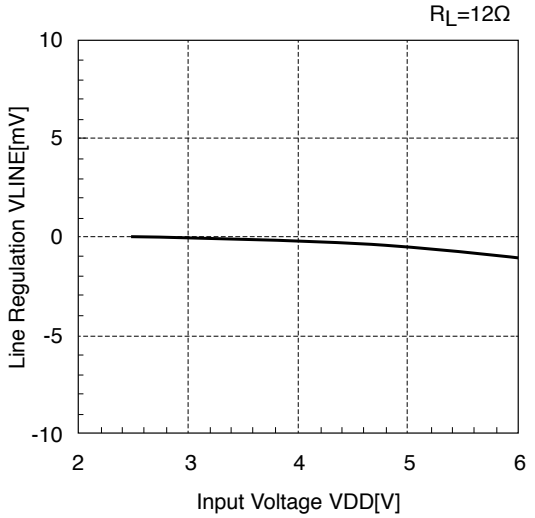
■ Input Voltage - Input Current



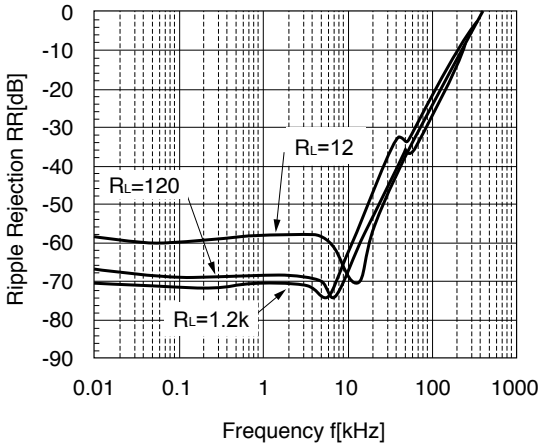
■ Load Regulation



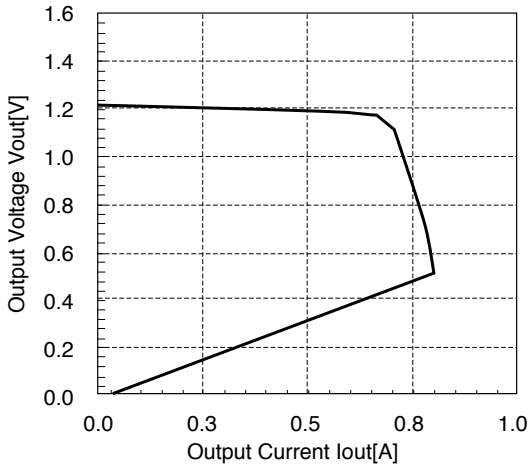
■ Line Regulation



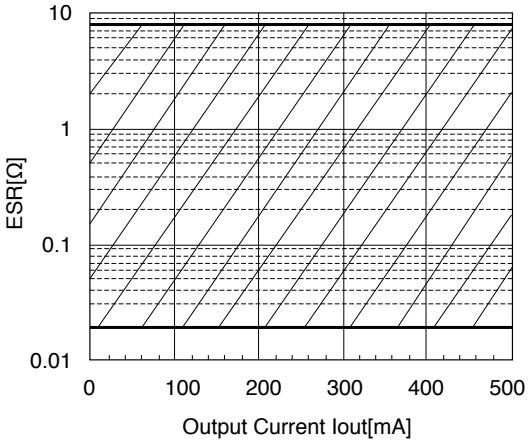
■ Ripple Rejection



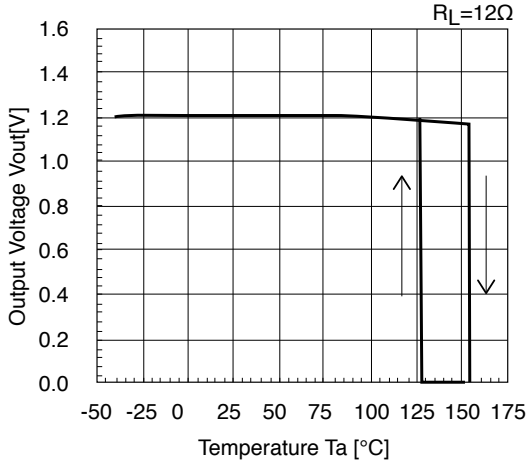
■ Output Current - Output Voltage



■ ESR stability area

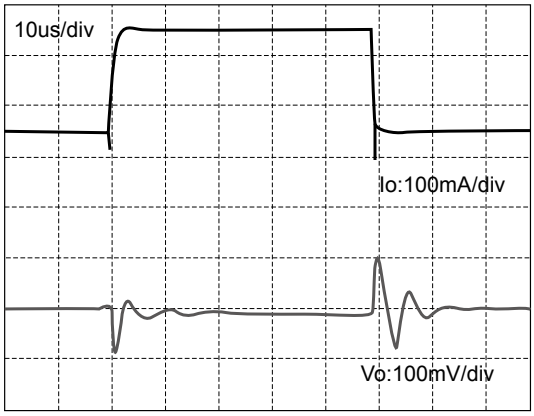


■ Output Voltage Temperature Coefficient

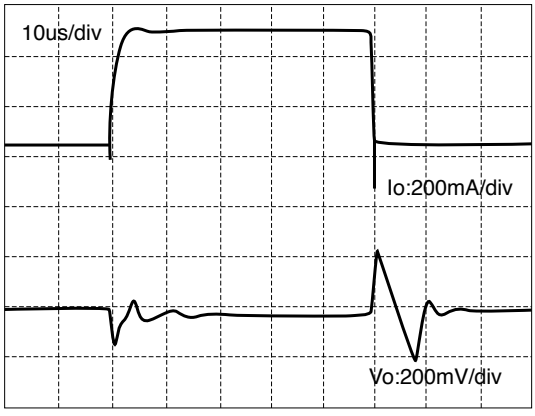


■ Load transient response(Cin=Co=1uF)

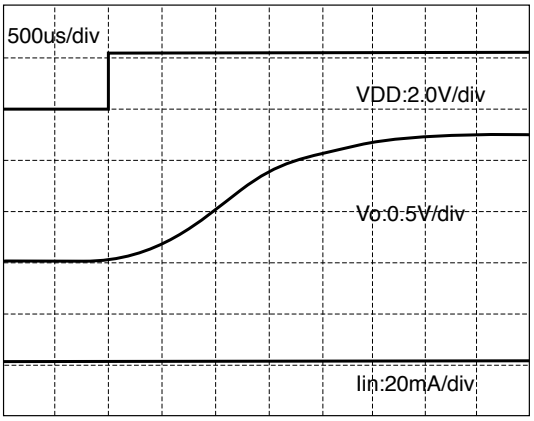
Io:50mA⇔250mA



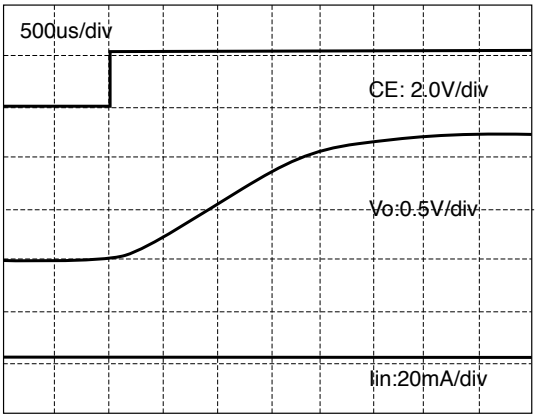
Io:50mA⇔500mA



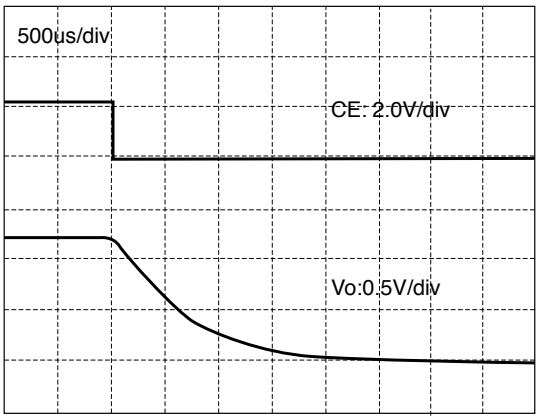
■ Input rise characteristics
(VDD=0V⇔2.2V, VCE=VDD)



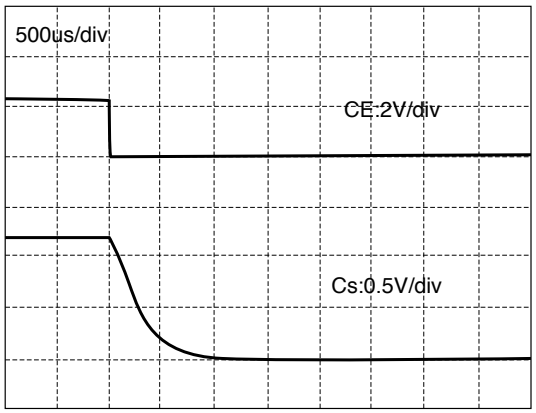
■ CE rise characteristics
(VDD=2.2V,CE=0V⇔VDD)



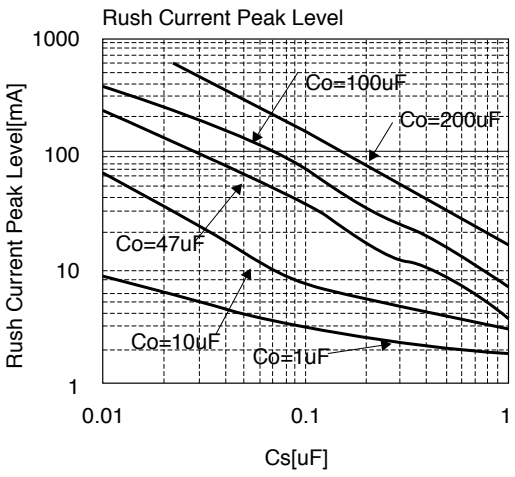
■ Vout discharge characteristics
(VDD=2.2V,CE=VDD⇔0V)

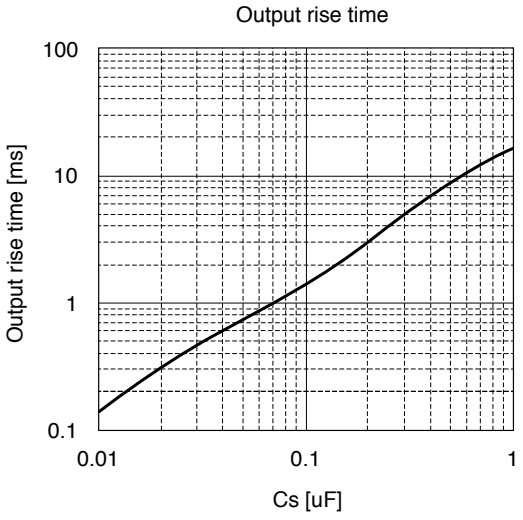


■ Cs discharge charact
(VDD=2.2V,CE=VDD⇔0V)



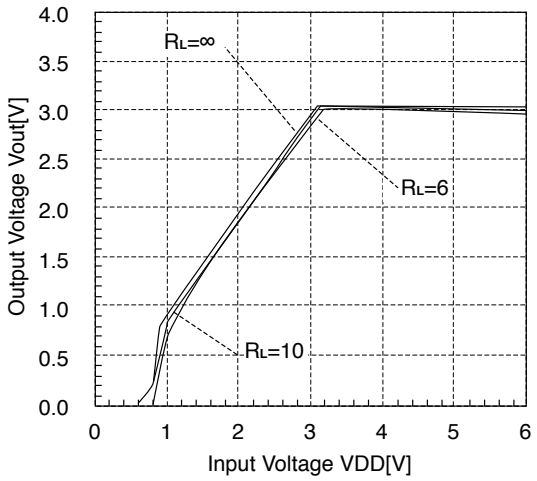
■ Rush Current characteristics
(Co:aluminum electrolytic capacitor)



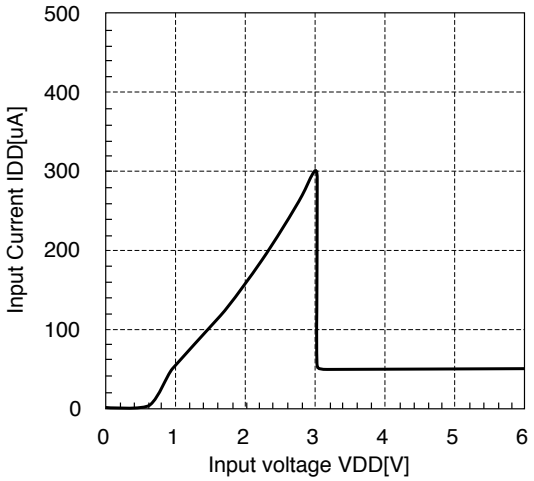


Characteristics (Vo=3.0V) (Except where noted otherwise $V_{DD}=V_{OUT}$(TYP.)+1V, $V_{CE}=V_{DD}$, Ta=25°C)

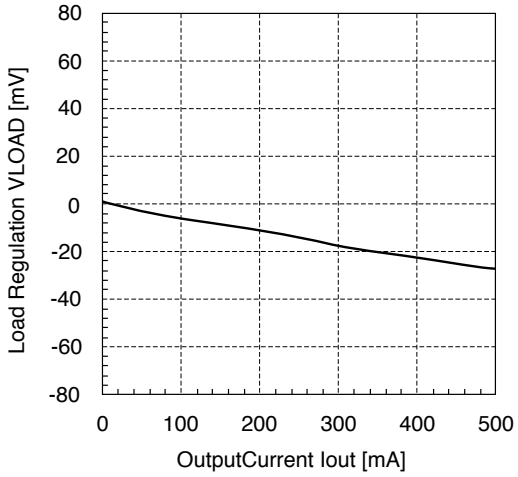
■ Input Voltage - Output Voltage



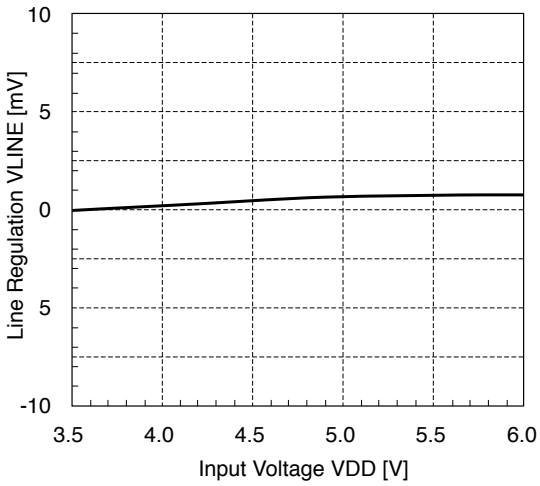
■ Input Voltage - Input Current R_L=∞



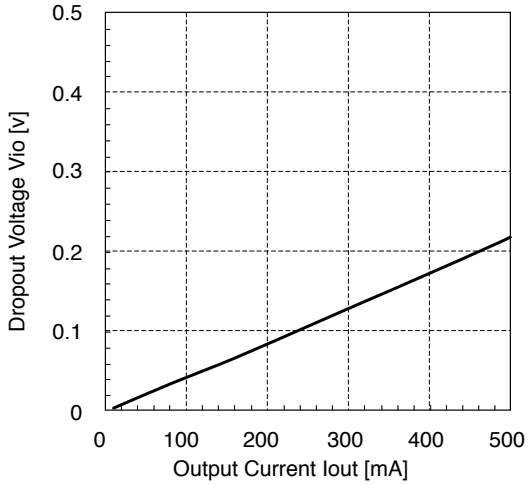
■ Load Regulation



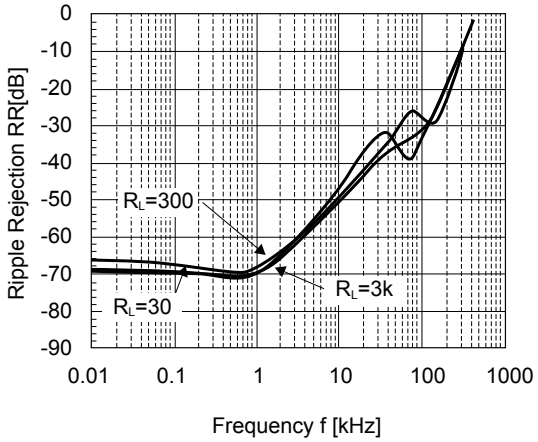
■ Line Regulation



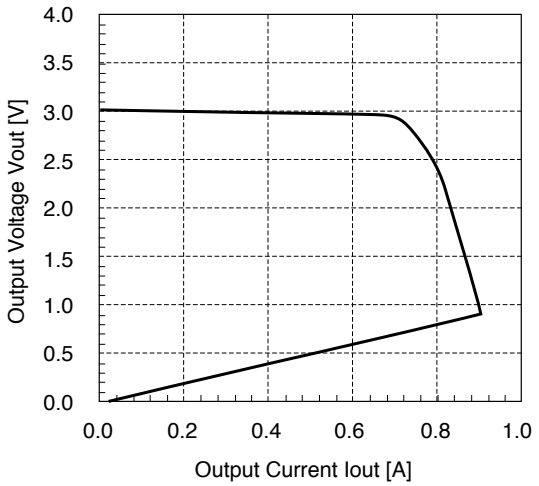
■ Dropout Voltage



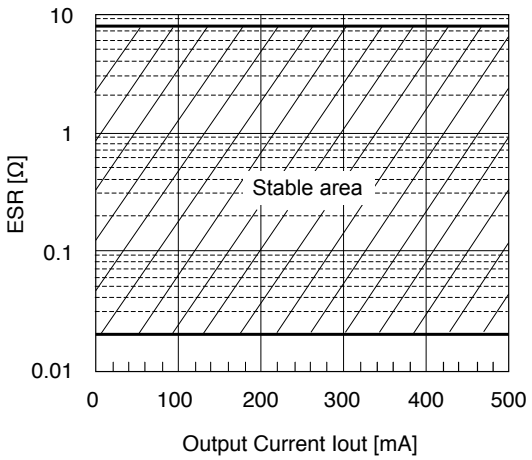
■ Ripple Rejection



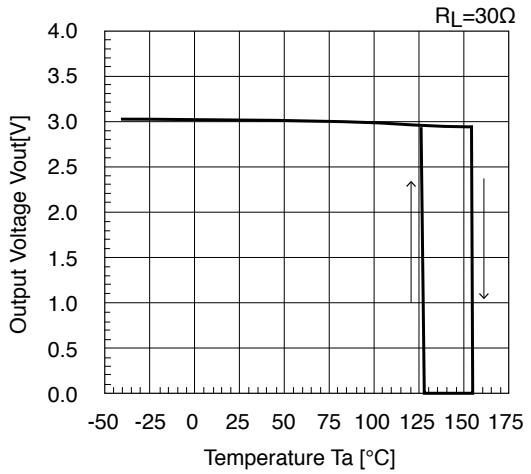
■ Output Current- Output Voltage



■ ESR stability area

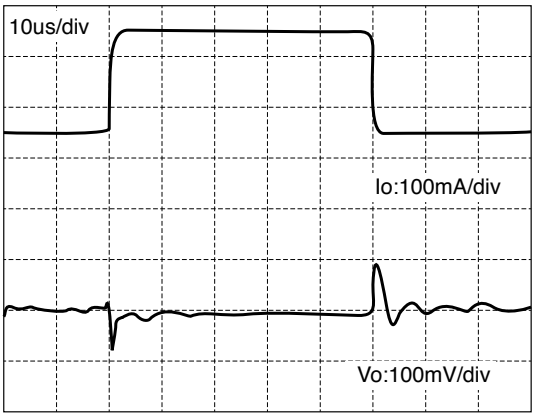


■ Outputvoltage Temperature Coefficient

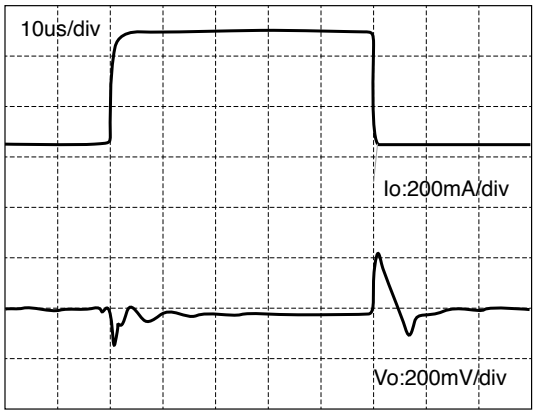


■ Load transient response(Cin=Co=1uF)

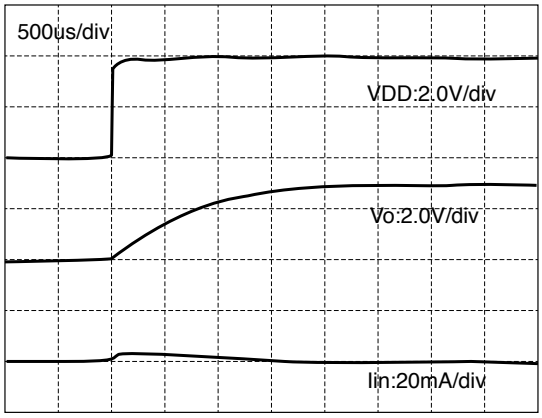
Io:50mA⇔250mA



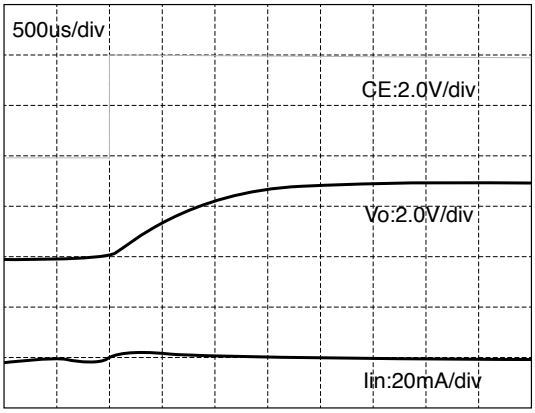
Io:50mA⇔500mA



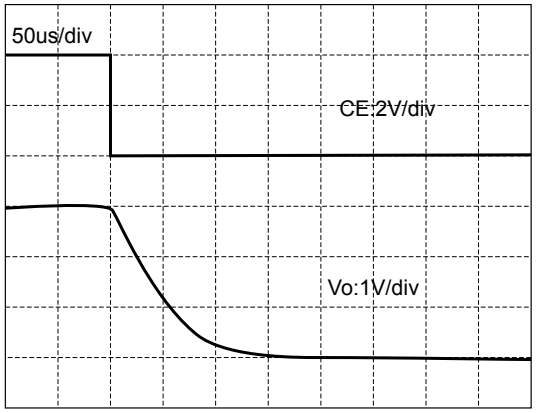
■ Input rise characteristics
(VDD=0V⇔4.0V, VCE=VDD)



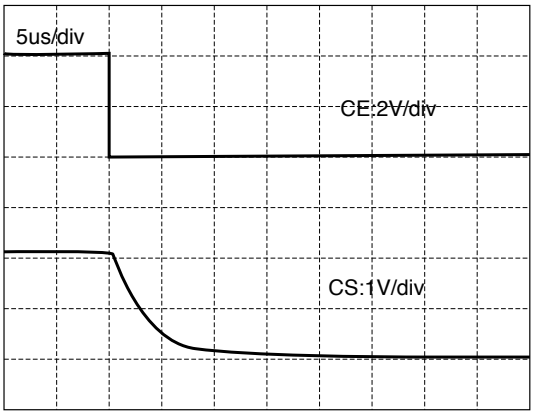
■ CE rise characteristics
(VDD=4.0V, CE=0V⇔VDD)



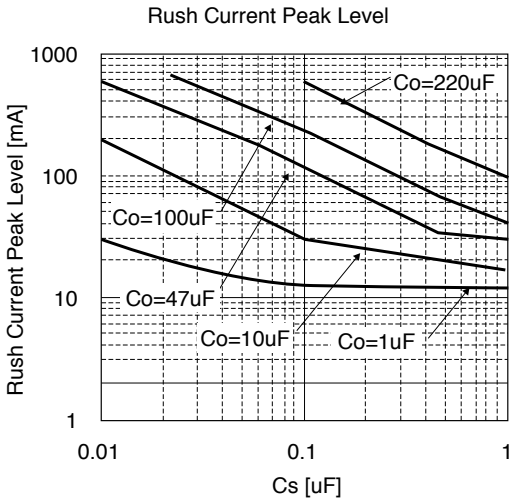
■ Vout discharge characteristics
(VDD=4.0V,CE=VDD⇔0V)

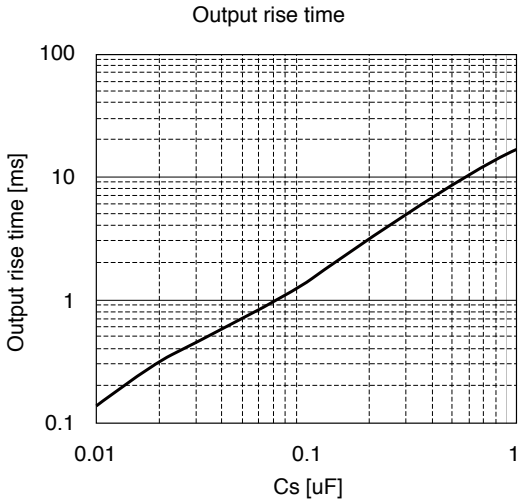


■ Cs discharge characteristics
(VDD=4.0V,CE=VDD⇔0V)



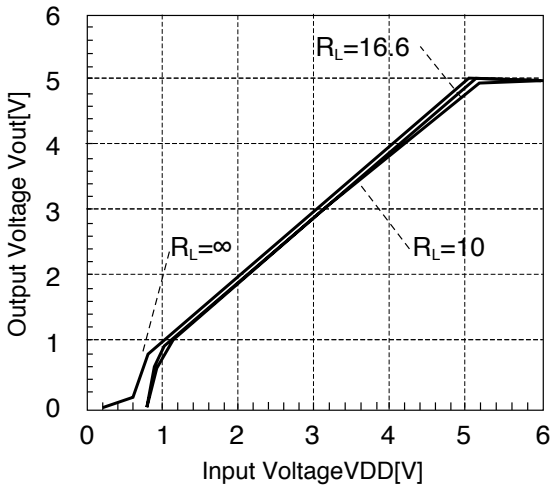
■ Rush Current characteristics
(Co:aluminum electrolytic capacitor)



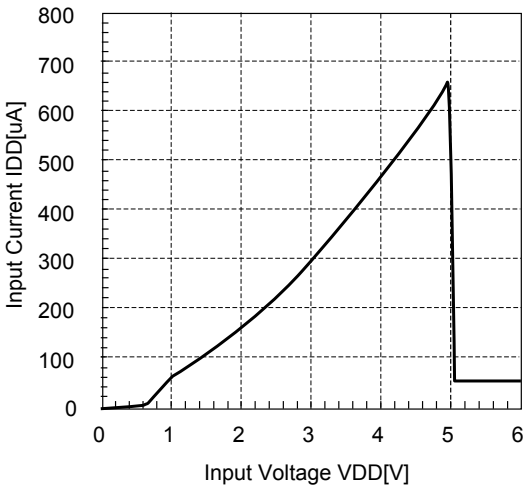


Characteristics (V_O=5.0V) (Except where noted otherwise $V_{DD}=V_{OUT}$(TYP.)+1V, $V_{CE}=V_{DD}$, Ta=25°C)

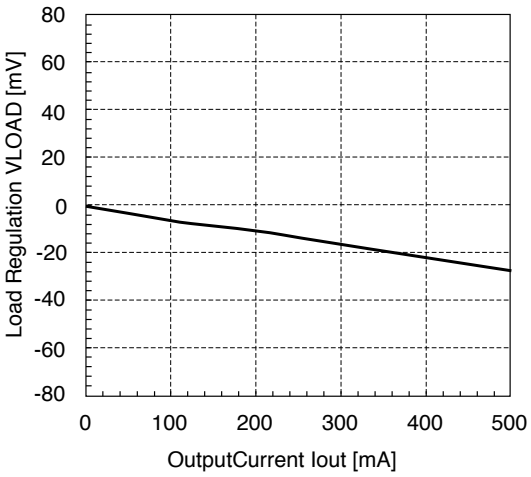
■ Input Voltage-Output Voltage



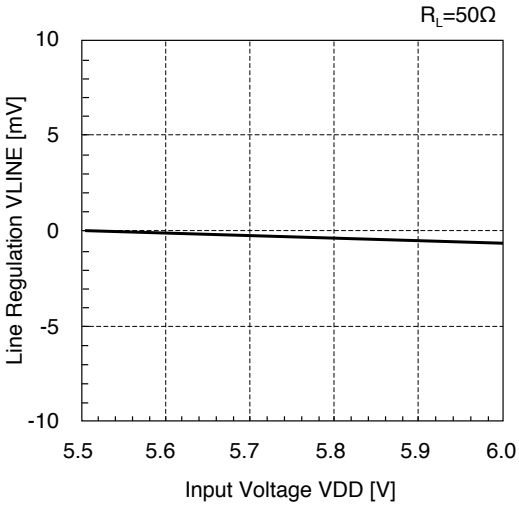
■ Input Voltage-Input Current R_L=∞



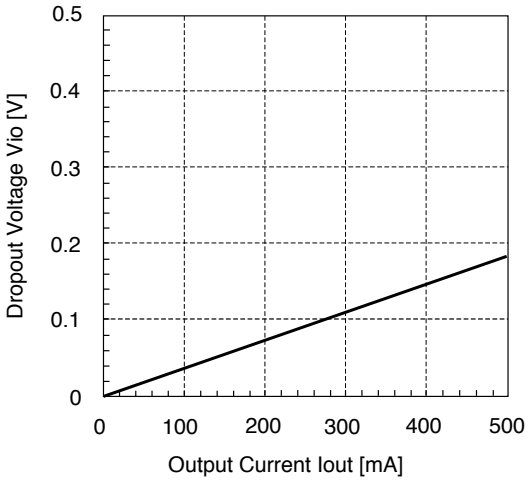
■ Load Regulation



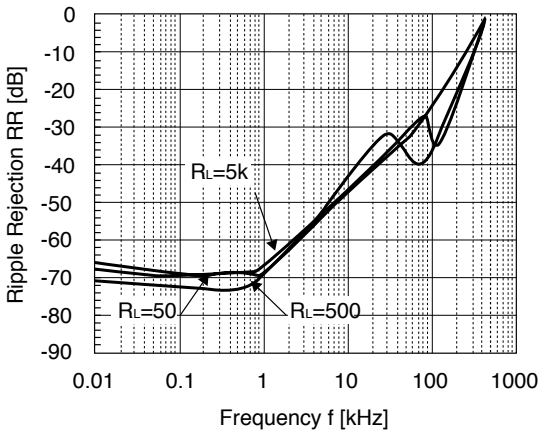
■ Line Regulation



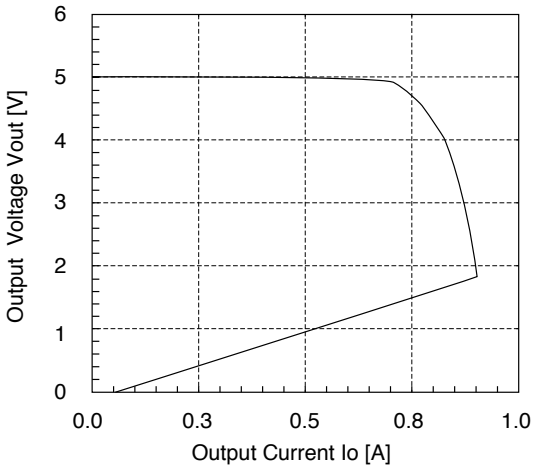
■ Dropout Voltage



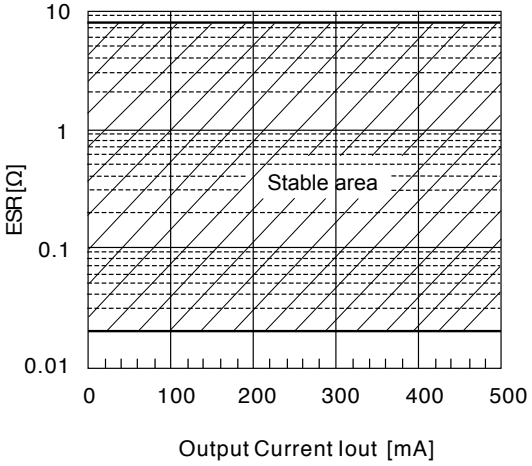
■ Ripple Rejection



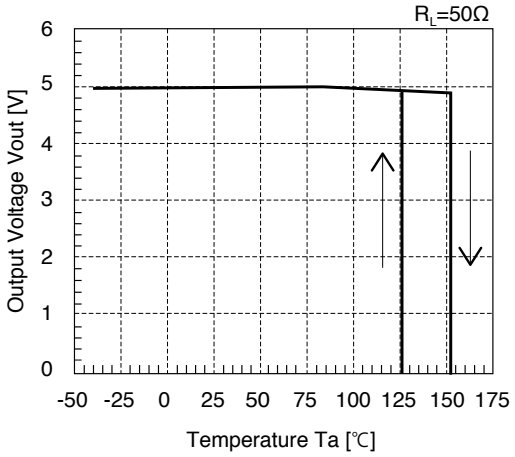
■ Output Current -Output Voltage



■ ESR stability area

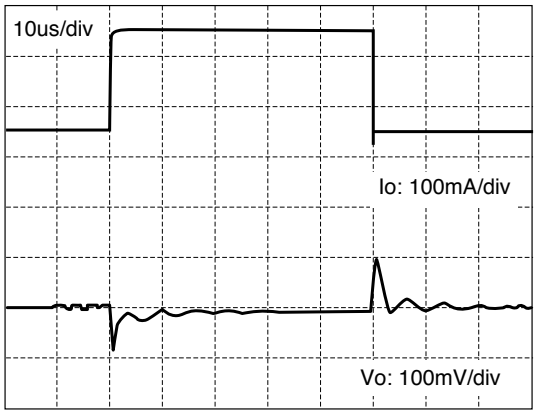


■ OutputVoltage Temperature Coefficient

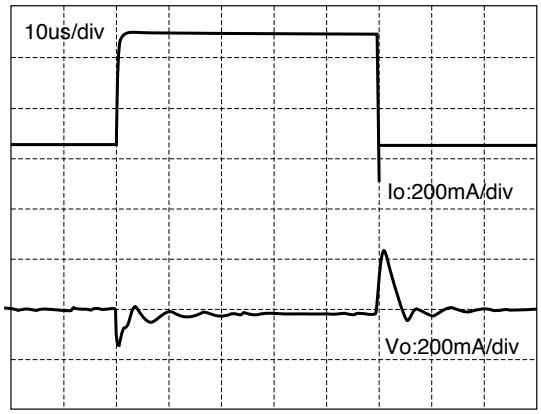


■ Load transient response (Cin=Co=1uF)

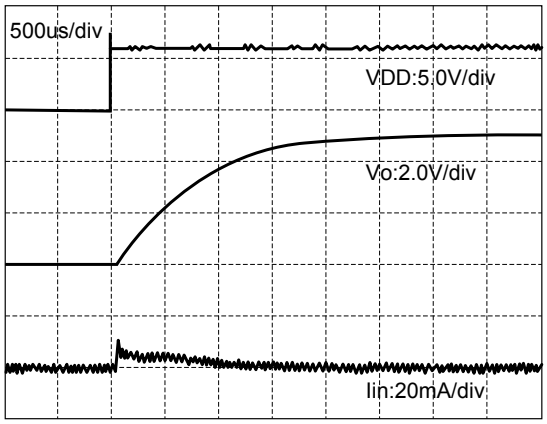
Io:50mA⇔250mA



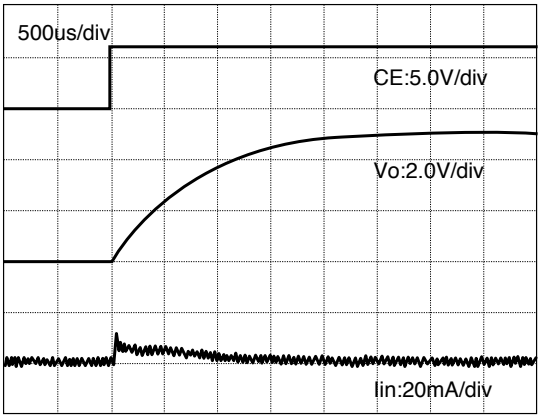
Io:50mA⇔500mA



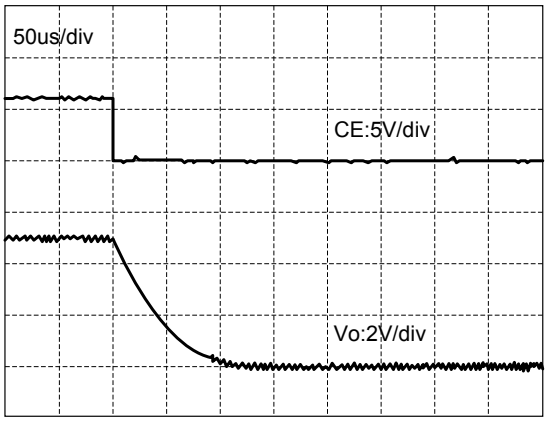
■ Input rise characteristics
(VDD=0V⇔6.0V, VCE=VDD)



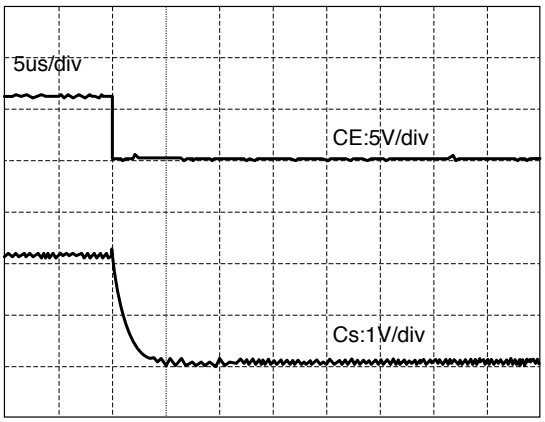
■ CE rise characteristics
(VDD=6.0V, CE=0V⇔VDD)



■ Vout discharge characteristics
(VDD=6.0V,CE=VDD⇔0V)



■ Cs discharge characteristics
(VDD=6.0V,CE=VDD⇔0V)



■ Rush Current characteristics
(Co:aluminum electrolytic capacitor)