500mA LDO with soft-start
Monolithic IC MM3478 Series

Outline

This IC is a 500mA LDO with soft-start.
The soft-start can reduce a rush current by the Cs capacitor on start-up.
Package is SOT89-5A 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. (I_O=500mA, V_O=3V)
8.	Line regulation	±0.2%/V max.
9.	Load regulation	80mV max.(I_O=1~500mA)
10.	Ripple rejection	70dB typ. (f=1kHz)
11.	Thermal shutdown	Built-in
12.	Output Capacitor	1μF

Package

SOT89-5A

Applications

1. TV
2. BD recorder/player
3. Printer
4. Game

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Model Name

M M 3 4 7 8 □ □ □ □ □ □

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_Standard)
		L	L HOUSING

e	
E	EMBOSS TAPE

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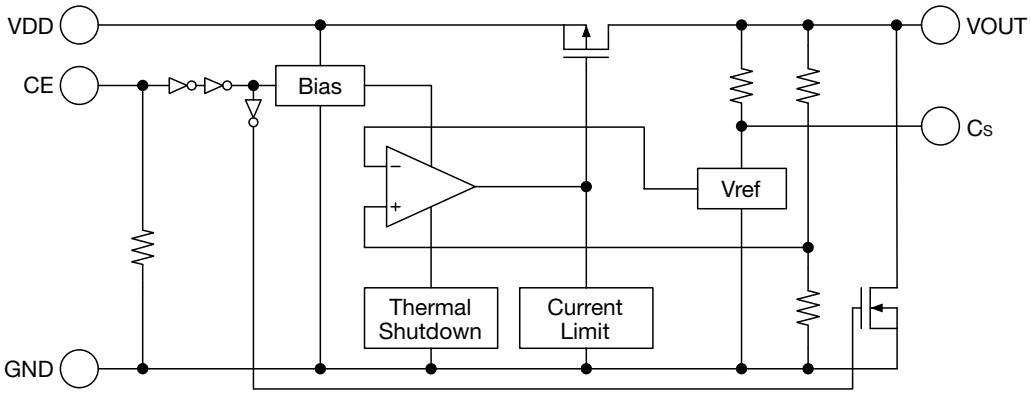
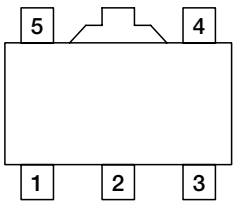
Block Diagram



Pin Assignment



SOT89-5A
(TOP VIEW)

1	CE
2	GND
3	Cs
4	VDD
5	VOUT

Pin Description

Pin No.	Pin name	Functions
1	CE	ON/OFF-Control pin CE: L → OUTPUT: OFF; CE: H → OUTPUT: ON Connect CE pin with VDD pin, when it is not used.
2	GND	GND pin
3	Cs	Soft-Start pin
4	VDD	Voltage-Supply pin
5	VOUT	Output pin

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

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

Item	Symbol	Ratings	Units
Storage Temperature	Tstg	−55~+150	°C
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~VDD+0.3	V
Cs Voltage	V_{CS}	−0.3~VDD+0.3	V
Output Current	I_{OMAX}	600	mA
Power Dissipation (Note1)	Pd	1780	mW

Note1 : 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

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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 (Note2)	$\Delta V_{OUT}/\Delta T$	I_{OUT}=100mA, −40≦Top≦+85°C		100		ppm/°C
Output Current	I_{OUT}		500			mA
Output Short-Circuit Current (Note2)	I_{short}	V_{OUT}=0V		30		mA
Thermal ShutDown Detect Temperature (Note2)	T_{SD}			150		°C
Thermal ShutDown Release Temperature (Note2)	T_{SR}			125		°C
Output Rise Time (Note2)	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 (Note2)	R_{DON}	V_{CE}=0V, V_{DD}=4V		30		Ω

Note2 : The parameter is guaranteed by design.

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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.
MM3478A12	I_{OUT}=10mA	1.185	1.200	1.215	I_{OUT}=200mA, V_{OUT}<2.0V (Note3)		0.30	0.40
MM3478A13		1.285	1.300	1.315				
MM3478A14		1.385	1.400	1.415				
MM3478A15		1.485	1.500	1.515			0.14	0.20
MM3478A16		1.584	1.600	1.616				
MM3478A17		1.683	1.700	1.717				
MM3478A18		1.782	1.800	1.818				
MM3478A19		1.881	1.900	1.919				
MM3478A20		1.980	2.000	2.020	I_{OUT}=200mA, 2.0V≦V_{OUT}, $V_{DD}=V_{OUT}$ (TYP.) –0.2V		0.14	0.20
MM3478A21		2.079	2.100	2.121				
MM3478A22		2.178	2.200	2.222				
MM3478A23		2.277	2.300	2.323				
MM3478A24		2.376	2.400	2.424				
MM3478A25		2.475	2.500	2.525				
MM3478A26		2.574	2.600	2.626				
MM3478A27		2.673	2.700	2.727			0.10	0.14
MM3478A28		2.772	2.800	2.828				
MM3478A29		2.871	2.900	2.929				
MM3478A30		2.970	3.000	3.030				
MM3478A31		3.069	3.100	3.131				
MM3478A32		3.168	3.200	3.232				
MM3478A33		3.267	3.300	3.333				
MM3478A34		3.366	3.400	3.434				
MM3478A35		3.465	3.500	3.535				
MM3478A36		3.564	3.600	3.636				
MM3478A37		3.663	3.700	3.737				
MM3478A38		3.762	3.800	3.838				
MM3478A39		3.861	3.900	3.939				
MM3478A40		3.960	4.000	4.040				
MM3478A41		4.059	4.100	4.141				
MM3478A42		4.158	4.200	4.242				
MM3478A43		4.257	4.300	4.343				
MM3478A44		4.356	4.400	4.444				
MM3478A45		4.455	4.500	4.545				
MM3478A46		4.554	4.600	4.646				
MM3478A47		4.653	4.700	4.747				
MM3478A48		4.752	4.800	4.848				
MM3478A49		4.851	4.900	4.949				
MM3478A50		4.950	5.000	5.050				

Note3 : 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.

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Model No.	Item							
	Output Voltage				Dropout Voltage			
	V_{OUT} (V)				Vio (V)			
	Measurement Conditions	Min.	Typ.	Max.	Measurement Conditions	Min.	Typ.	Max.
MM3478A12	I_{OUT}=10mA	1.185	1.200	1.215	I_{OUT}=500mA, V_{OUT}<2.0V (Note4)		1.00	1.30
MM3478A13		1.285	1.300	1.315				
MM3478A14		1.385	1.400	1.415				
MM3478A15		1.485	1.500	1.515			0.35	0.45
MM3478A16		1.584	1.600	1.616				
MM3478A17		1.683	1.700	1.717				
MM3478A18		1.782	1.800	1.818				
MM3478A19		1.881	1.900	1.919				
MM3478A20		1.980	2.000	2.020	I_{OUT}=500mA, 2.0V≦V_{OUT}, V_{DD}=V_{OUT} (TYP.) –0.2V		0.35	0.45
MM3478A21		2.079	2.100	2.121				
MM3478A22		2.178	2.200	2.222				
MM3478A23		2.277	2.300	2.323				
MM3478A24		2.376	2.400	2.424				
MM3478A25		2.475	2.500	2.525				
MM3478A26		2.574	2.600	2.626				
MM3478A27		2.673	2.700	2.727			0.25	0.35
MM3478A28		2.772	2.800	2.828				
MM3478A29		2.871	2.900	2.929				
MM3478A30		2.970	3.000	3.030				
MM3478A31		3.069	3.100	3.131				
MM3478A32		3.168	3.200	3.232				
MM3478A33		3.267	3.300	3.333				
MM3478A34		3.366	3.400	3.434				
MM3478A35		3.465	3.500	3.535				
MM3478A36		3.564	3.600	3.636				
MM3478A37		3.663	3.700	3.737				
MM3478A38		3.762	3.800	3.838				
MM3478A39		3.861	3.900	3.939				
MM3478A40		3.960	4.000	4.040				
MM3478A41		4.059	4.100	4.141				
MM3478A42		4.158	4.200	4.242				
MM3478A43		4.257	4.300	4.343				
MM3478A44		4.356	4.400	4.444				
MM3478A45		4.455	4.500	4.545				
MM3478A46		4.554	4.600	4.646				
MM3478A47		4.653	4.700	4.747				
MM3478A48		4.752	4.800	4.848				
MM3478A49		4.851	4.900	4.949				
MM3478A50		4.950	5.000	5.050				

Note4 : 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.

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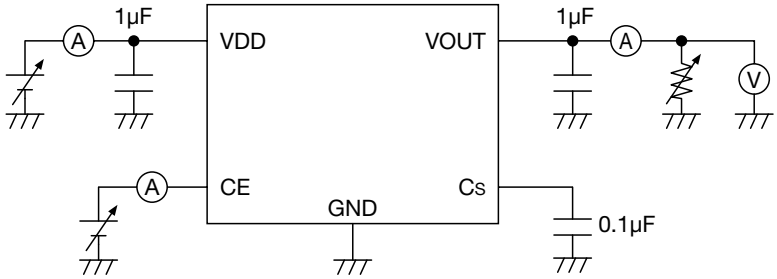
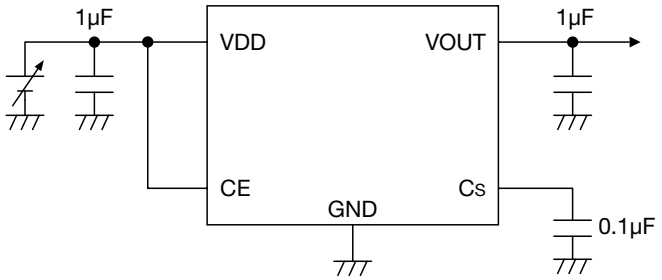
Measuring Circuit



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.

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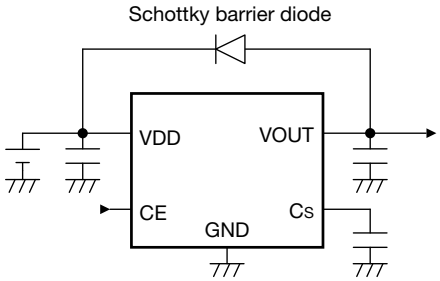
· Note

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 the vertical 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.

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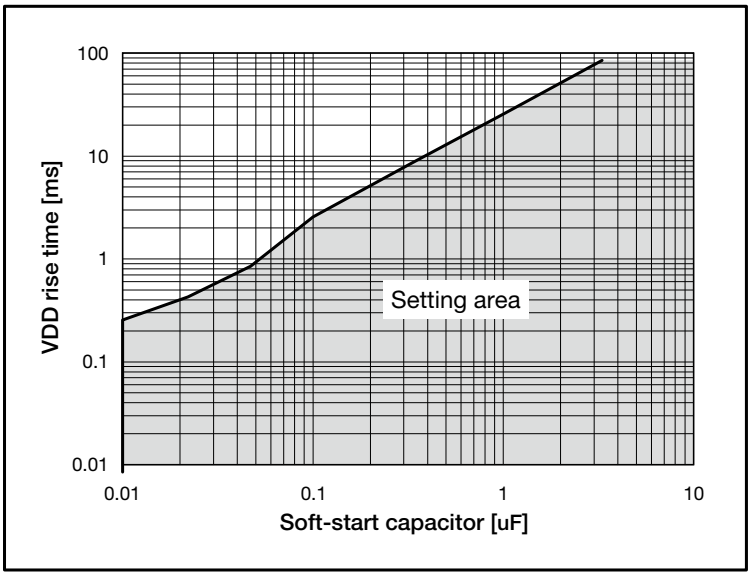
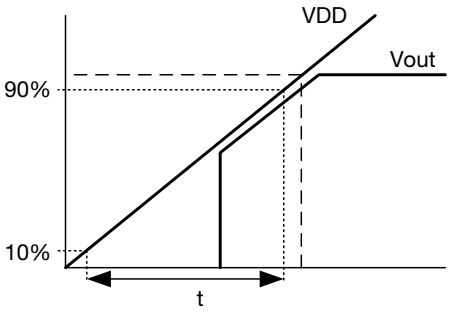
19. When VDD rise time is longer than Vout rise time, Vout rise time is decided by VDD rise time. At this time, Vout is may rose more than typical voltage.
Please set to soft-start capacitor for the VDD rise time in the slash area shown in Fig. 1.
Fig. 1 is common for all the voltage ranks, because soft 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.

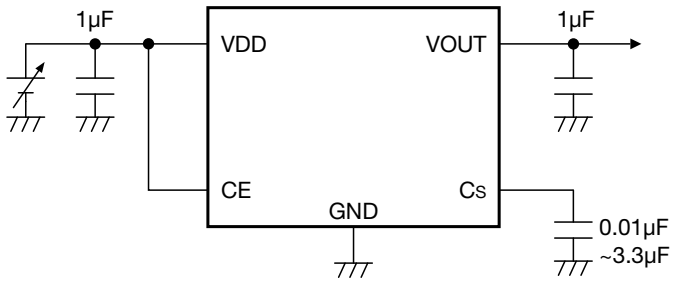
Condition : VDD=Vout (typ.) +1V, CE=VDD, Ta=-40°C~+85°C



Fig, 1 Soft-start capacitor vs VDD rise time



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

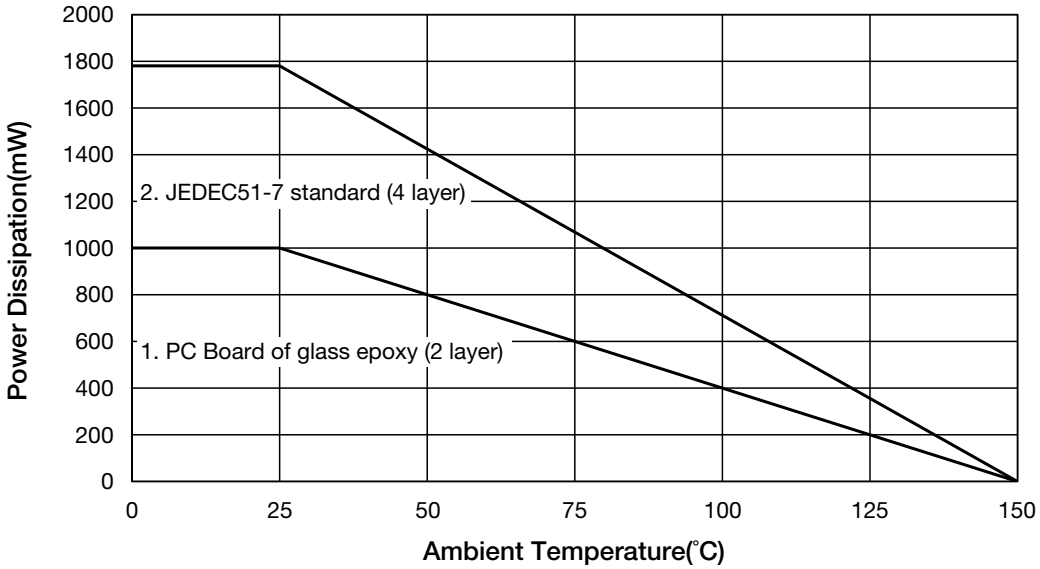


Fig, 2 Test Circuit

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.

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.)



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.

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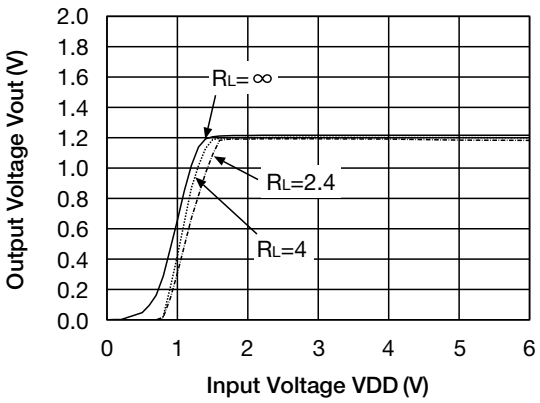
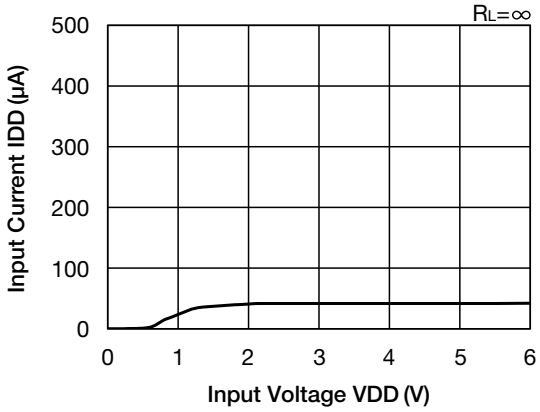
Characteristics (V_{OUT}=1.2V) (Except where noted otherwise V_{DD}=V_{OUT}(TYP.)+1V, V_{CE}=V_{DD}, Ta=25°C)

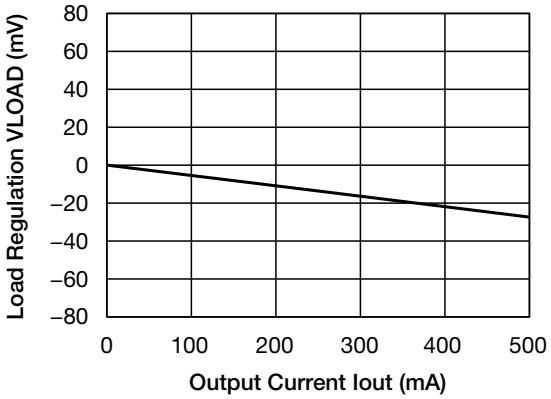
Input Voltage - Output Voltage



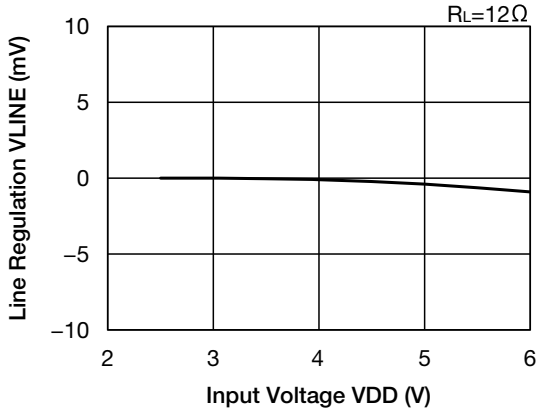
Input Voltage - Input Current



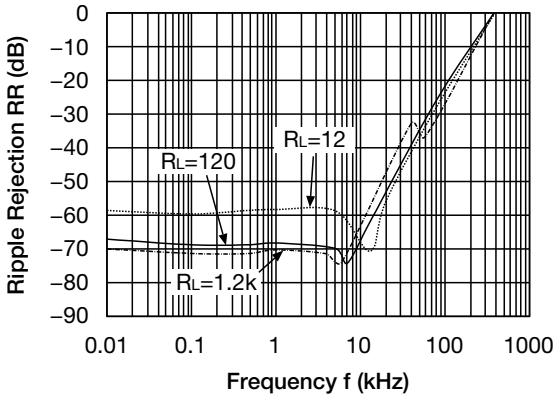
Load Regulation



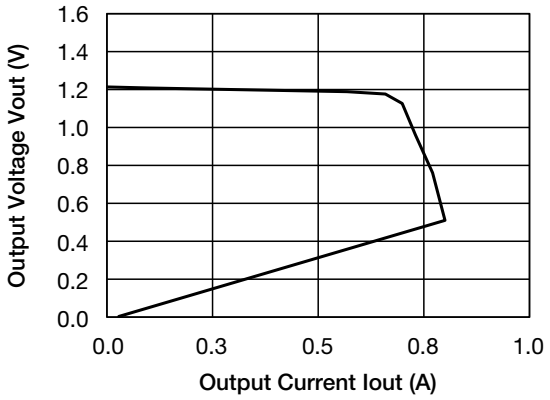
Line Regulation



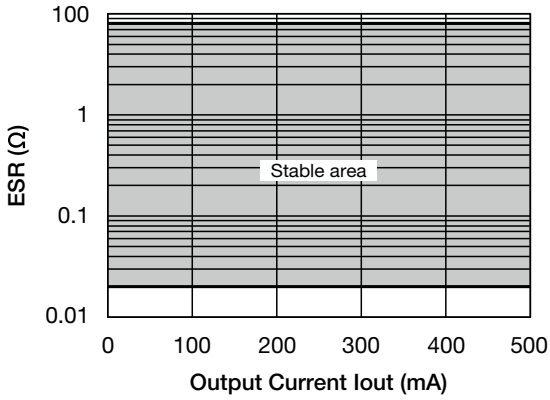
Ripple Rejection



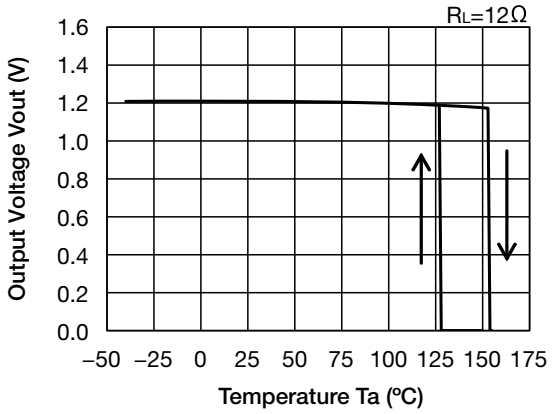
Output Current – Output Voltage



ESR stable area

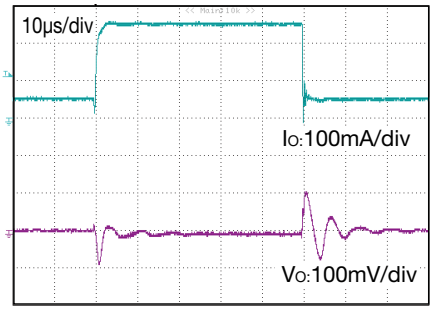


Output Voltage Temperature Coefficient

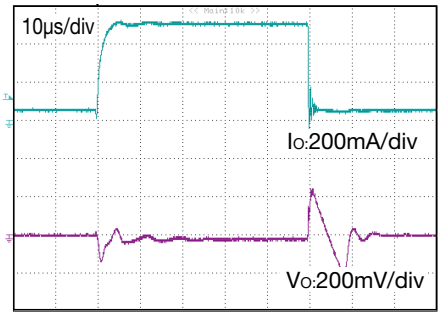


Load Transient response (Cin=Co=1μF)

IO=50mA⇔250mA



IO=50mA⇔500mA



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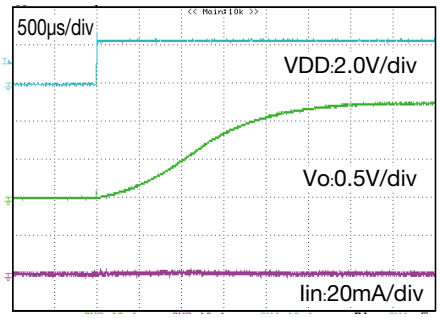
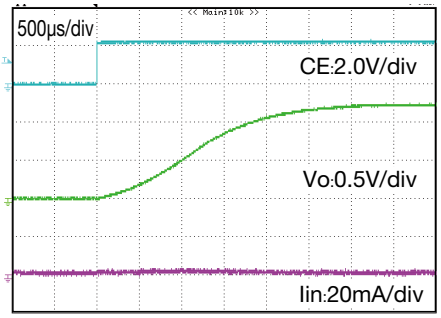
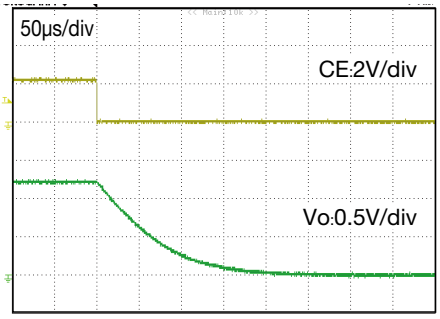
Input rise characteristics (VDD=0V⇔2.2V, VCE=VDD)



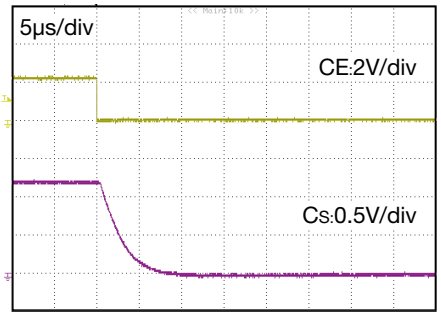
CE rise characteristics (VDD=2.2V, CE=0V⇔VDD)



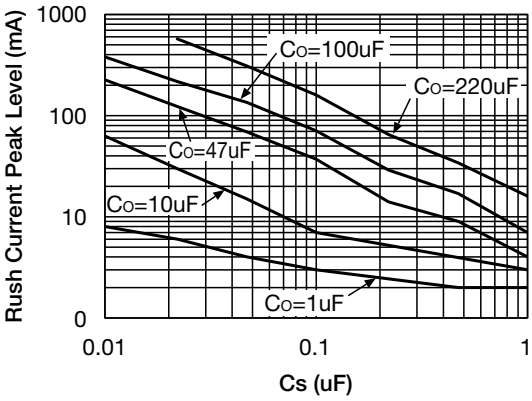
Vout discharge characteristics (VDD=2.2V, CE=VDD⇔0V)



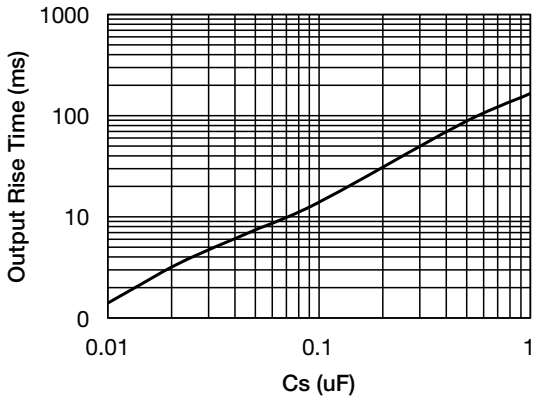
Cs discharge characteristics (VDD=2.2V, CE=VDD⇔0V)



Rush Current Peak Level Co: Aluminum electrolytic capacitor



Output rise time



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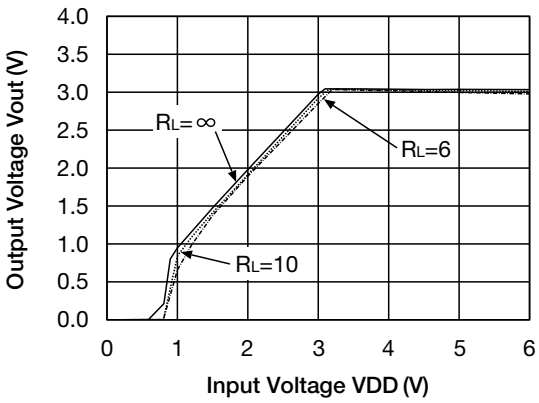
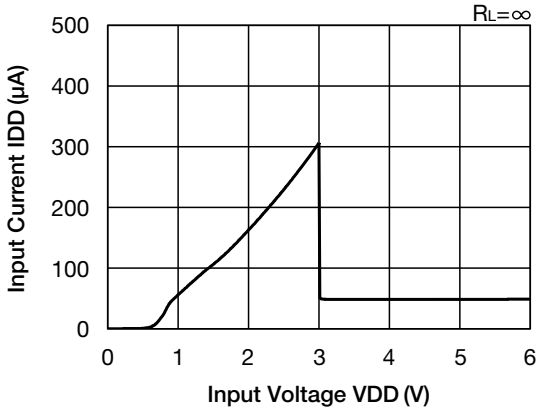
Characteristics (V_{OUT}=3.0V) (Except where noted otherwise V_{DD}=V_{OUT}(TYP.)+1V, V_{CE}=V_{DD}, Ta=25°C)

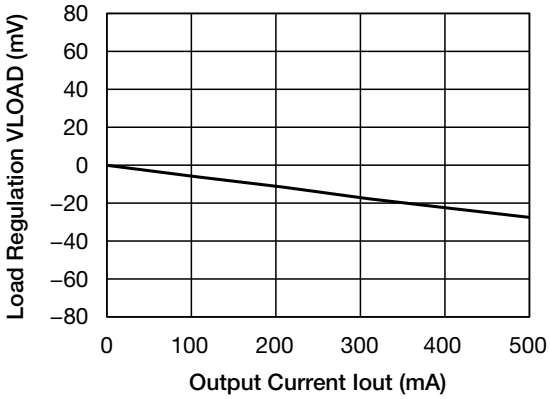
Input Voltage - Output Voltage



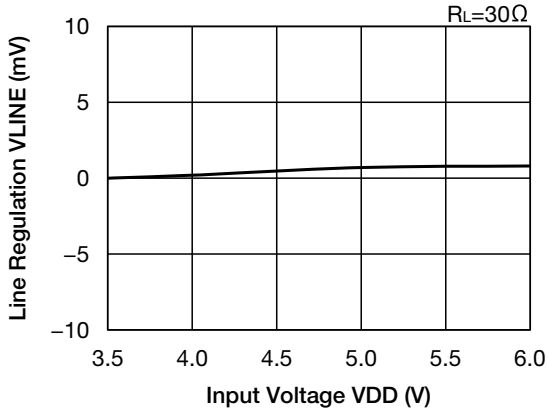
Input Voltage - Input Current



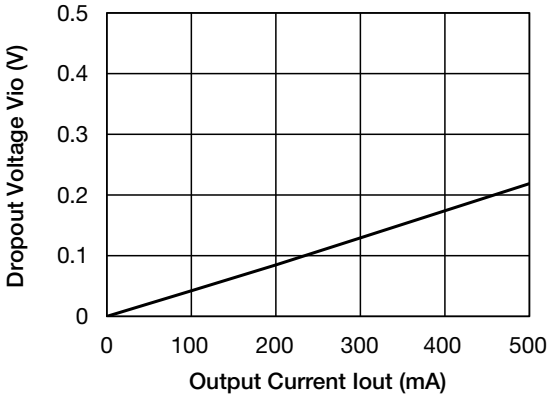
Load Regulation



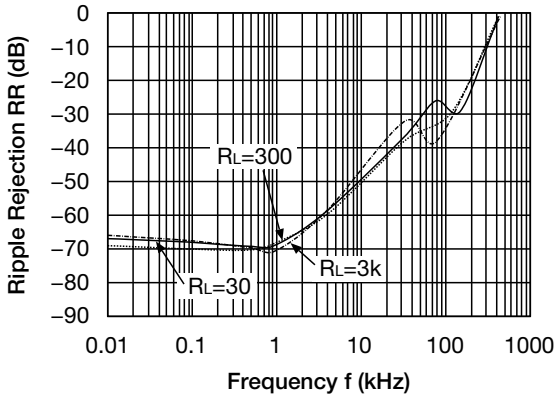
Line Regulation



Dropout Voltage



Ripple Rejection



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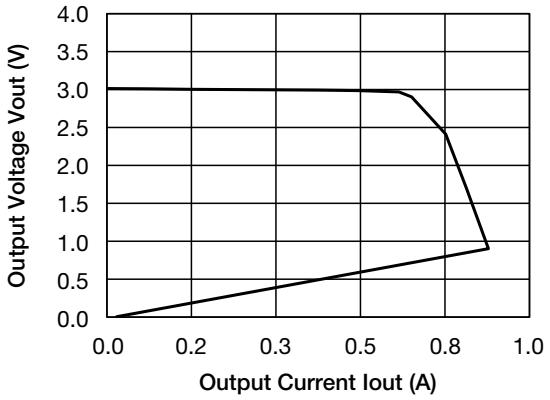
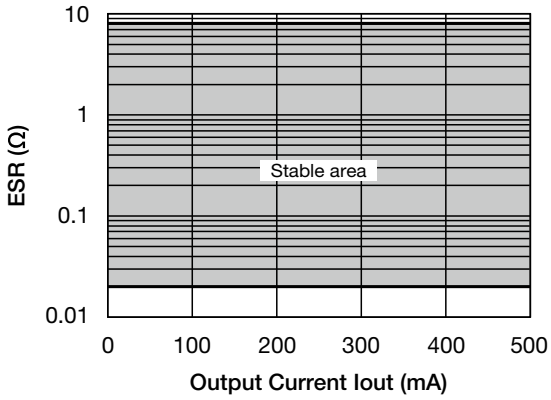
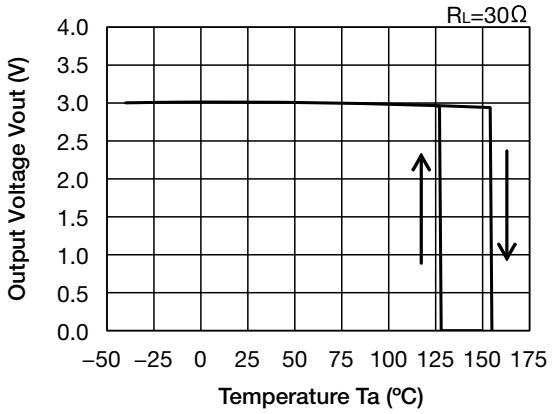
Output Current – Output Voltage



ESR stable area

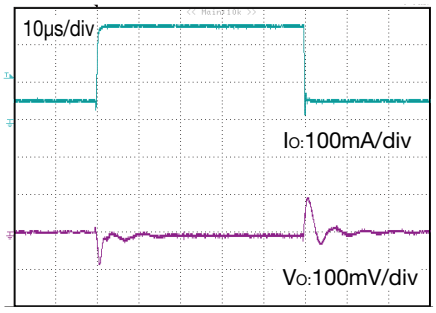


Output Voltage Temperature Coefficient

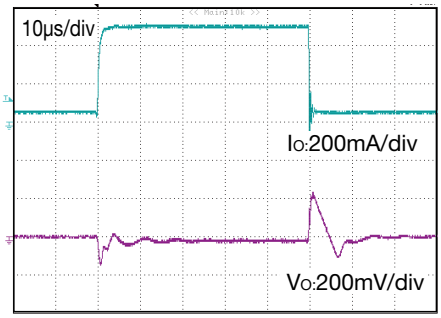


Load Transient response (Cin=Co=1µF)

IO=50mA⇔250mA



IO=50mA⇔500mA



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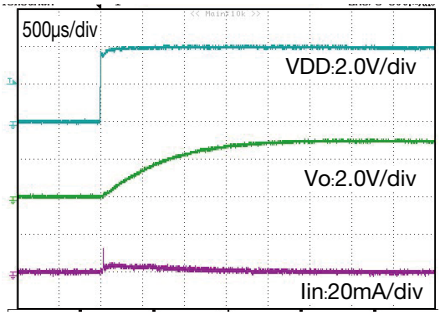
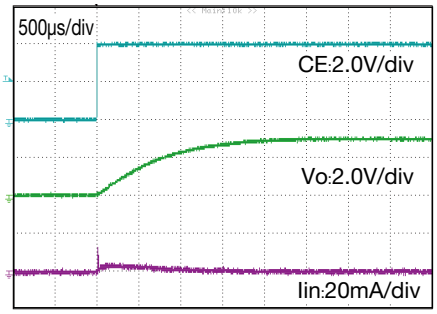
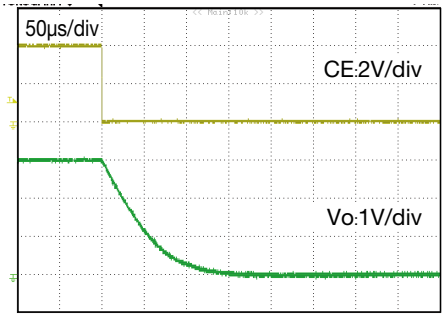
Input rise characteristics (VDD=0V⇔4.0V, VCE=VDD)



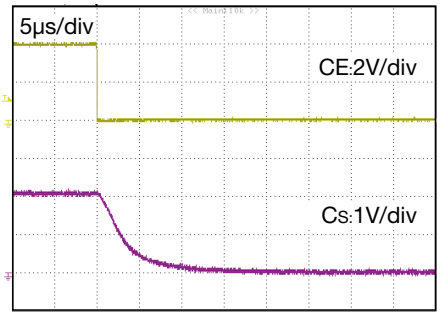
CE rise characteristics (VDD=4.0V, CE=0V⇔VDD)



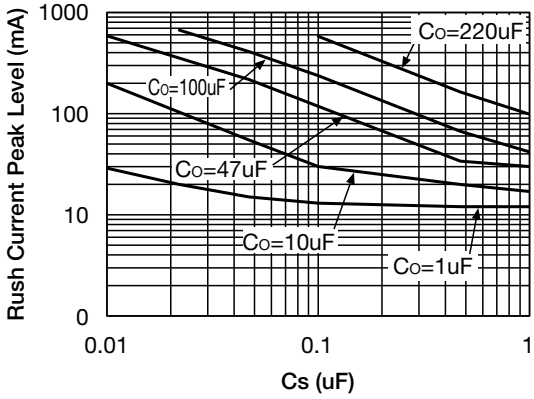
Vout discharge characteristics (VDD=4.0V, CE=VDD⇔0V)



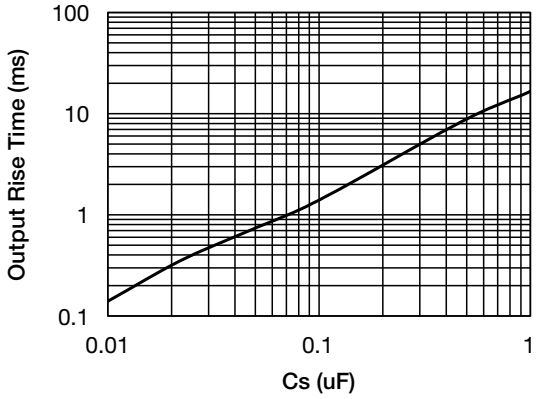
Cs discharge characteristics (VDD=4.0V, CE=VDD⇔0V)



Rush Current Peak Level Co: Aluminum electrolytic capacitor



Output rise time



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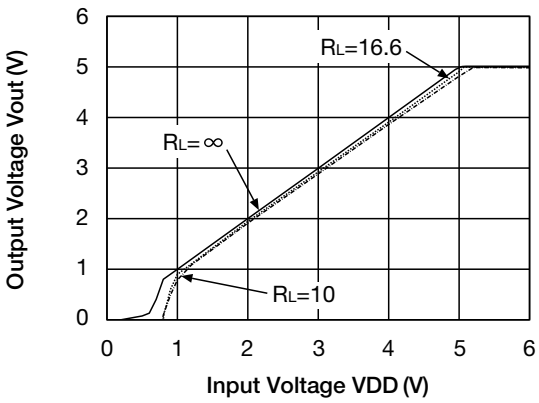
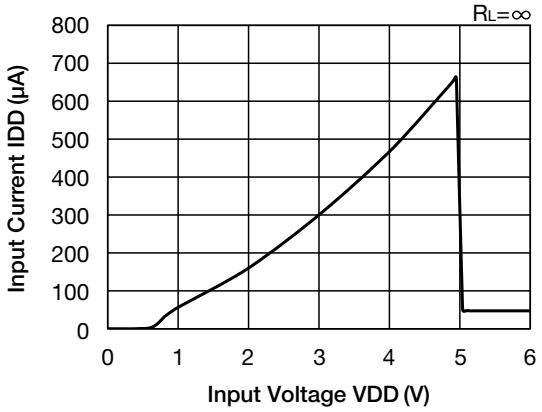
Characteristics (V_{OUT}=5.0V) (Except where noted otherwise V_{DD}=V_{OUT}(TYP.)+1V, V_{CE}=V_{DD}, Ta=25°C)

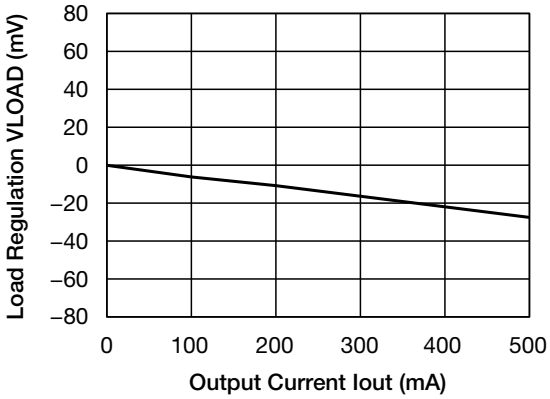
Input Voltage - Output Voltage



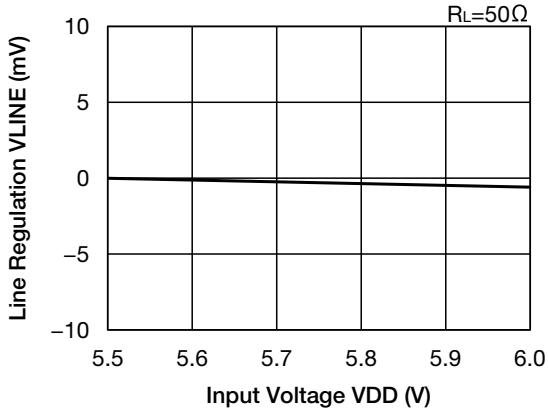
Input Voltage - Input Current



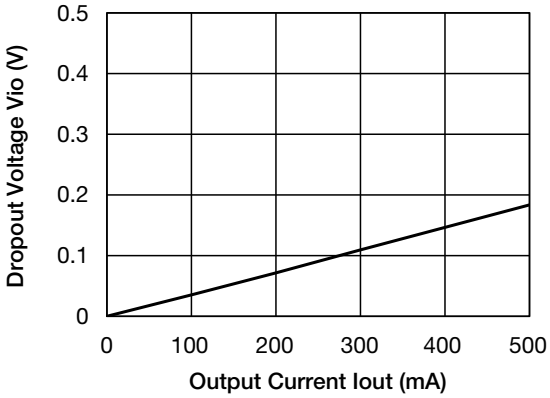
Load Regulation



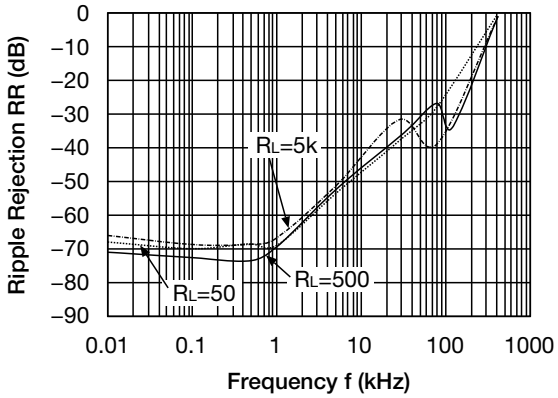
Line Regulation



Dropout Voltage



Ripple Rejection



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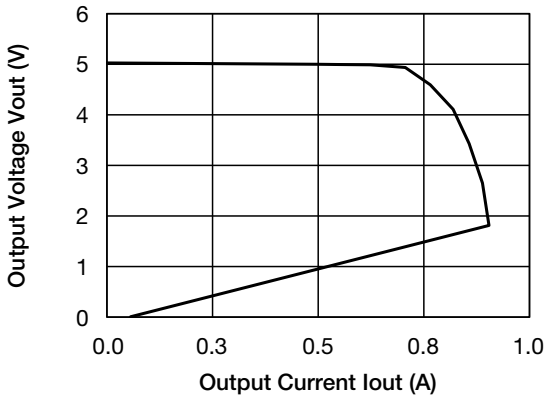
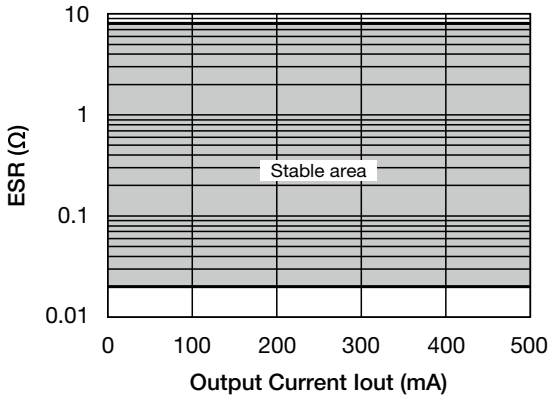
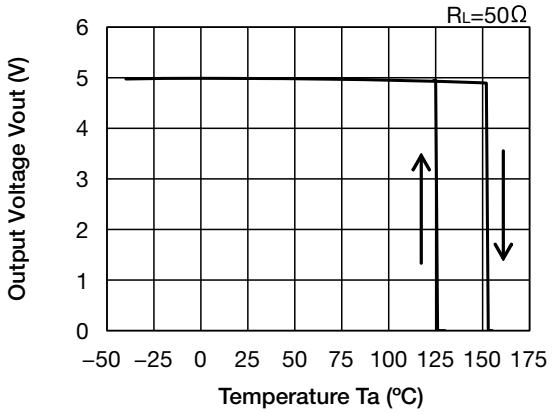
Output Current – Output Voltage



ESR stable area

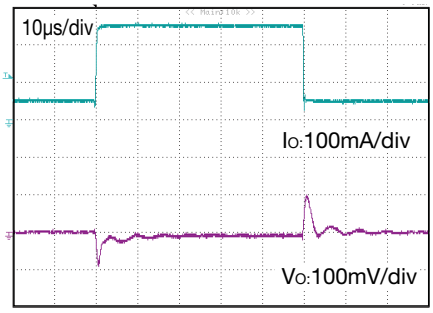


Output Voltage Temperature Coefficient

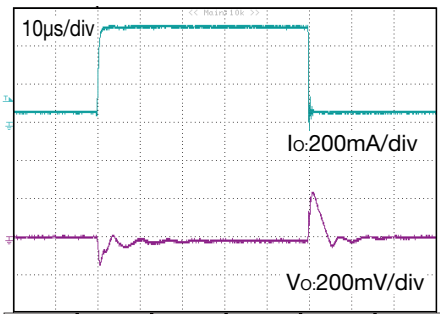


Load Transient response (Cin=Co=1μF)

IO=50mA⇔250mA



IO=50mA⇔500mA



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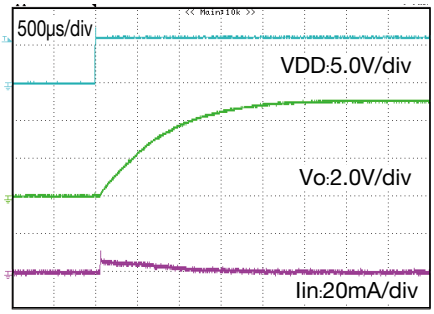
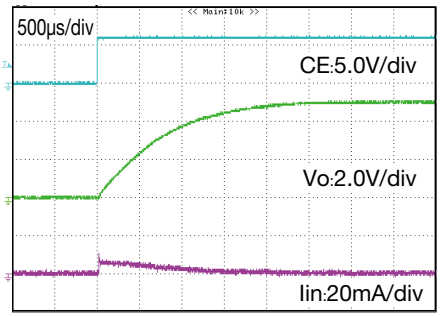
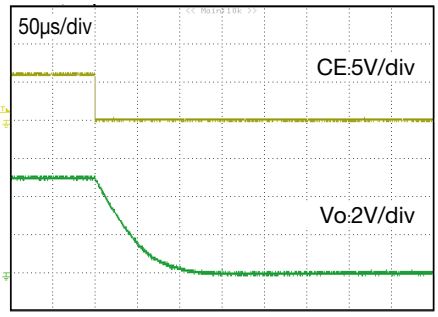
Input rise characteristics (VDD=0V⇔6.0V, VCE=VDD)



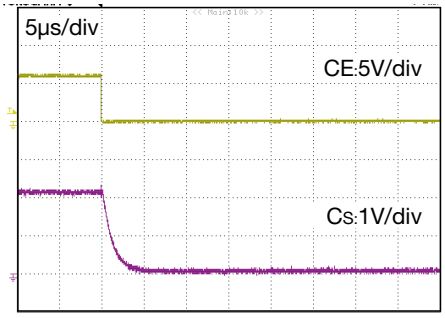
CE rise characteristics (VDD=6.0V, CE=0V⇔VDD)



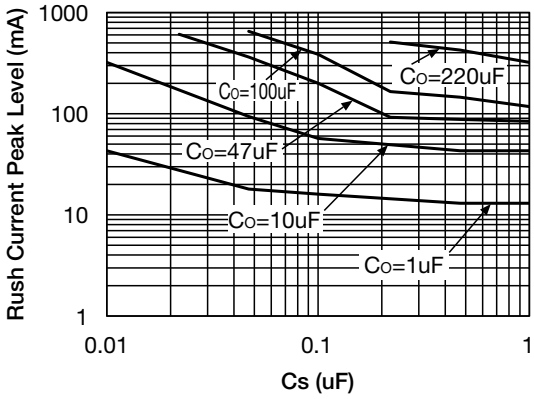
Vout discharge characteristics (VDD=6.0V, CE=VDD⇔0V)



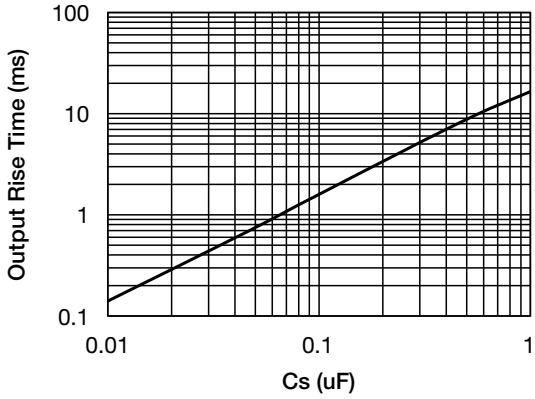
Cs discharge characteristics (VDD=6.0V, CE=VDD⇔0V)



Rush Current Peak Level Co: Aluminum electrolytic capacitor



Output rise time



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