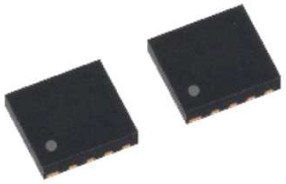
100mA LDO with connect error detection

MM1936 Series



Overview

This IC is a 100mA LDO with conection error detection for antenna.
The IC supplies the power for external connection equipment of car navigation (GPS, TV, Microphone), and detect open or short-circuit of output load.
To shut down LDO output automatically when short detection, it also improve safety.

Features

- Open/Short circuit detection
- Setting error detect delay time by external capacitor
- ON/OFF control

Main specifications

- Maximum rating supply voltage : -0.3V to 16V
- Maximum rating output voltage : -0.3V to 18V
- Operating voltage range : V_{OUT}(Typ.)+Vio(Max.) to 14V
- Operating ambient temperature : -40℃ to 85℃
- Output current : 100mA
- Input current (OFF) : Max. 1μA
- No-load input current : Typ. 400μA (V_{OUT}≦5.0V)
- Output voltage range : 3.0V to 8.0V (0.1V step)
- Output voltage accuracy : ±2%(I_{OUT}=1mA)
- Line regulation : Max. 0.1%/V (V_{IN}=V_{OUT}(Typ.)+1V to 14V, I_{OUT}=1mA)
- Load regulation : Typ. 15mV (I_{OUT}=1mA to 100mA)
- Dropout voltage : Typ. 0.2V (I_{OUT}=100mA)
- PSRR : Typ. 70dB (f=1kHz , VOUT≦5.0V)
- Rop pin current : ±5% (I_{OUT}=5mA, Vrop=1V)
- Rsc pin current : ±10% (I_{OUT}=60mA, Vrsc=1V)
- Error output : Open error, Short error
- Output capacitor : 2.2uF (Ceramic capacitor)
- Protection function : Over current protection, Thermal shutdown, Reverse current protection
- Additional function : ON/OFF control, Connection error detection (open/short flag output)
  Error detect delay time

Packages

- SSON-10B

Application

- In-vehicle infotainment device
- Power supply for antenna

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Model Name

M M 1 9 3 6 X X X X X X

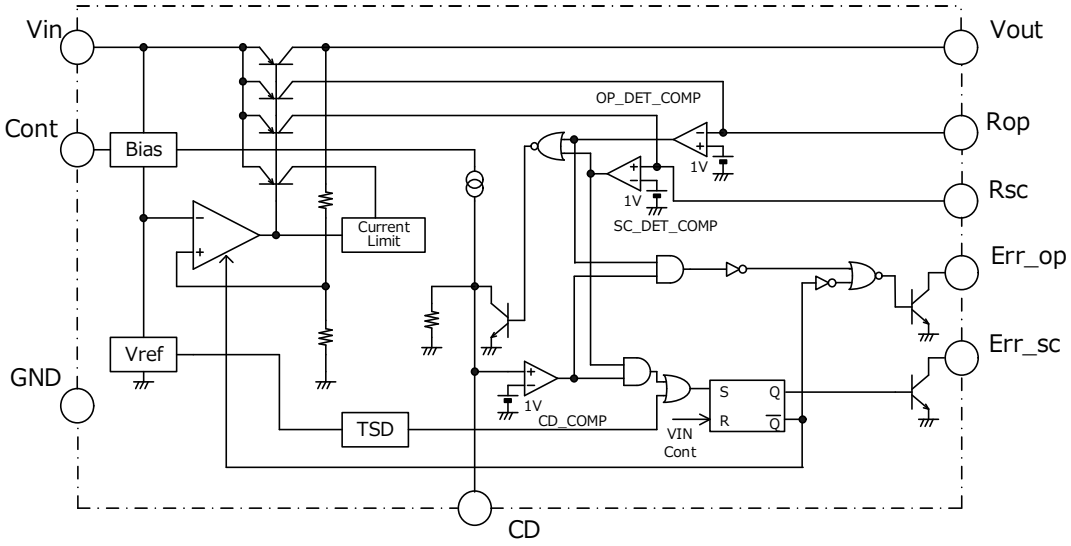
Series name (A) (B) (C) (D) (E)

(A)	Function Type	Fig.1	Cont=H active、without discharge function
(B)	Output voltage rank	30 ～ 80	Output voltage can be designated in the range from 3.0V(30) to 8.0V(80) in 0.1V steps.
(C)	Package	R	SSON-10B
(D)	Packing specifications 1	R	R housing (Standard)
		L	L housing
(E)	Packing specifications 2	E	Emboss tape / Halogen free

■ Fig.1 Function Type

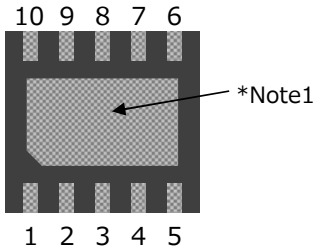
Function Type	Actual load current (Max.)	Output voltage
A	60mA	from 3.00V/ 0.1Vstep
B	100mA	from 7.40V～/ 0.1Vstep

Block Diagram



Pin Configuration

- SSON-10B



Top view

Pin No.	Pin name	Function
1	V_{OUT}	Output voltage
2	Rop	Open load detection resistance
3	Rsc	Short-circuit detection resistance
4	CD	Delay time setting pin
5	GND	Ground
6	Cont	Control input
7	Err_sc	Short-circuit detection output
8	Err_op	Open load detection output
9	NC	No connection
10	V_{IN}	Power supply input

*Note1:Heat spreader bottom with GND.

Absolute Maximum Ratings

Item		Symbol	Min.	Max.	Unit
Storage temperature		Tstg	-55	150	℃
Junction temperature *Note2		Tj_{MAX}	-	150	℃
Supply voltage		V_{IN}	-0.3	16	V
Output voltage *Note3		V_{OUT}	-0.3	18	V
Cont input voltage		V_{cont}	-0.3	16	V
Output current		Iomax	0	200	mA
Err_op/Err_sc voltage		Verr	-0.3	16	V
Err_op/Err_sc current		Ierr	-	5	mA
Power dissipation *Note4	SSON-10B	Pd	-	1770	mW

*Note2:In consideration of product life, please examine the use in less than 80%.

*Note3:Battery-short test, t=3min.

*Note4:JEDEC51-7 standard 114.3mm×76.2mm t=1.6mm Copper foil area 80%

Recommended Operating Conditions

Item	Symbol	Min.	Max.	Unit
Operating ambient temperature	Topr	-40	85	℃
Operating voltage	Vop	$V_{OUT(Typ.)}$+Vio(Max.)	14.0	V
Output current	Iop	0	100	mA

Electrical Characteristics

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
No-Load Input Current	I_{CC}	I_{OUT}=0mA, V_{OUT}≦5.0V Rpu_op=Rpu_sc=∞	-	400	550	μA
		I_{OUT}=0mA, 5.0V<V_{OUT} Rpu_op=Rpu_sc=∞	-	500	650	μA
Input Current(OFF)	I_{CCOFF}	V_{CONT}=0V	-	0.1	1	μA
Output Voltage *Note5	V_{OUT}	I_{OUT}=1mA	×0.98	-	×1.02	V

*Note5:Please refer to another page.

Electrical Characteristics (Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Dropout Voltage	Vio	V_{IN}=V_{OUT}-0.2V I_{OUT}=100mA	-	0.20	0.40	V
Line Regulation	V_{LINE}	V_{IN}=V_{OUT}+1V~14V I_{OUT}=1mA	-	-	0.10	%/V
Load Regulation	V_{LOAD}	I_{OUT}=1mA~100mA	-	15	60	mV
VOUT Temperature Coefficient *Note7	ΔV_{OUT} /ΔT_{OP}	I_{OUT}=1mA -40≦Ta≦85℃	-	±100	-	ppm/℃
Ripple Rejection *Note7	RR1	f=1kHz, Vripple=1V I_{OUT}=10mA, V_{OUT}≦5.0V	-	70	-	dB
Ripple Rejection *Note7	RR2	f=1kHz, Vripple=1V I_{OUT}=10mA, 5.0V<V_{OUT}	-	65	-	dB
Current limit	Io_limit		120	170	-	mA
Cont PIN Input Current	Icont	Vcont=1.6V	-	3	12	μA
Cont Pin High Threshold Voltage	VcontH		1.6	-	-	V
Cont Pin Low Threshold Voltage	VcontL		-	-	0.3	V
Thermal shutdown temperature *Note7	Tsd		-	150	-	℃
Rop pin current	Iop	I_{OUT}=5mA Vrop=1V	228	240	252	μA
Rsc pin current	Isc	I_{OUT}=60mA Vrsc=1V	1350	1500	1650	μA
Rop pin threshold voltage	Vt_op	Vrop=H→L Verr_op=H→L	0.95	1.00	1.05	V
Rop pin hysteresis voltage	Vth_op	Vrop=L→H Verr_op=L→H	-	175	-	mV
Rsc pin threshold voltage	Vt_sc	Vrsc=L→H Verr_sc=H→L	0.95	1.00	1.05	V
Err_op output voltage	Verr_op	Vrop=L Ierr_op=100μA	-	-	0.2	V
Err_sc output voltage	Verr_sc	Vrsc=H Ierr_sc=100μA	-	-	0.2	V
CD pin current	Icd	Vcd=0V	-	5.00	-	μA
CD pin threshold voltage	Vt_cd	Vcd=L→H	0.90	1.00	1.10	V
CD pin hysteresis voltage	Vth_cd	Vcd=H→L	-	250	-	mV

*Note6:The parameter is guaranteed by design.

Electrical Characteristics (Function:B)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

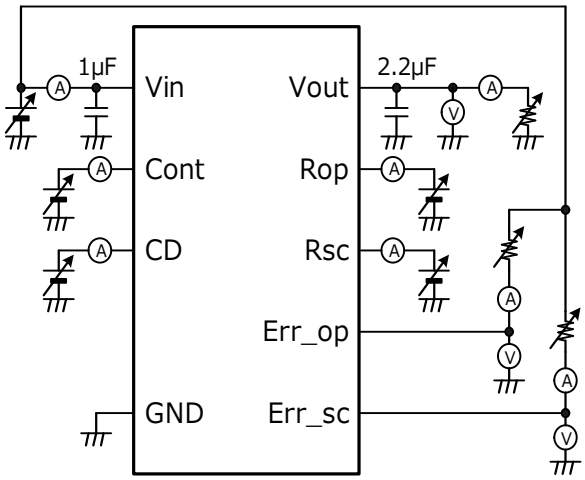
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Dropout Voltage	Vio	V_{IN}=V_{OUT}-0.2V I_{OUT}=100mA	-	0.20	0.40	V
Line Regulation	V_{LINE}	V_{IN}=V_{OUT}+1V~14V I_{OUT}=1mA	-	-	0.10	%/V
Load Regulation	V_{LOAD}	I_{OUT}=1mA~100mA	-	15	60	mV
VOUT Temperature Coefficient *Note7	ΔV_{OUT} /ΔT_{OP}	I_{OUT}=1mA -40≦Ta≦85℃	-	±100	-	ppm/℃
Ripple Rejection *Note7	RR1	f=1kHz, Vripple=1V I_{OUT}=10mA, V_{OUT}≦5.0V	-	70	-	dB
Ripple Rejection *Note7	RR2	f=1kHz, Vripple=1V I_{OUT}=10mA, 5.0V<V_{OUT}	-	65	-	dB
Current limit	Io_limit		180	250	-	mA
Cont PIN Input Current	Icont	Vcont=1.6V	-	3	12	μA
Cont Pin High Threshold Voltage	VcontH		1.6	-	-	V
Cont Pin Low Threshold Voltage	VcontL		-	-	0.3	V
Thermal shutdown temperature *Note7	Tsd		-	150	-	℃
Rop pin current	Iop	I_{OUT}=5mA Vrop=1V	228	240	252	μA
Rsc pin current	Isc	I_{OUT}=60mA Vrsc=1V	1350	1500	1650	μA
Rop pin threshold voltage	Vt_op	Vrop=H→L Verr_op=H→L	0.95	1.00	1.05	V
Rop pin hysteresis voltage	Vth_op	Vrop=L→H Verr_op=L→H	-	175	-	mV
Rsc pin threshold voltage	Vt_sc	Vrsc=L→H Verr_sc=H→L	0.95	1.00	1.05	V
Err_op output voltage	Verr_op	Vrop=L Ierr_op=100μA	-	-	0.2	V
Err_sc output voltage	Verr_sc	Vrsc=H Ierr_sc=100μA	-	-	0.2	V
CD pin current	Icd	Vcd=0V	-	5.00	-	μA
CD pin threshold voltage	Vt_cd	Vcd=L→H	0.90	1.00	1.10	V
CD pin hysteresis voltage	Vth_cd	Vcd=H→L	-	250	-	mV

*Note6:The parameter is guaranteed by design.

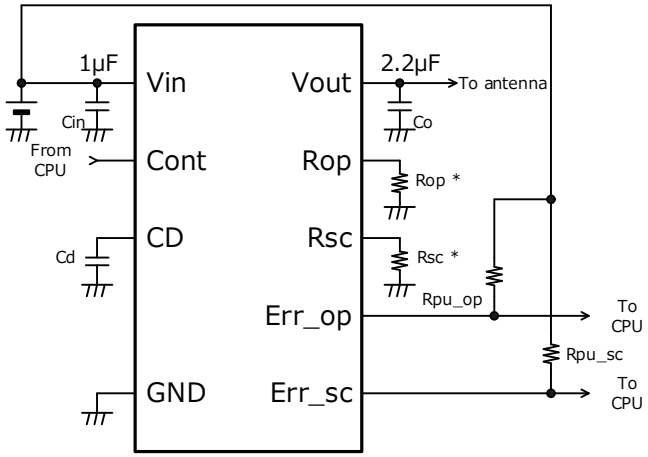
Electrical Characteristics

Model name	Item			
	Output voltage			
	V_{OUT} (V)			
	Conditions	Min.	Typ.	Max.
MM1936A30	Function:A IOUT=1mA	2.940	3.000	3.060
MM1936A31		3.038	3.100	3.162
MM1936A32		3.136	3.200	3.264
MM1936A33		3.234	3.300	3.366
MM1936A34		3.332	3.400	3.468
MM1936A45		4.410	4.500	4.590
MM1936A46		4.508	4.600	4.692
MM1936A47		4.606	4.700	4.794
MM1936A48		4.704	4.800	4.896
MM1936A49		4.802	4.900	4.998
MM1936A50		4.900	5.000	5.100
MM1936A74		7.252	7.400	7.548
MM1936A77		7.546	7.700	7.854
MM1936A80		7.840	8.000	8.160
MM1936B80	Function:B IOUT=1mA	7.840	8.000	8.160

Test Circuit



Application Circuit



*constant setting formula (for estimate)
Rop = Vt_op / I_rop
Rsc = Vt_sc / I_rsc
Cd=(td*Icd)/Vt_cd=td*Icd

Vt_op:Rop threshold voltage
Io_op:Open circuit detection current
Vt_sc:Rsc threshold voltage
Io_sc:Short circuit detection current
Icd:CD pin current
td:Delay time
Vt_cd:CD pin threshold voltage

* The formula of the fixed number setting is the rough estimate value.
Please check the application notebook and do fixed number setting.

(Example of external parts)

- Output capacitor Ceramic capacitor 2.2μF
- Input Capacitor Ceramic capacitor 1.0μF *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.

Note

1. Please use this IC within the stated absolute maximum ratings.
   The IC is liable to malfunction should the ratings be exceeded.

2. There is a possibility that it becomes impossible to maintain this performance and reliability IC original when using 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 capacitor has dependency by the supply voltage and temperature.
   It is able to unstable operation when you use the capacitor with intense capacitance change such as micro.
   Please use the effective capacity to exceed 1μF, because the value changes by the environment used.

7. The wire of Vin and GND is required to print full ground plane for noise and stability.

8. The input capacitor must be connected a distance of less than 1cm from input pin.

9. The over current protection circuit of the vertical type is built into this IC.

10. It is possible to become unstable operation when using it with Dropout voltage no margin.
    Please evaluate it enough when there is no margin in Dropout voltage.

11. It is possible to unstable when this IC is used in high electromagnetic field.
    Please evaluate IC on the set.

12. If negative voltage over maximum rating for Vout,
    Connected schottky barrier diode between Vout-GND, and the voltage is in within rating.

13. The absolute maximum ratings of the output voltage is for short-circuit to power supply test.
    In normal operation, it must be used to Vin>Vout.

14. 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.

15. After set delay time of the timer, the turning off latch outputs it
    when thermal shutdown starts or it detects it short. Please input Vin or Cont again to release the latch.

Note

16. A reverse bias protection function is built in this IC.
    When reverse bias occurs, You can use it without protection Diode.

17. When reverse biased, reverse current is generated.
    In this case, when the voltage difference between input and output increases,
    shut down the internal circuit to prevent heat generation.
    Internal circuit shutdown is latch protected. (At this time, the Short flag is output as Low.)
    Please input Vin or Cont again to release the latch.

18. When establishing an open detect current, please consider a release hysteresis.

19. When LDO start up, inrush current occurs.
    When start up, inrush current is detected, and there is a possibility that a short detect.
    Please be sure to establish the detection delay time of the IC
    so as not to detect a short circuit until LDO starts.

20. Detection delay time setting will be open/short detection commonness.
    The short detection delay time and the open detection delay time become same.

21. The total precision of the current detection (Ta=25℃) is decided by following looseness.

	Open	Short
Detect Current	±5%	±10%
comparator Threshold	±5%	±5%
Detect setting Resistance	±α	±α
TTL	10%±α	15%±α

    It's necessary to consider the temperature special quality and a supply voltage
    fluctuation as well as the above.

22. Each terminal output when detecting it abnormally, will be the following.
    Each output is latched at the time of short detection and thermal shut down (TSD) detection.
    Please input Vin or Cont again to release the latch.

	Normal	Open	Short	TSD
Err_op	High	Low	High	High
Err_sc	High	High	Low	Low
LDO Output	Enabled	Enabled	Disabled	Disabled
LATCHED	No	No	Yes	Yes

23. After checking the application notebook about details of MM1936.

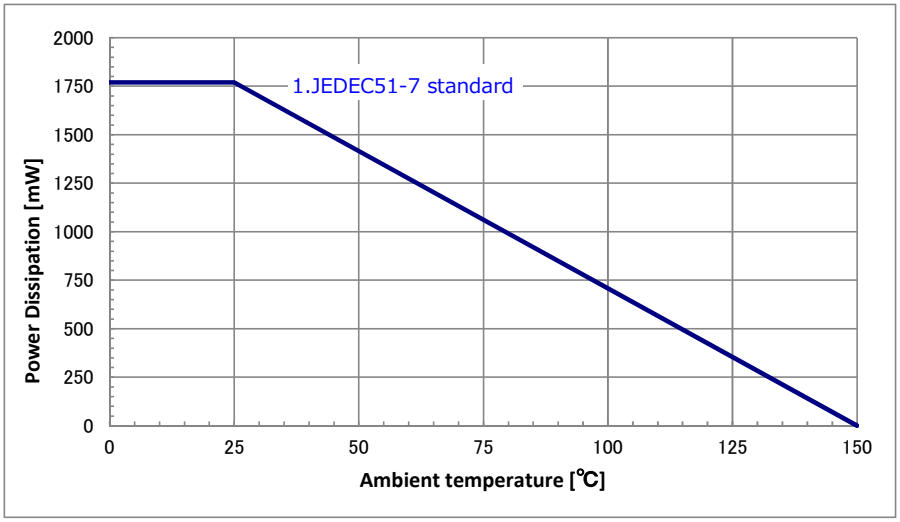
About Power Dissiopation

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.

- SSON-10B

1. JEDEC51-7 standard (4 layer FR-4 board)

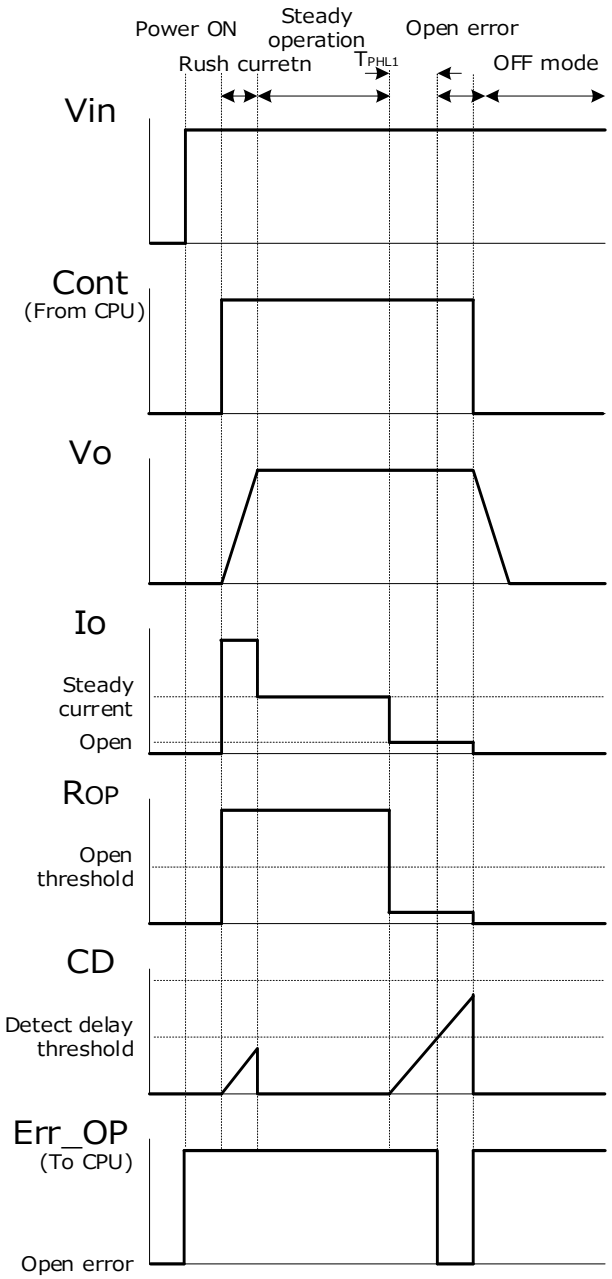
Board size	114.3mm×76.2mm t=1.6mm Copper foil area 80%
Power dissipation	1770mW Ta=25℃



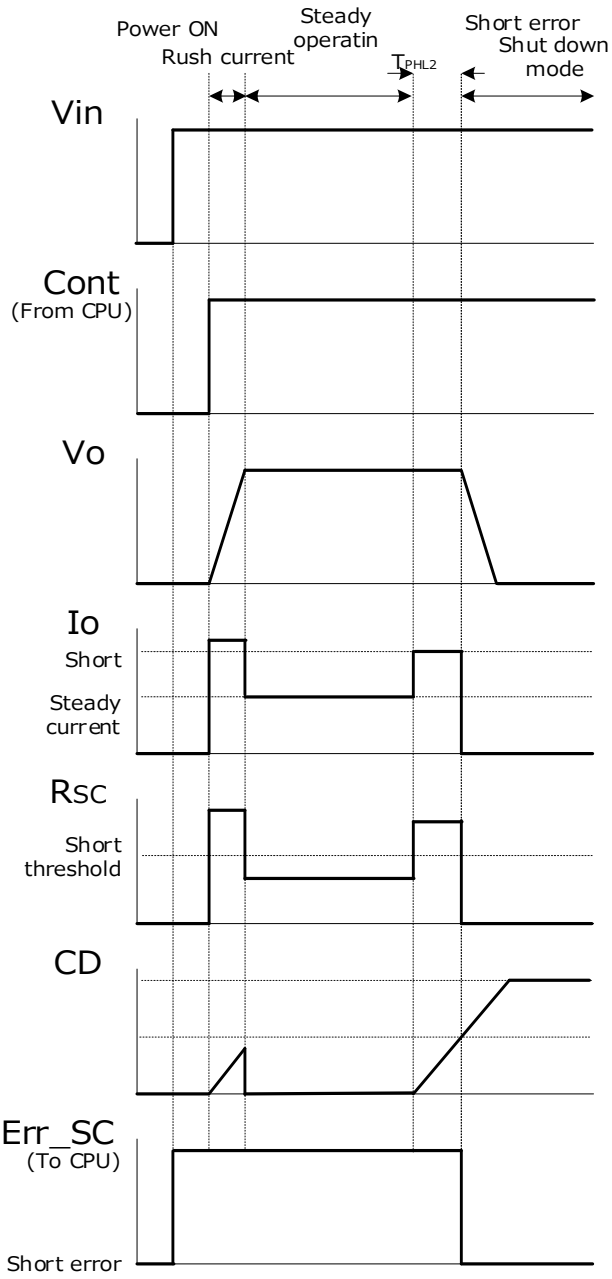
It is recommended to layout the VIA for heat radiation in the GND pattern of reverse (of IC) when there is the GND pattern in the inner layer (in using multiplayer substrate).
By increasing these copper foil pattern area of PCB, Power dissipation improves.

Timing chart

■ Open error



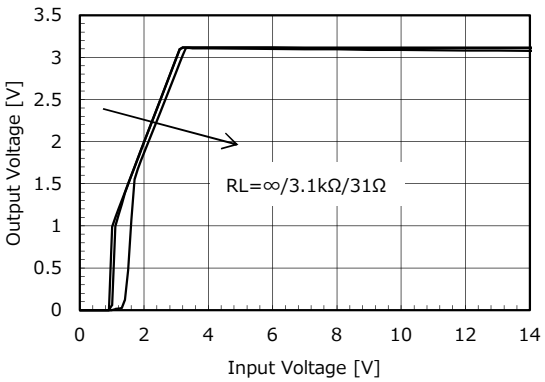
■ Short error



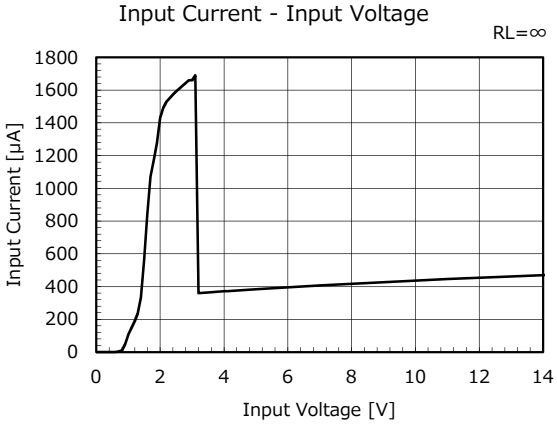
Typical Performance Characteristics (VOUT=3.1V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

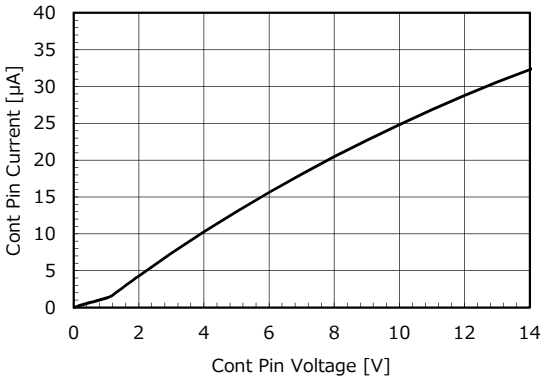
Output Voltage - Input Voltage



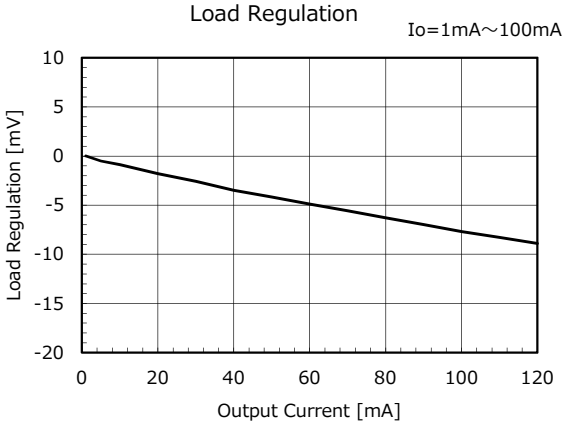
Input Current - Input Voltage



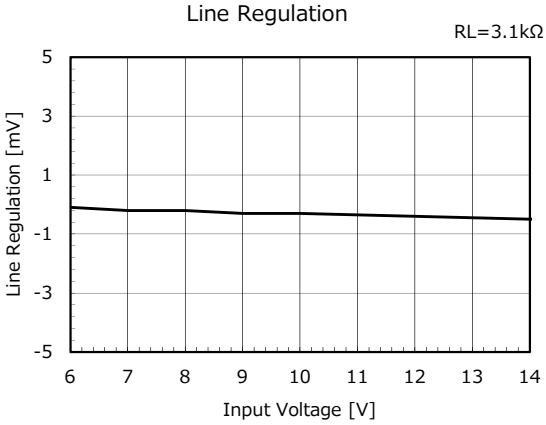
Cont Pin Current - Cont Pin Voltage



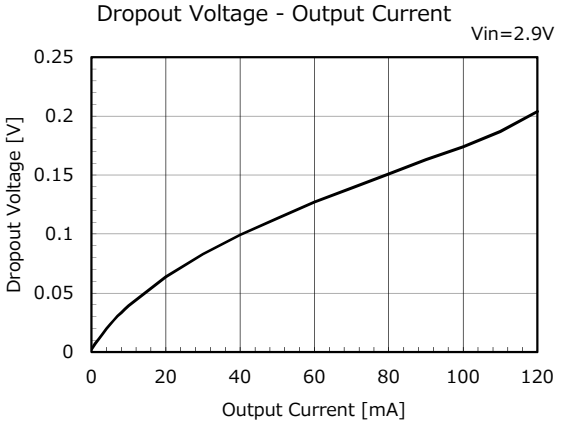
Load Regulation



Line Regulation



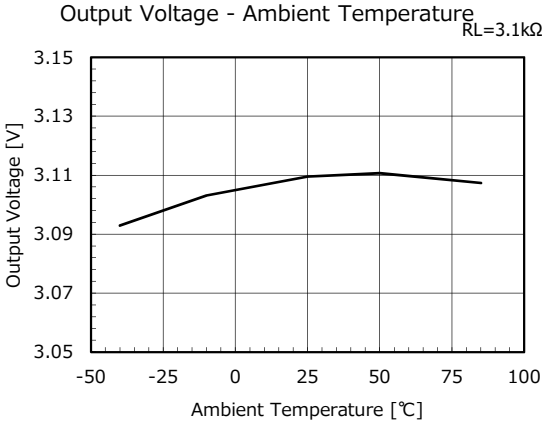
Dropout Voltage - Output Current



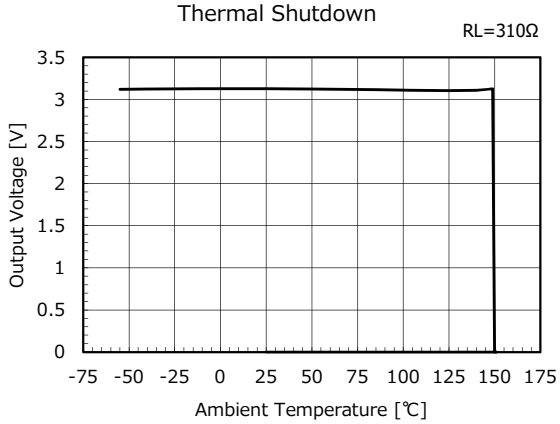
Typical Performance Characteristics (VOUT=3.1V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

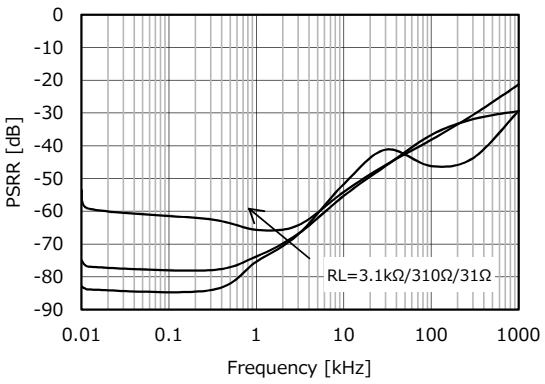
Output Voltage - Ambient Temperature



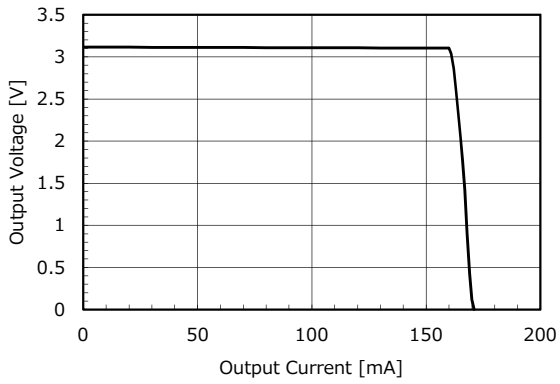
Thermal Shutdown



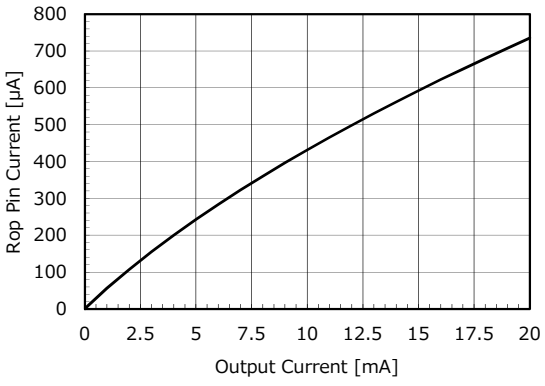
Power Supply Ripple Rejection



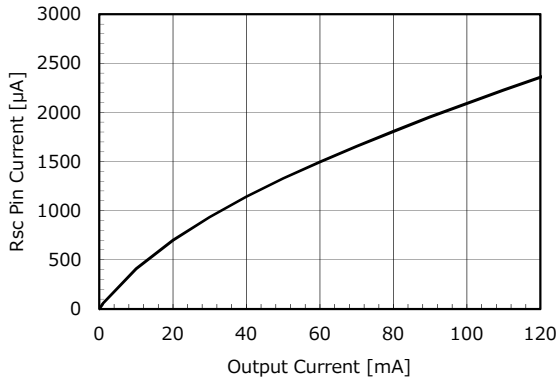
Current Limit



Rop Pin Current - Output Current



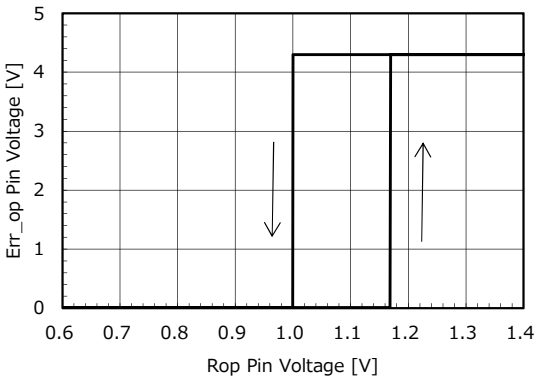
Rsc Pin Current - Output Current



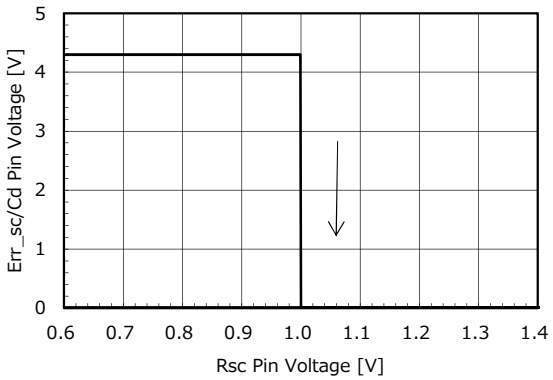
Typical Performance Characteristics (VOUT=3.1V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

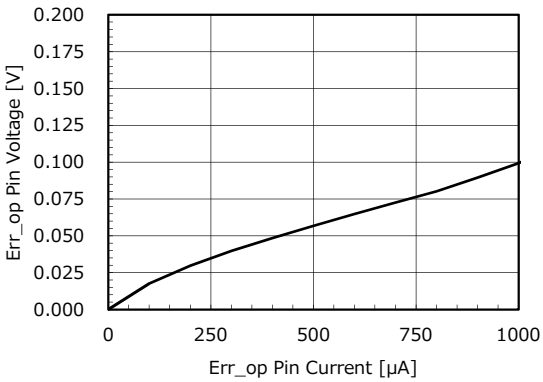
Rop Threshold Voltage



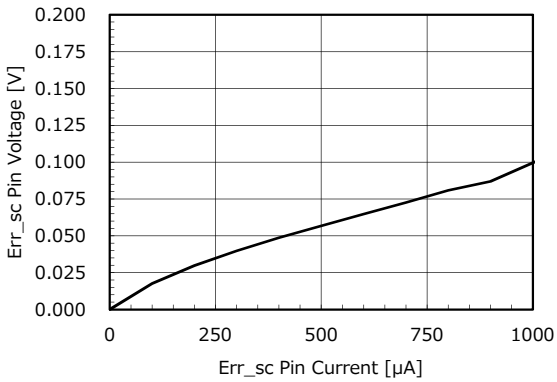
Rsc Threshold Voltage



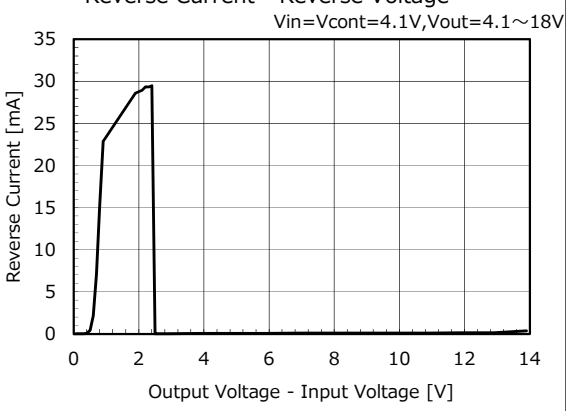
Err_op Pin Voltage - Err_op Pin Current



Err_sc Pin Voltage - Errsc Pin Current



Reverse Current - Reverse Voltage



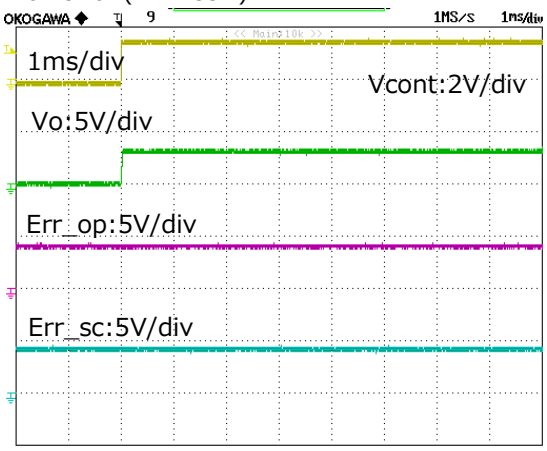
Typical Performance Characteristics (VOUT=3.1V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

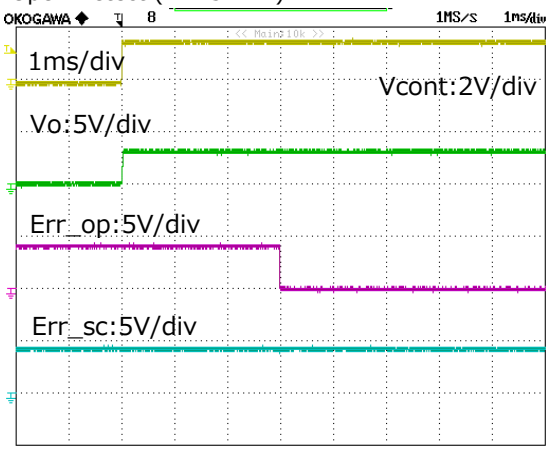
- Turn On Tansient Response

  Open Detect Current=5mA, Short Detect Curret=80mA

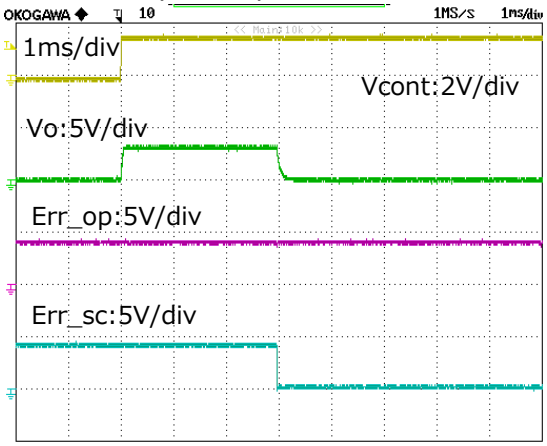
Non error (RL=155Ω)



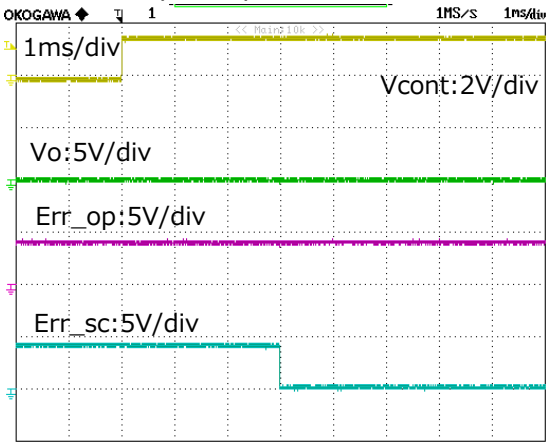
Open Detect (RL=3.1kΩ)



Short Detect (RL=31Ω)

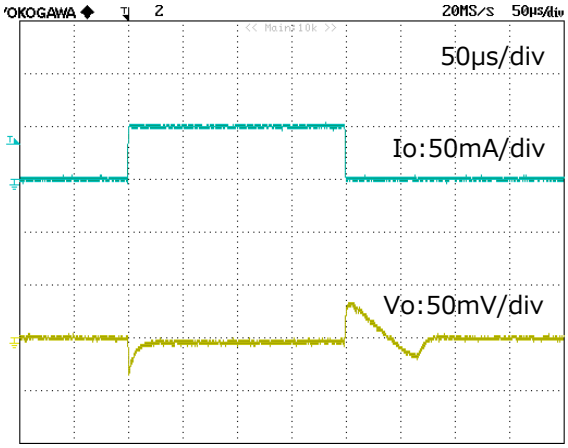


Short Detect (RL=0Ω)

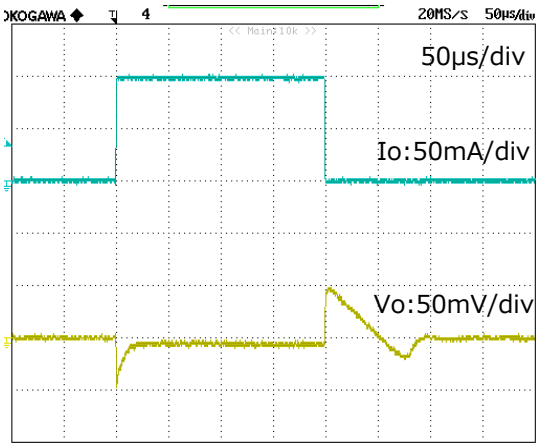


- Load transient response

Iout=1mA⇔50mA



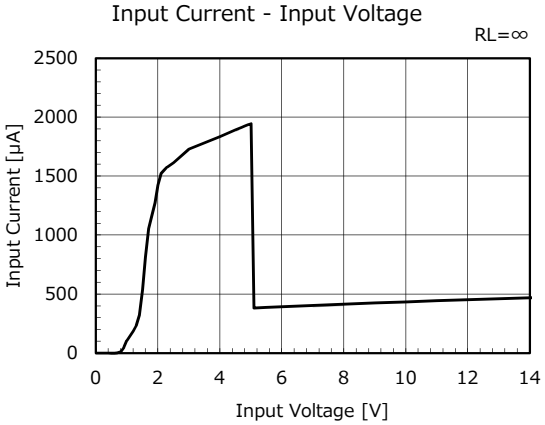
Iout=1mA⇔100mA



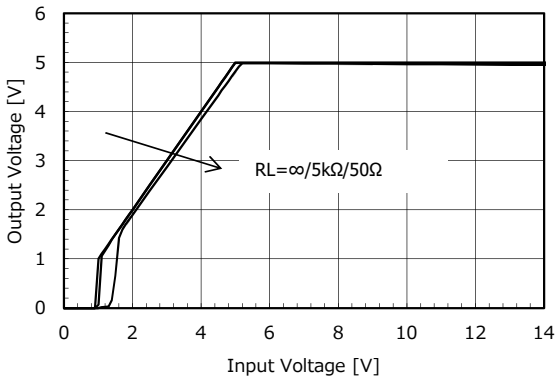
Typical Performance Characteristics (VOUT=5.0V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

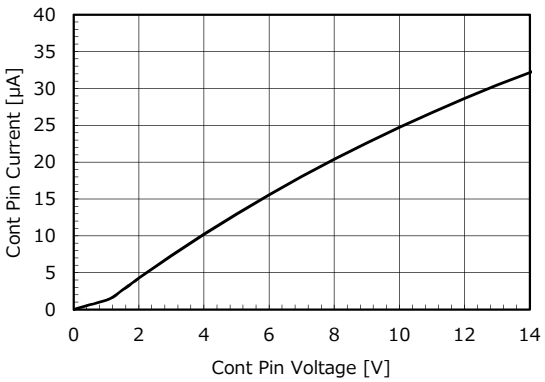
Input Current - Input Voltage



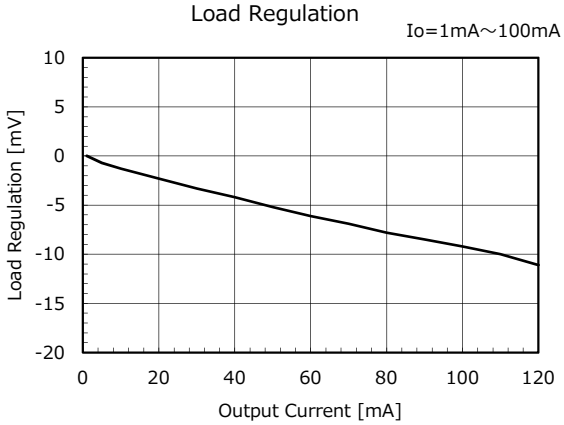
Output Voltage - Input Voltage



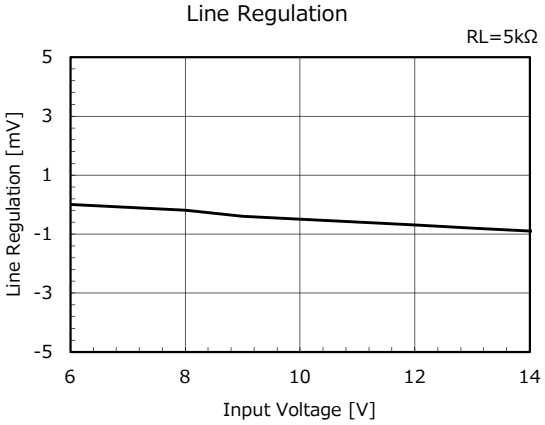
Cont Pin Current - Cont Pin Voltage



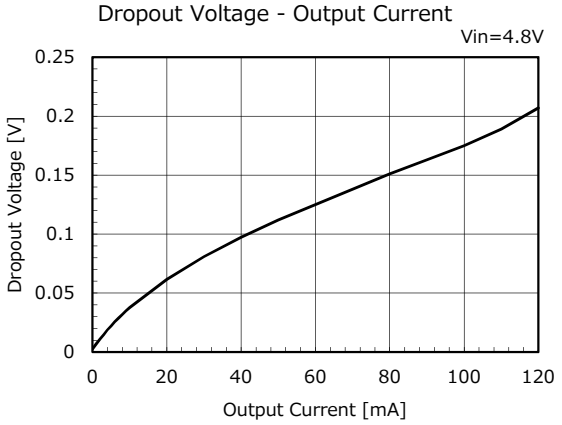
Load Regulation



Line Regulation



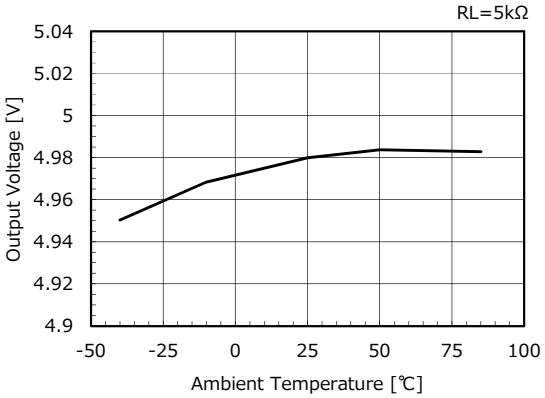
Dropout Voltage - Output Current



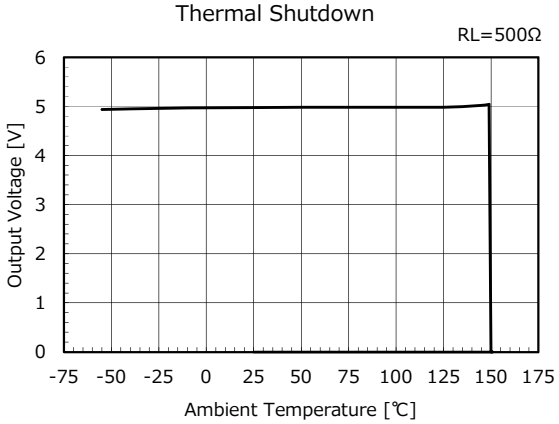
Typical Performance Characteristics (VOUT=5.0V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

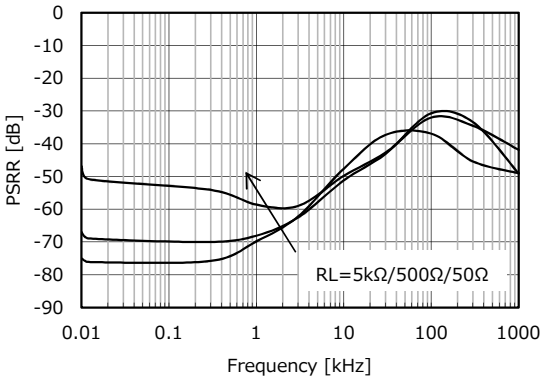
Output Voltage - Ambient Temperature



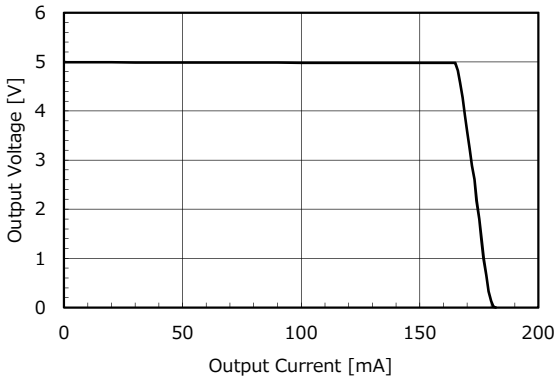
Thermal Shutdown



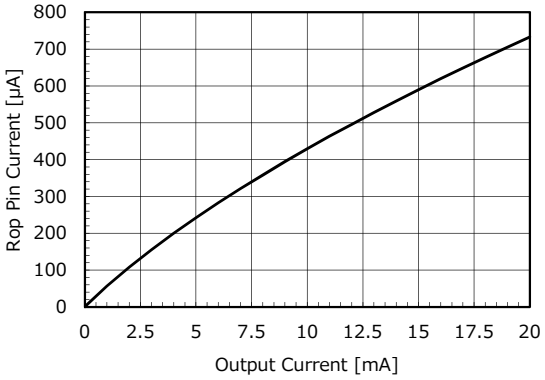
Power Supply Ripple Rejection



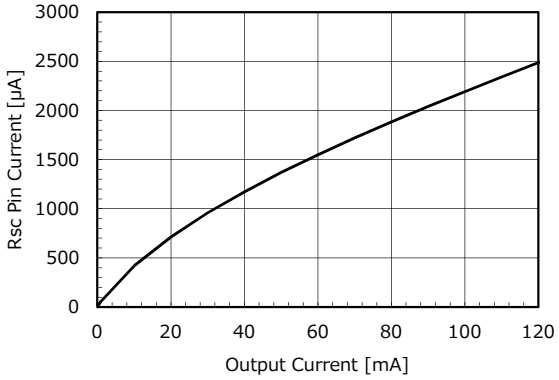
Current Limit



Rop Pin Current - Output Current

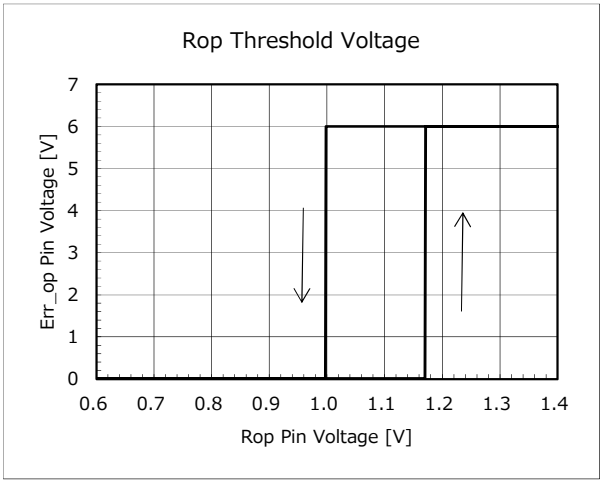


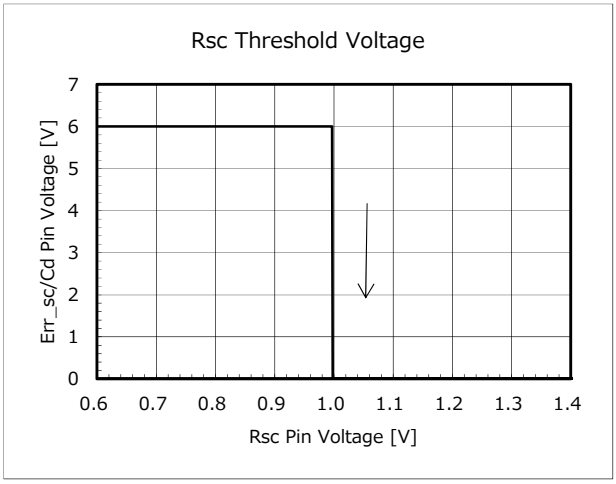
Rsc Pin Current - Output Current

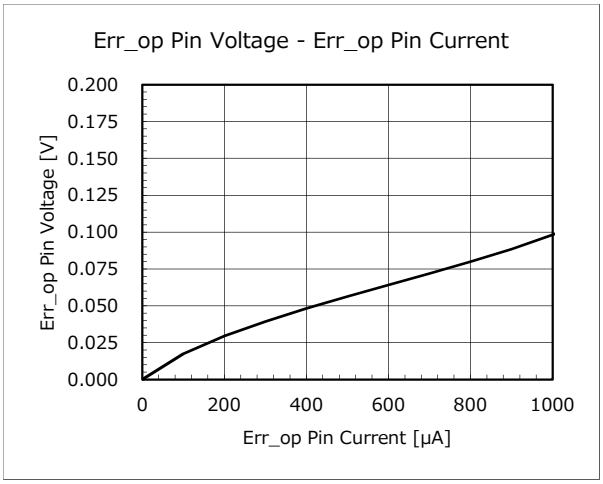


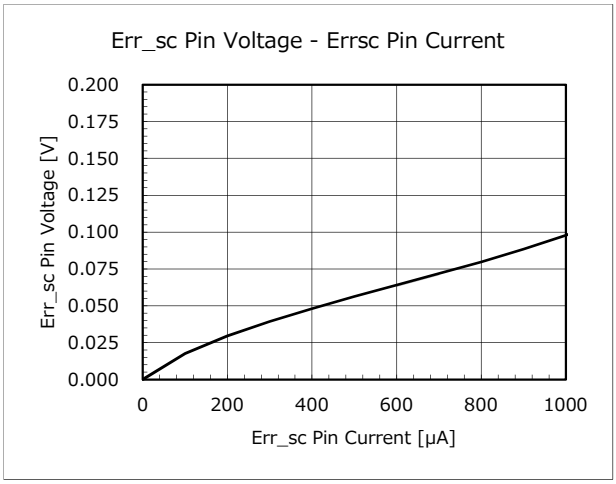
Typical Performance Characteristics (VOUT=5.0V/Function:A)

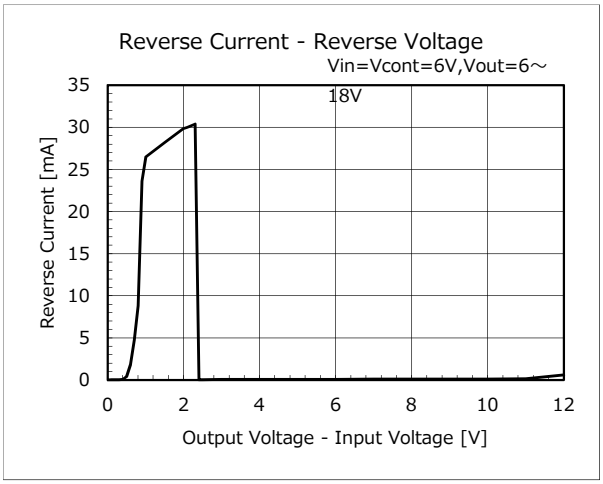
(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)











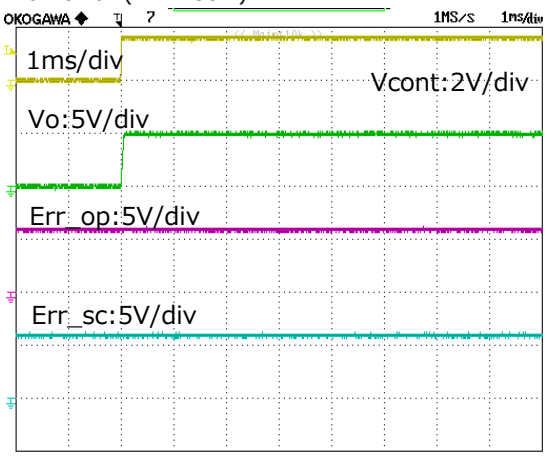
Typical Performance Characteristics (VOUT=5.0V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

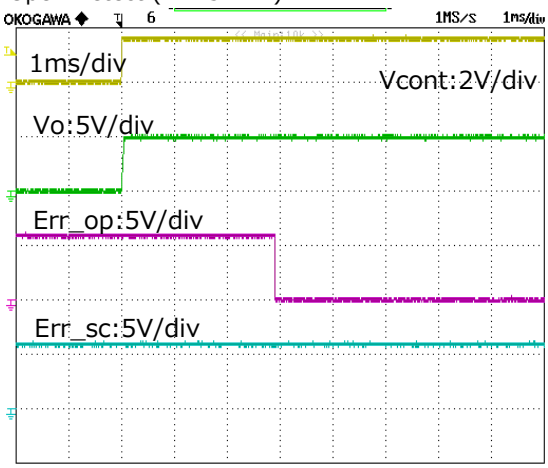
- Turn On Tansient Response

  Open Detect Current=5mA, Short Detect Curret=80mA

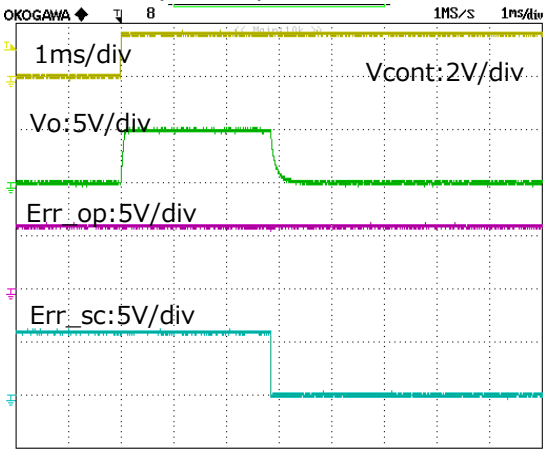
Non error (RL=155Ω)



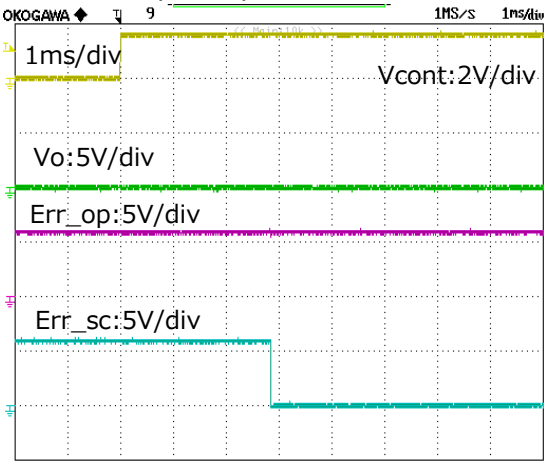
Open Detect (RL=3.1kΩ)



Short Detect (RL=31Ω)

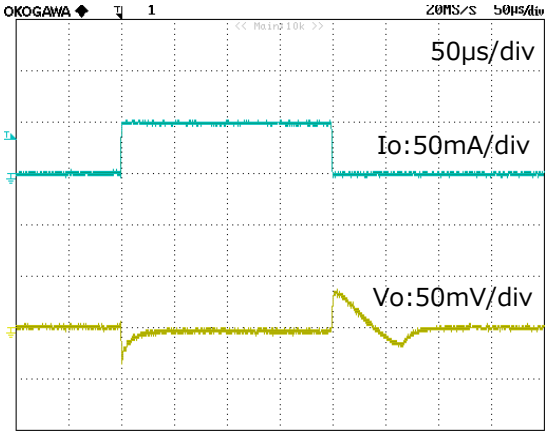


Short Detect (RL=0Ω)

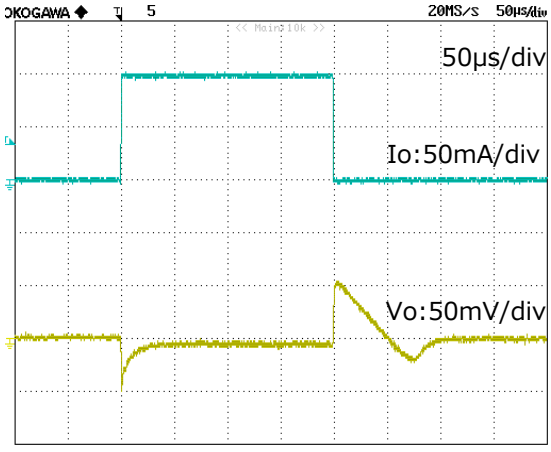


- Load transient response

Iout=1mA⇔50mA

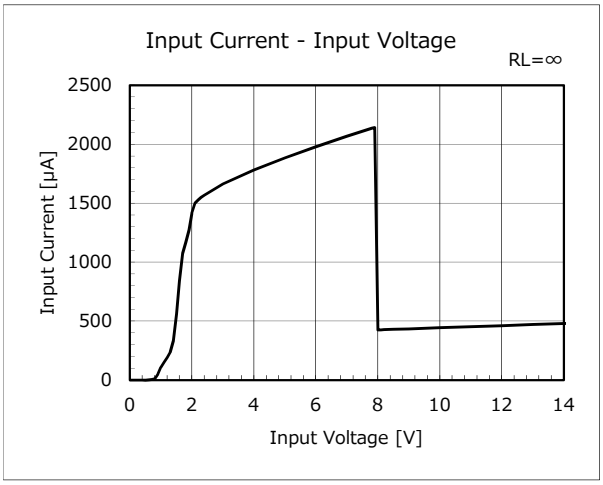


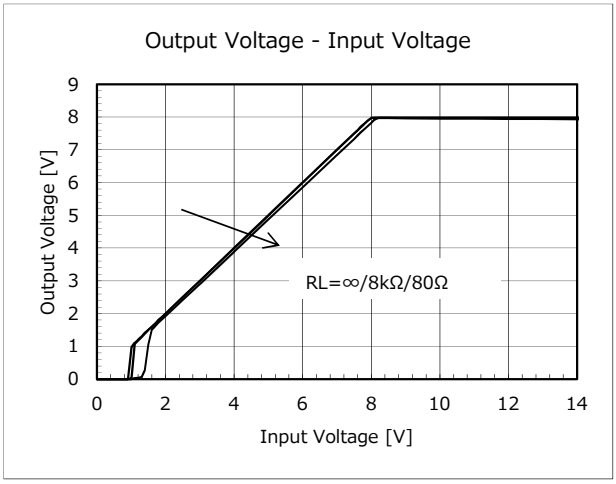
Iout=1mA⇔100mA

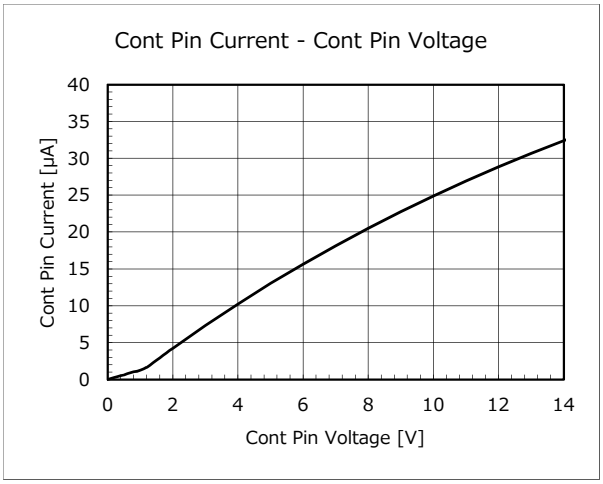


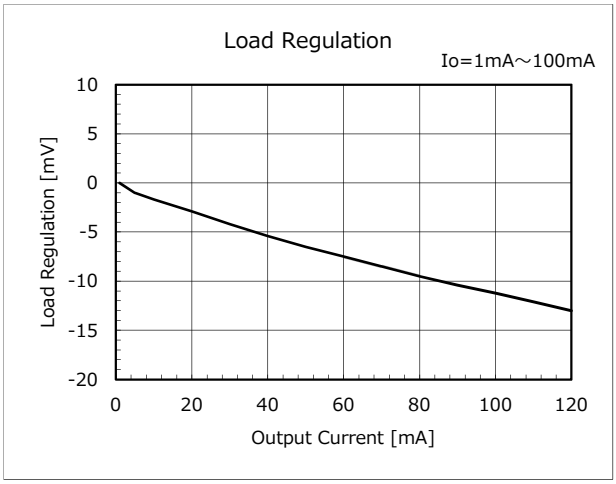
Typical Performance Characteristics (VOUT=8.0V/Function:A)

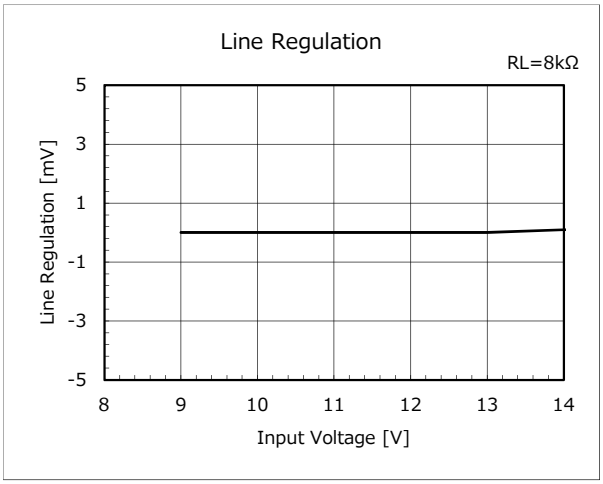
(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

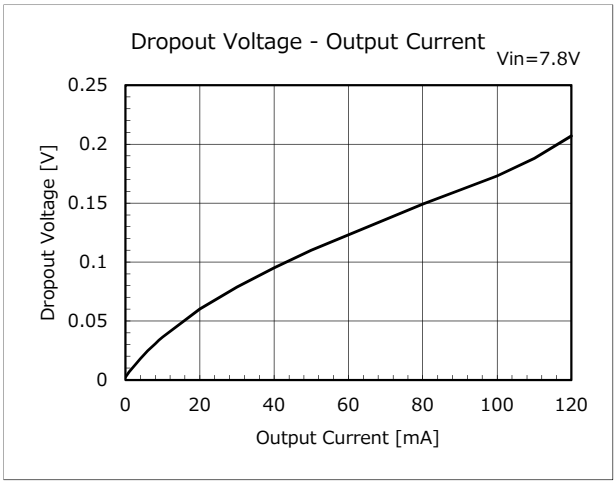








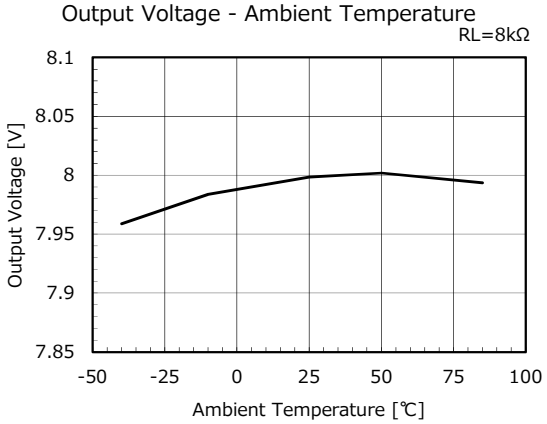




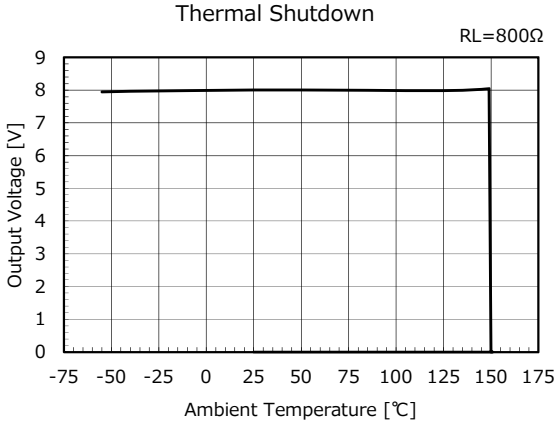
Typical Performance Characteristics (VOUT=8.0V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

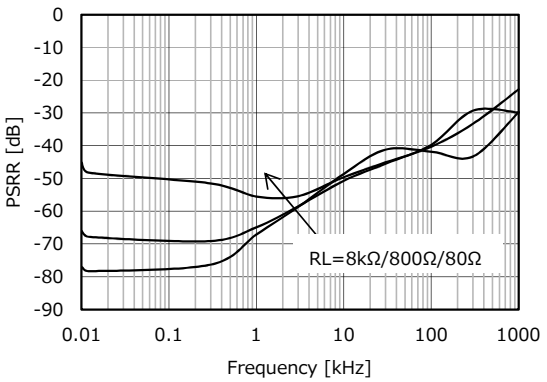
Output Voltage - Ambient Temperature



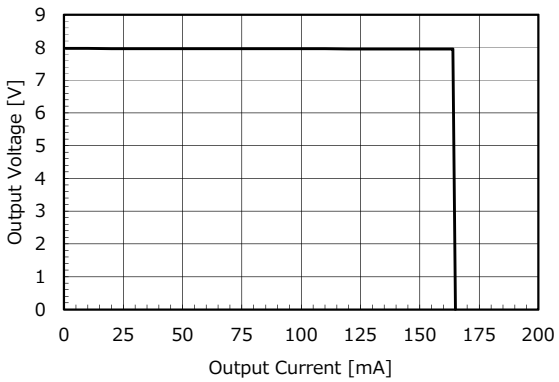
Thermal Shutdown



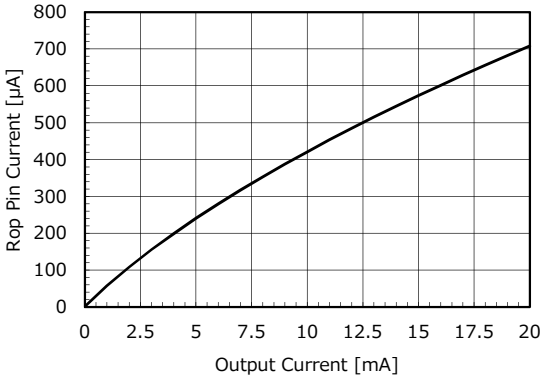
Power Supply Ripple Rejection



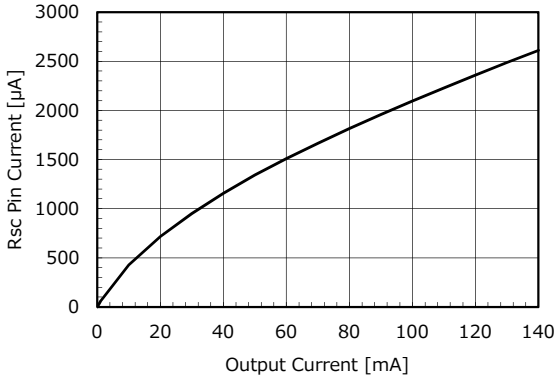
Current Limit



Rop Pin Current - Output Current

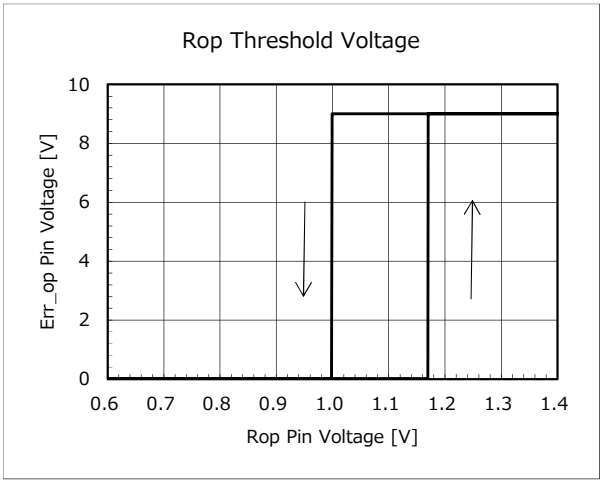


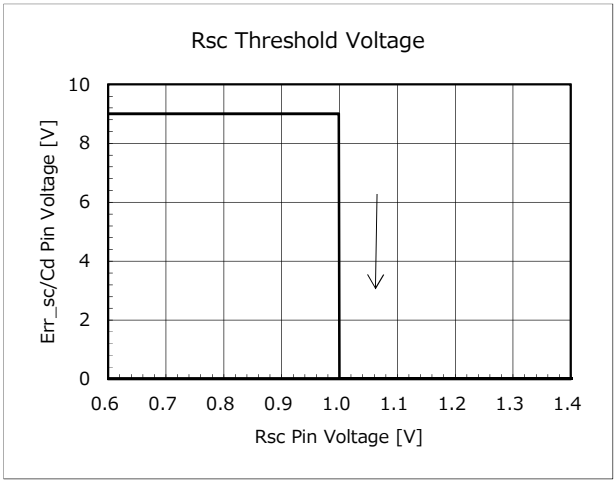
Rsc Pin Current - Output Current

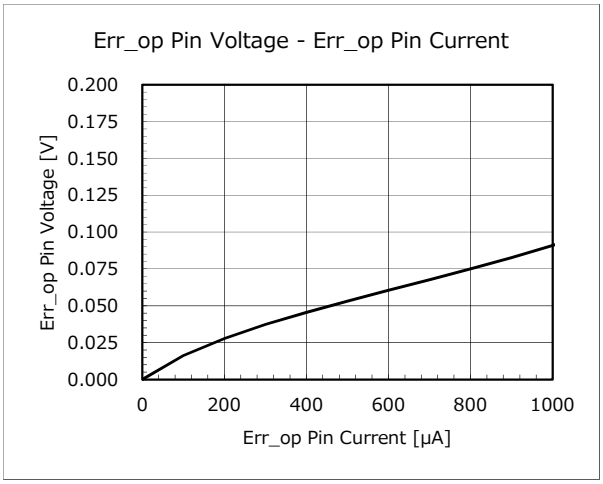


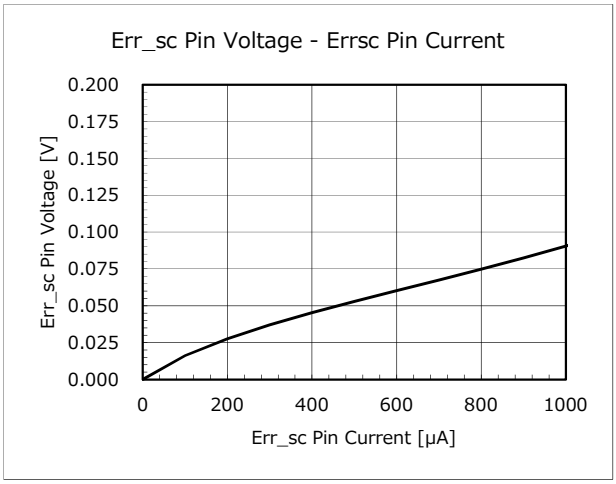
Typical Performance Characteristics (VOUT=8.0V/Function:A)

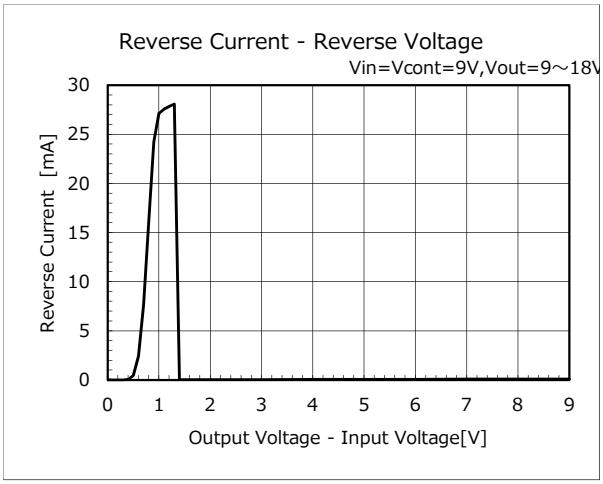
(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)











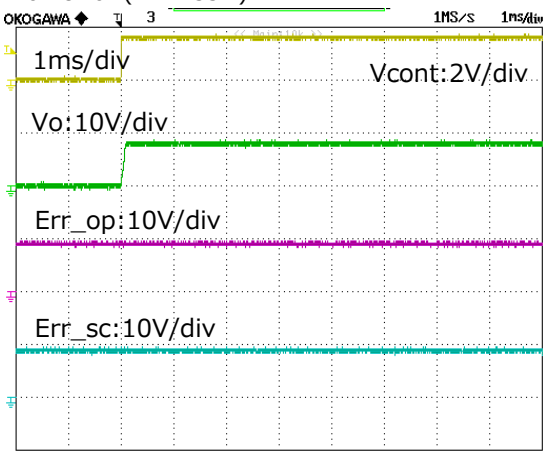
Typical Performance Characteristics (VOUT=8.0V/Function:A)

(V_{IN}=V_{OUT}(Typ.)+1V, Vcont=V_{IN}, Ta=25℃, unless otherwise specified)

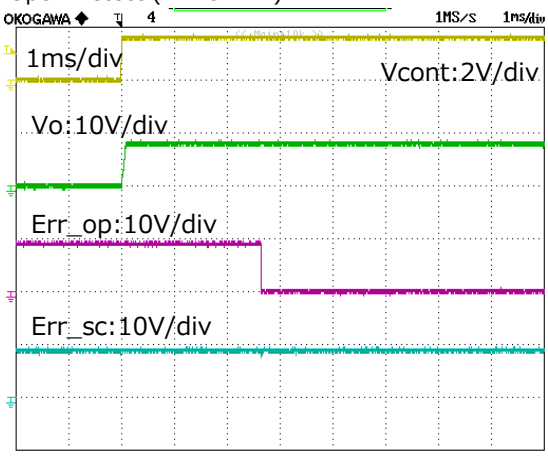
- Turn On Tansient Response

  Open Detect Current=5mA, Short Detect Curret=80mA

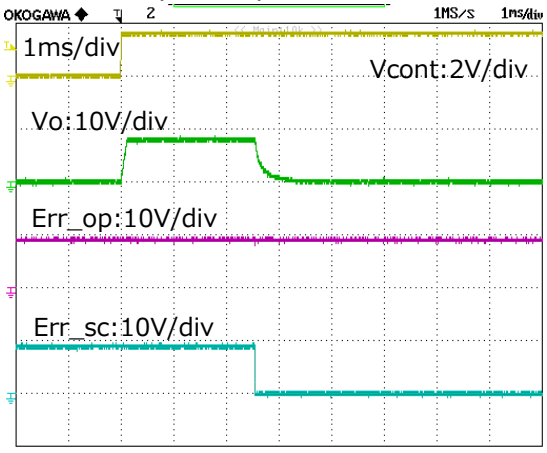
Non error (RL=155Ω)



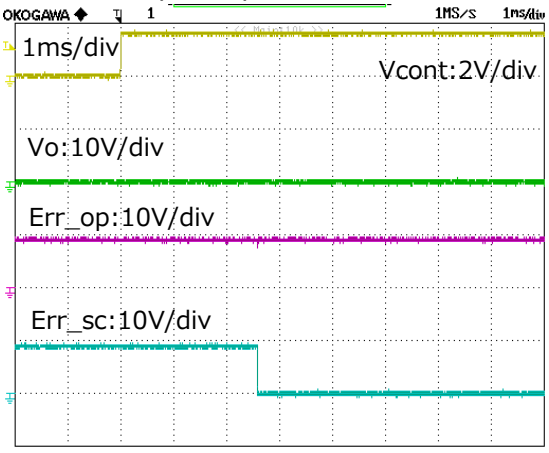
Open Detect (RL=3.1kΩ)



Short Detect (RL=31Ω)

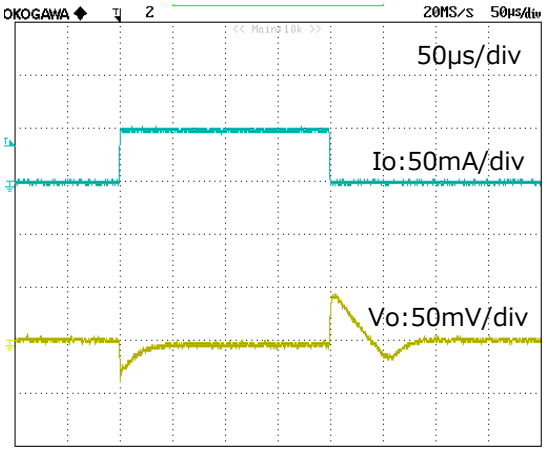


Short Detect (RL=0Ω)



- Load transient response

Iout=1mA⇔50mA



Iout=1mA⇔100mA