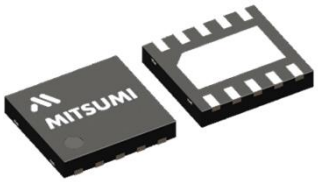
High voltage LDO with connect error detection

MM4007 Series



Overview

The MM4007 is a high voltage 300mA LDO with connection detection. The IC can be directly used to car battery by operating input voltage 36V.

The IC supplies the power for external connection equipment of car navigation (Camera, Radio, TV, etc.), and the IC can detect open or short-circuit of output load.

Features

- High voltage operation
- Open/Short circuit detection
- ON/OFF control

Main specifications

- Maximum rating supply voltage : -0.3V to 45V
- Operating voltage range : 5 to 36V
- Operating ambient temperature : -40℃ to 105℃
- Output current : 300mA
- Input current (OFF) : Max. 1μA
- No-load input current : Typ. 400μA
- Output voltage range : 5V to 10V (Adj.)
- FB pin voltage : 2.350V±1%
- Line regulation : Max. 0.1%/V (V_{DD}=12V to 36V)
- Load regulation : Typ. 15mV (I_{OUT}=1mA to 300mA)
- Dropout voltage : Typ. 0.5V (V_{OUT}(Typ.)=8V, I_{OUT}=300mA)
- PSRR : Typ. 80dB (f=1kHz)
- Rop pin current : ±10% (I_{OUT}=5mA, Vrop=1.47V)
- Rsc pin current : ±10% (I_{OUT}=100mA, Vrsc=1.47V)
- Error output : Open circuit Error, Short circuit Error
- Output capacitor : 4.7uF (Ceramic capacitor)
- Protection function : Over current protection, Thermal shutdown, Over voltage 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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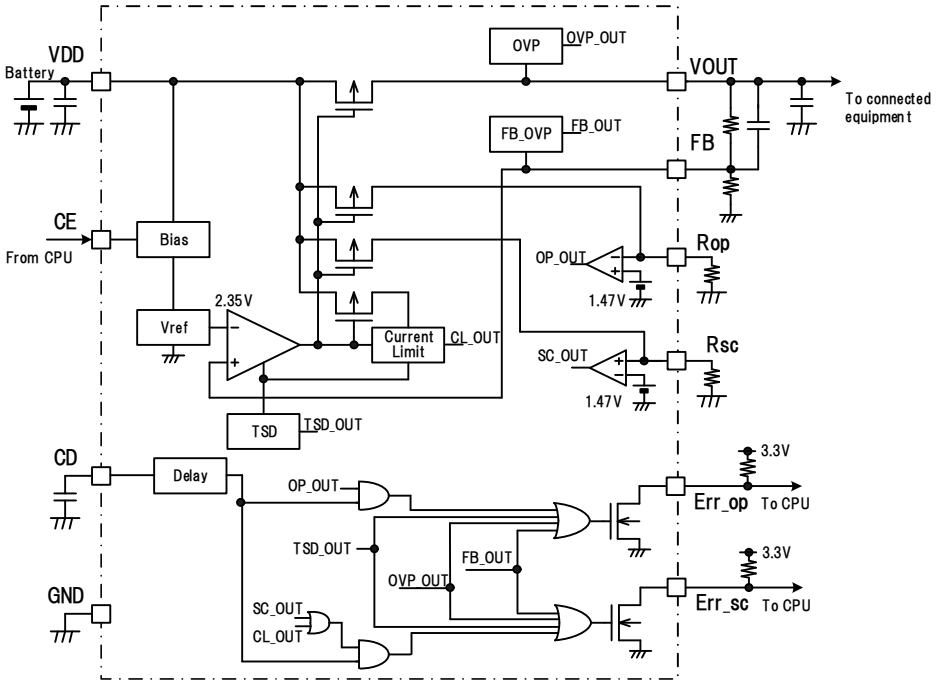
機種名

M M 4 0 0 7 A 0 0 R R E

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

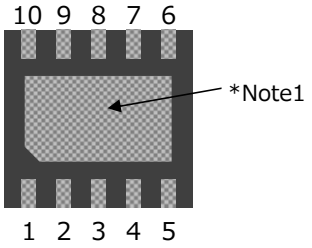
(A)	Function Type	A	-
(B)	Output voltage rank	00	Adjustable output voltage
(C)	Package	R	SSON-10B
(D)	Packing specifications 1	R	R housing
(E)	Packing specifications 2	E	Emboss tape / Halogen free

Block Diagram



Pin Configuration

■ SSON-10B



Top view

Pin No.	Pin name	Function
1	V_{OUT}	Output voltage pin
2	FB	Output voltage feedback pin Output voltage is set by adjusting the resistor between VOUT, FB and GND.
3	Rop	Open load detection resistance pin Open load current is set by resistor.
4	Rsc	Short-circuit detection resistance pin Short-circuit current is set by resistor.
5	CD	Delay time setting pin. Detection time is set by capacitor.
6	Err_sc	Short-circuit detection output pin Resistor is connected for pull-up.
7	Err_op	Open load detection output pin. Resistor is connected for pull-up.
8	GND	Ground pin
9	CE	Chip enable pin
10	V_{DD}	Power supply input pin

*Note1:裏タブはGNDに接続して下さい

Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit
Supply voltage	V_{IN}	-0.3	45	V
VOUT pin voltage	V_{OUT}	-0.3	45	V
CE pin voltage	Vcont	-0.3	45	V
Err_op, Err_sc pin voltage	Iomax	-0.3	5	V
Output current	Verr	-	400	mA
Err_op, Err_sc pin current	Ierr	-	20	mA
Junction Temperature	Tj_{MAX}	-	150	℃
Storage temperature	Tstg	-55	150	℃
Power Dissipation	Pd	-	1770	mW

*Note2:VDD≧VOUT condition. Except input and output voltage is reverse.

*Note3:In considering product life, please examine the use in less than 80%.

*Note4:JEDEC51-7 standard 114.3mm×76.2mm, t=1.6mm

Recommended Operating Conditions

Item	Symbol	Min.	Max.	Unit
Operating Ambient temperature	Topr	-40	105	℃
Operating voltage	Vop	5	36	V
Output voltage range	V_{OUT}	5	10	V
Output current	Iop	0	300	mA

Electrical Characteristics

(V_{OUT}(Typ.)=8V, V_{DD}=12V, V_{CE}=2.5V, Io=1mA, Ta=25℃, unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
OFF input current	IDD_off	VCE=0V, Io=0A	-	-	1.0	μA
No-load input current	IDD	Io=0A	-	400	800	μA
FB pin voltage	VFB	Ta=25℃	2.327	2.350	2.374	μA
		-40℃≦Ta≦105℃ *Note5	2.303	2.350	2.397	V
FB voltage temperature coefficient	⊿VFB/⊿Ta	-40℃≦Ta≦105℃	-	100	-	ppm/℃
Line regulation	Vline	VDD=12V to 36V	-	0.02	0.1	%/V
Load regulation	Vload	Io=1mA to 300mA	-	15	60	mV
Dropout voltage	Vio	VOUT(TYP.)=8V, VDD=7.8V, Io=300mA	-	0.5	0.8	V
Output current limit	Icl	VOUT=0V	300	700	1200	mA
Power supply ripple rejection *Note5	RR	Vripple=0.5Vp-p, f=1kHz	-	80	-	dB

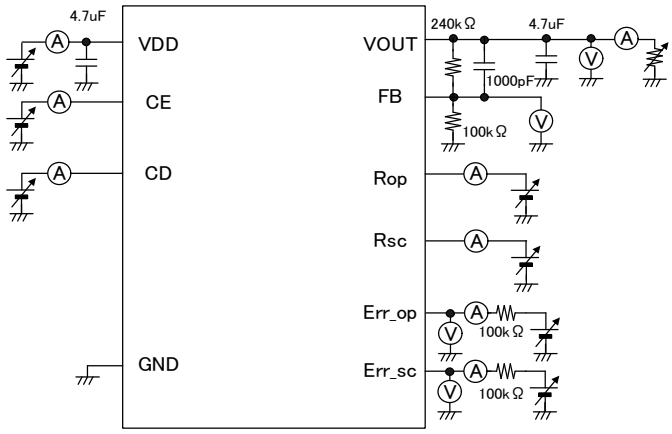
*Note5:The parameter is guaranteed by design.

Electrical Characteristics

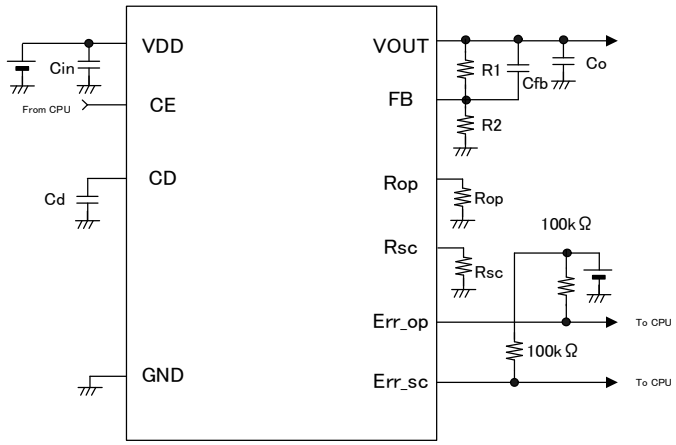
(V_{OUT}(Typ.)=8V, V_{DD}=12V, V_{CE}=2.5V, Io=1mA, Ta=25℃, unless otherwise specified)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
CE input voltage high	VCEH		2.5	-	36	V
CE input voltage low	VCEL		0	-	0.6	V
CE input current	ICE	VCE=12V	-	-	40	μA
Over voltage protect voltage	Vovp		10.2	11.0	11.8	V
FB over voltage protect	VFBovp		110	120	130	%
Rop pin current	Irop	Io=5mA, Vrop=1.47V	153	170	187	μA
Rop threshold voltage	Vth_op	Rop=H→L	1.40	1.47	1.54	V
Rop hysteresis voltage	Vhys_op		0.02	0.03	0.04	V
Rsc pin current	Irsc	Io=100mA, Vrsc=1.47V	216	240	264	μA
Rsc threshold voltage	Vth_sc	Rsc=L→H	1.40	1.47	1.54	V
Rsc hysteresis voltage	Vhys_sc		0.02	0.03	0.04	V
Err_op output voltage	Verr_op	Vrop=L, Ierr_op=0.5mA	-	-	0.2	V
Err_sc output voltage	Verr_sc	Vrsc=H, Ierr_sc=0.5mA	-	-	0.2	V
CD pin current	Icd	Vcd=0V	3.0	5.0	7.0	μA
CD threshold voltage	Vth_cd	Vcd=L→H	1.40	1.47	1.54	V

Test Circuit



Application Circuit

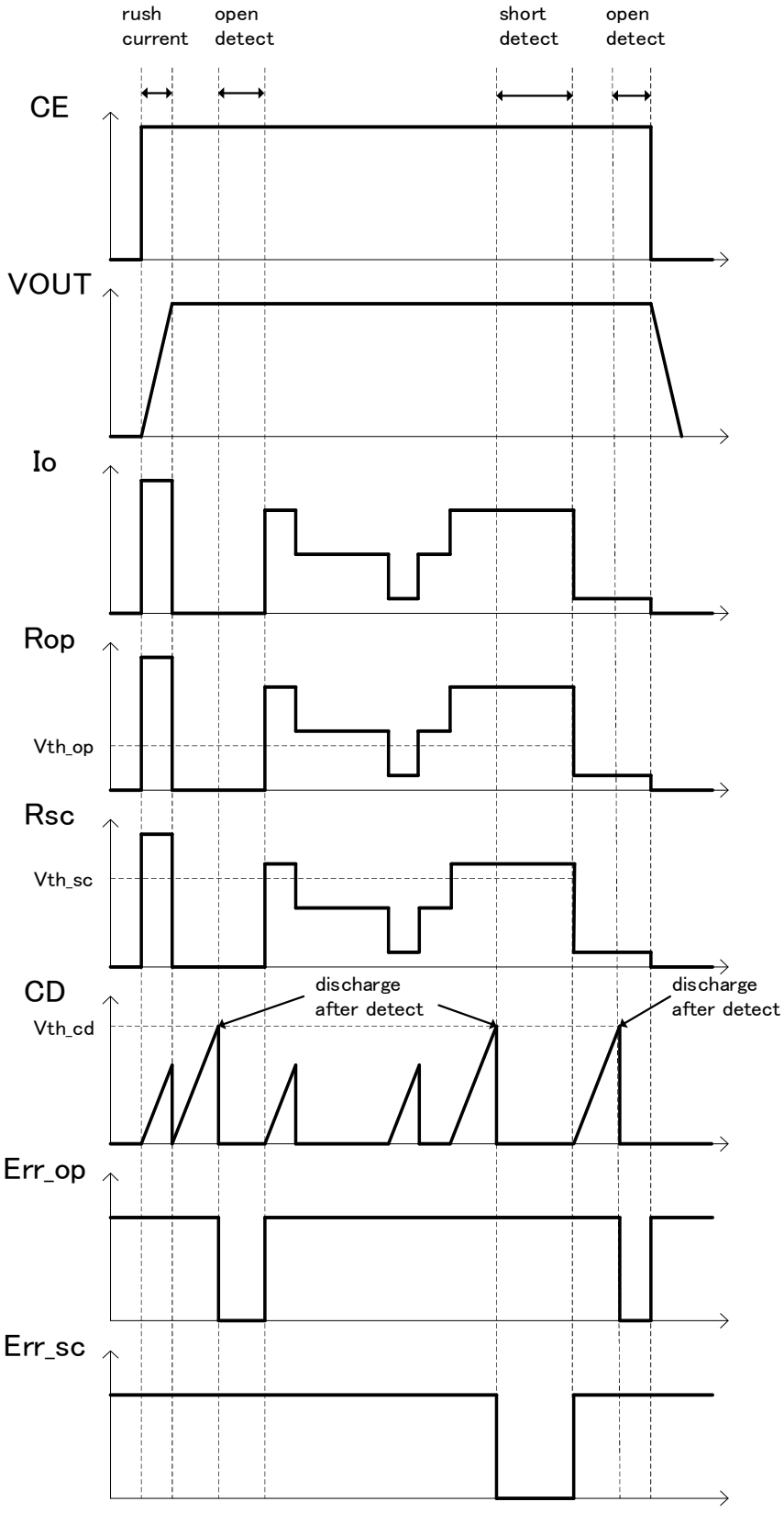


(Reference example of external parts)

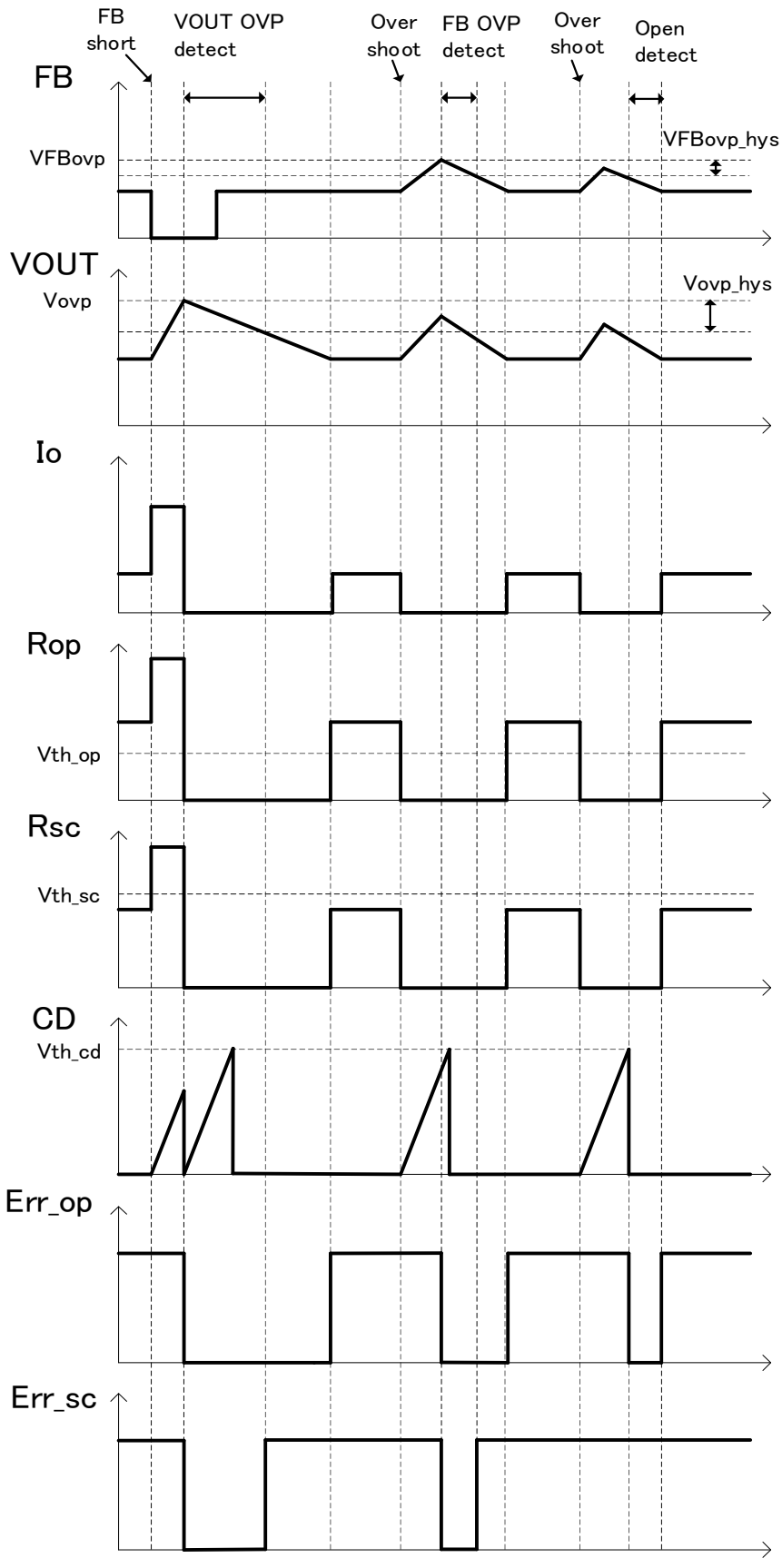
- Output capacitor Co — Ceramic capacitor 4.7μF rated over 50V
- Input capacitor Cin — Ceramic capacitor 4.7μF rated over 50V
- Adjustable resistance R2 — 10kΩ～100kΩ
- Phase compensation Cfb — Ceramic capacitor 1000pF rated over 50V

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

Timing Chart (Open,short detection)



Timing Chart (FB OVP,OVP)



Feature description

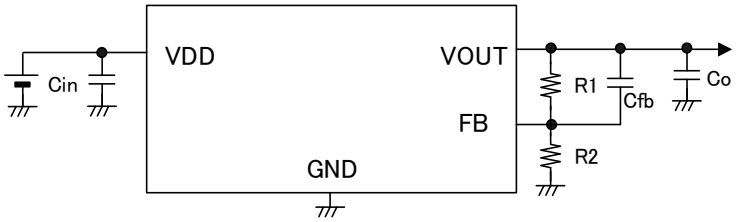
1. Detection delay time setting will be common for open load/short-circuit detection .
   So the short-circuit detection delay time and the open load delay time become same.

2. Each terminal output when detecting it abnormally, will be the following table.

Terminal	Detection						
	Normal	Open	Short	Current Limit	TSD	OVP	FB OVP
Err_op	High	Low	High	High	Low	Low	Low
Err_sc	High	High	Low	Low	Low	Low	Low
LDO output	Enabled	Enabled	Enabled	Disabled	Disabled	Disabled	Disabled

3. Output voltage can be set with external resistor. Output voltage range is 5V～10V.
   Use resistance value in the range of below formula.

   VOUT=VFB×(R1+R2)÷R2
   VFB=2.350V
   5V≦VOUT≦10V
   10kΩ≦R2≦100kΩ



4. The set value can be designed the following calculation for Open detect resistance
   and short detect resistance, delay capacitance.

   Rop=Vth_op÷Irop
   Rsc=Vth_sc÷Irsc
   Cd=(td×Icd)÷Vth_cd

Rop:Open detect resistance
Rsc:Short detect resistance
Cd:Delay capacitance
Vth_op:Rop threshold voltage
Vth_sc:Rsc threshold voltage
Vth_cd:Cd threshold voltage
Irop:Rop pin current
Irsc:Rsc pin current
Icd:CD pin current
td:Detect delay time

Note

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

2. There is a possibility that it becomes impossible to maintain this performance and reliability IC original if use 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.

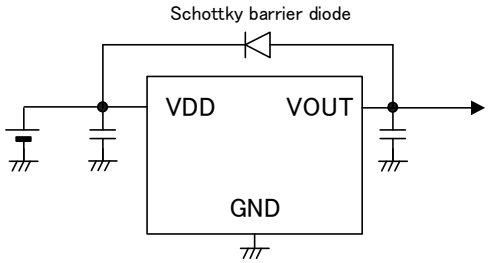
5. The ESR of capacitor must be defined in ESR stability area.
   It is possible to use a ceramic capacitor without ESR resistance for output.

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 effective capacitance of over 4.0μF and temperature characteristic of over X7R.

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

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

9. 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.



10. The FB terminal is affected by the noise. Please be careful about pattern enough.
    It is able to operate unstable in the influence of floating capacity.

11. The over current protection circuit built in this IC is vertical type.

12. 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.

13. It is possible to increase output voltage if the condition is low output current(under 1mA) and high temperature.
    The provision is to add load(over 1mA).

Note

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

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

16. It is a possible that IC generates heat when the output terminal is short-circuited.
    The thermal shutdown circuit operates in this situation, and it will do operation that protects IC.
    However the thermal shutdown circuit is designed only to prevent thermal runaway,
    Do not continue to use that the operation of this circuit is assumed.
    The characteristic changes in the substrate condition.
    Please evaluate IC in the set.

17. When establishing an open load detection current, please consider a release hysteresis.

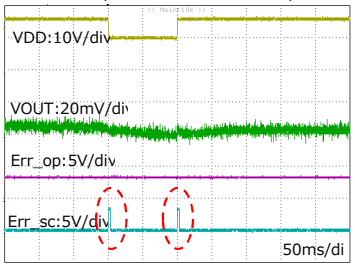
18. When LDO start up, inrush current occurs.
    When start up, it is possible that inrush current instead of short-circuit current is detected.
    Please be sure to establish the detection delay time by adjusting Cd capacitor
    not to detect short-circuit until LDO starts.

19. If the voltage between input and output is less than 1.5V, Rop & Rsc current fluctuates.
    Please use the input voltage under the condition of output voltage +1.5V or more.

20. Rop and Rsc pin is high impedance to out current, So the chattering occur to influence of noise.
    If chattering occur, adding capacitance reduce the noise.

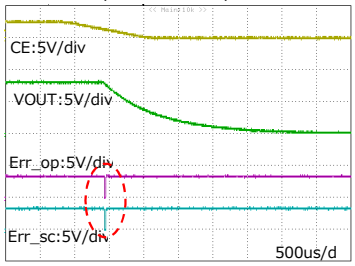
21. When output voltage and current change transiently, Err_op or Err_sc may be release detection.
    Because no delay time for Open and short release detection.
    Detect again after detection delay time.

    VOUT=8V, VDD=16V⇔10V, tr=tf=1V/us, RL=80Ω(short detect:100mA)



22. It is possible that Err_op and Err_sc voltage output L voltage once when turn off.
    If this is problem, please set that it will not be detected by microcomputer.

    VOUT=8V, VDD=12V, CE=2.5→0V, tf=1ms, RL=160Ω



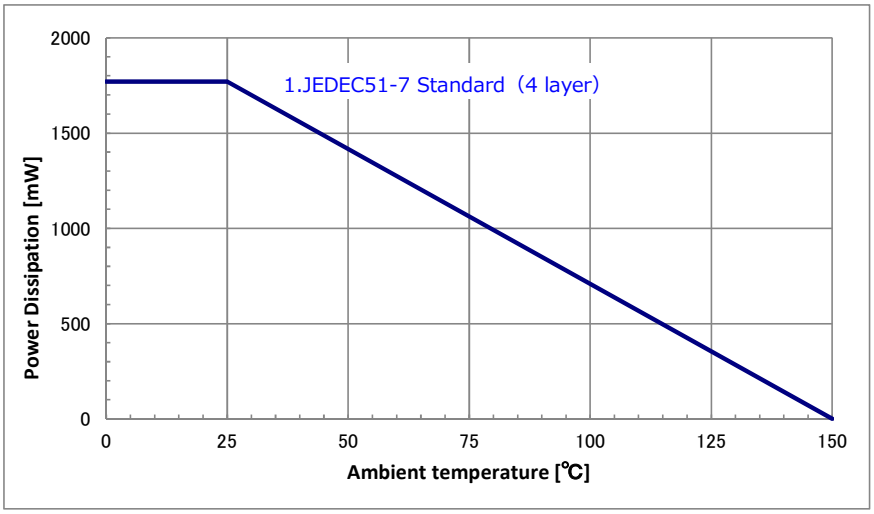
About Power dissipation

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.

- SSON-10C

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

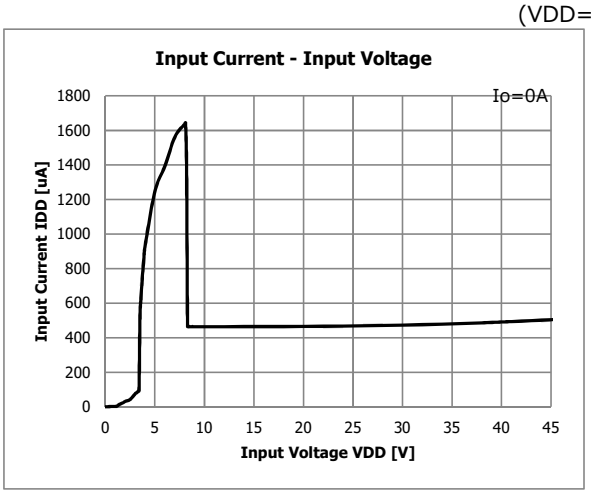
Board size	114.3mm×76.2mm t=1.6mm Copper foil area 80%
Power dissipation	1770mW Ta=25℃
Thermal resistance	3.9℃/W

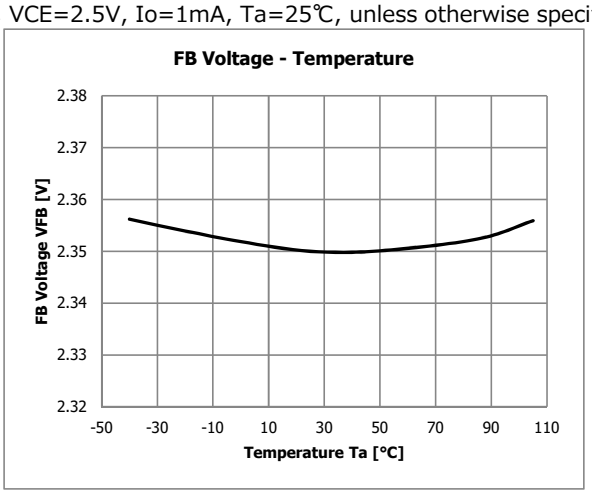


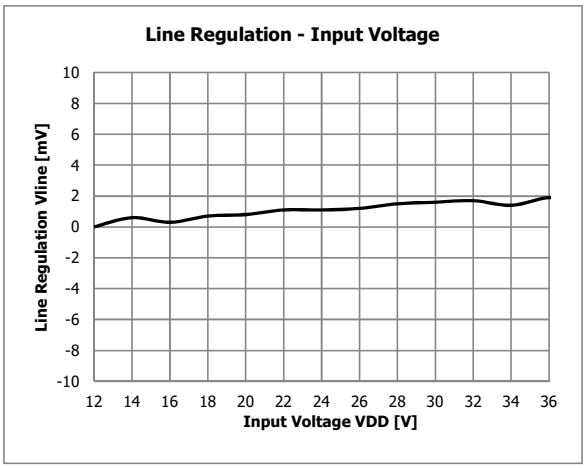
It is recommended to layout the VIA for heat radiation in the GND pattern of reverse (of IC) when there is the GND pattern in the inner layer (in using multiplayer substrate).
By increasing these copper foil pattern area of PCB, Power dissipation improves.

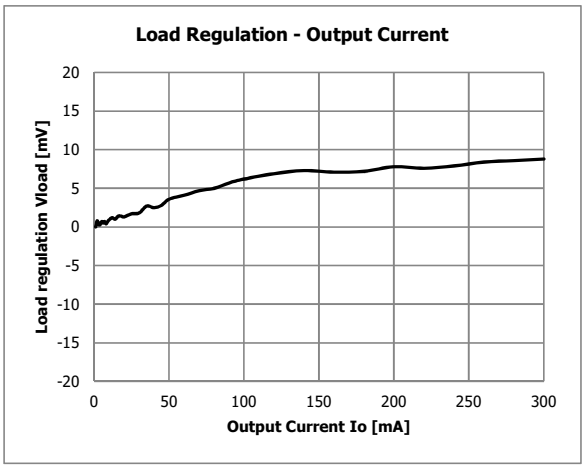
Typical Performance Characteristics

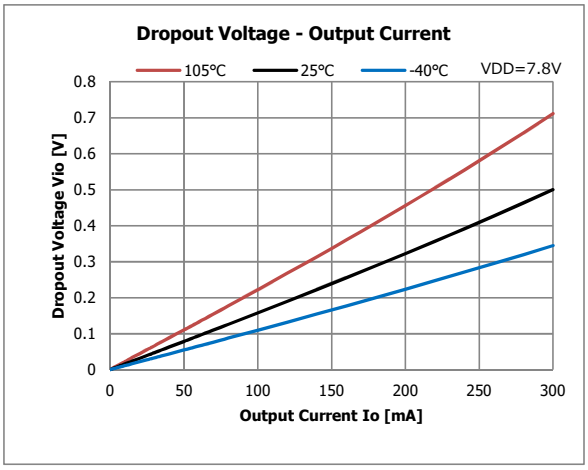
(VDD=12V, VCE=2.5V, Io=1mA, Ta=25℃, unless otherwise specified)

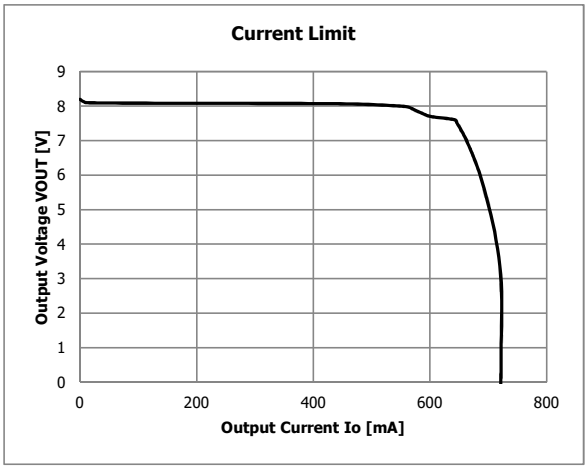












Typical Performance Characteristics

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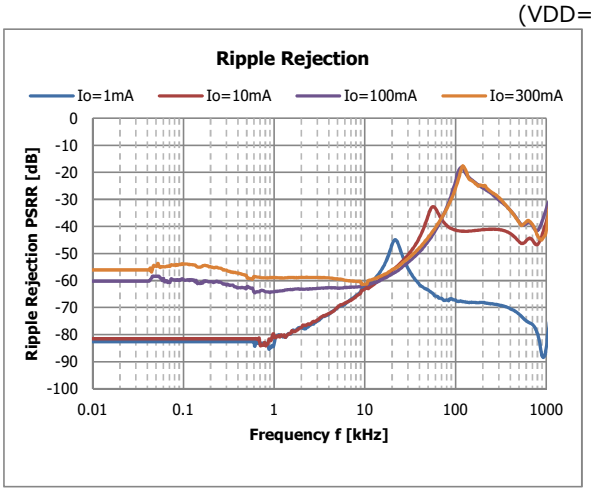
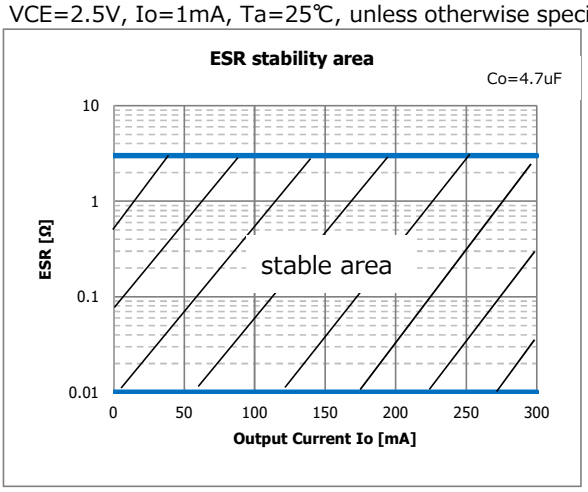
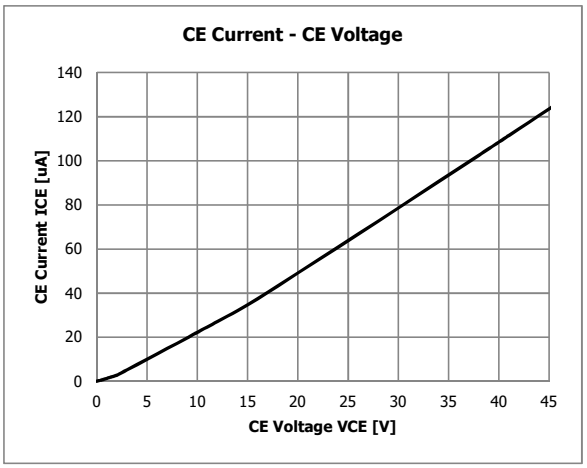
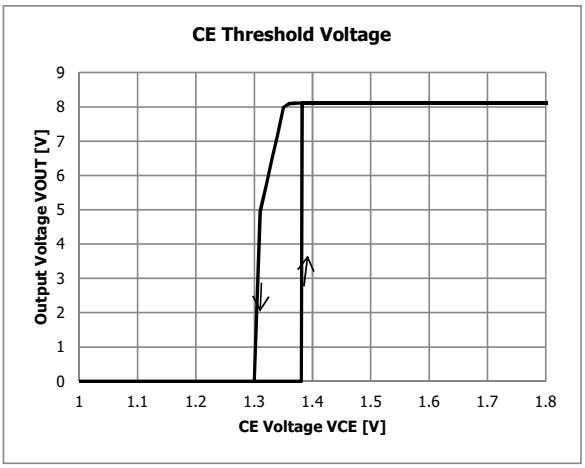
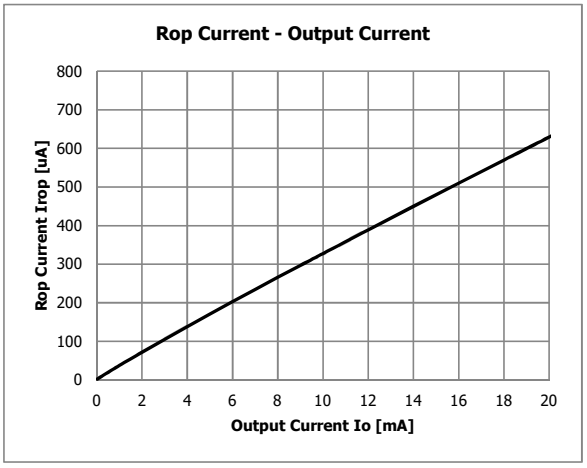
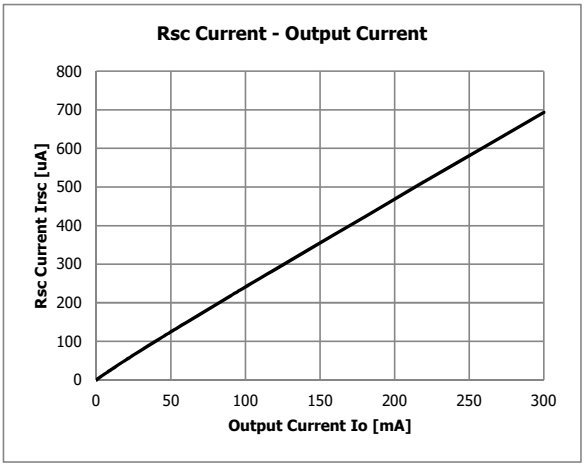






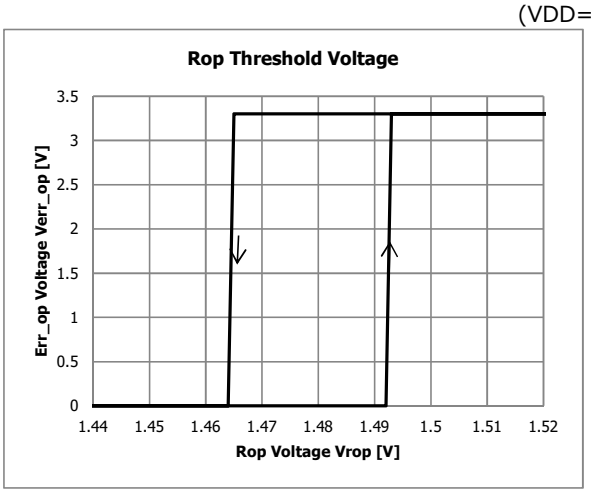


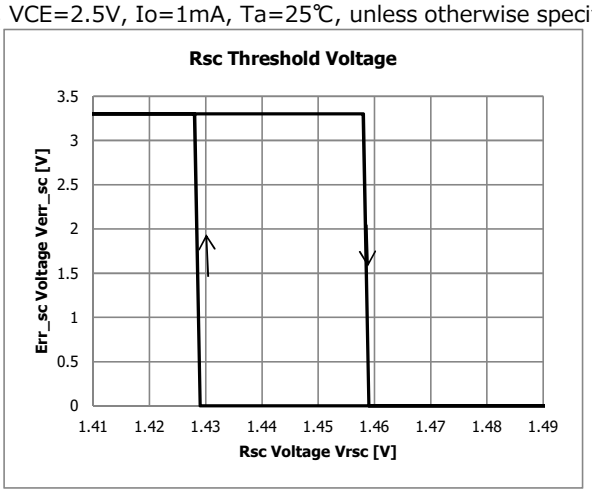


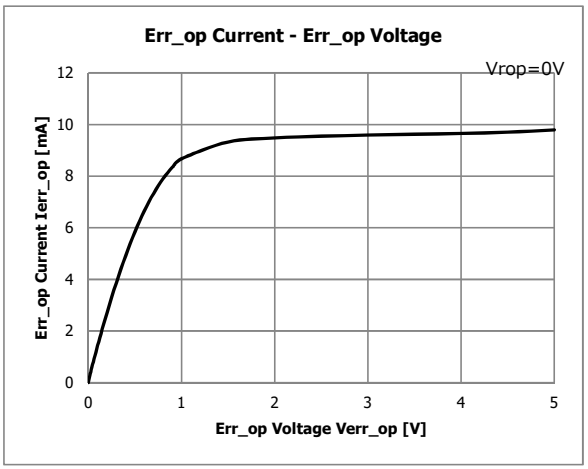


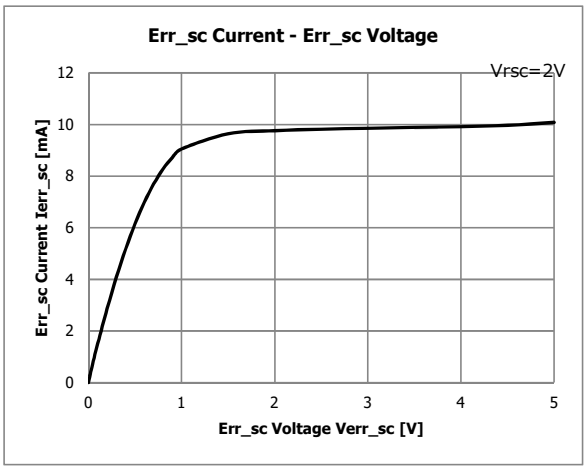
Typical Performance Characteristics

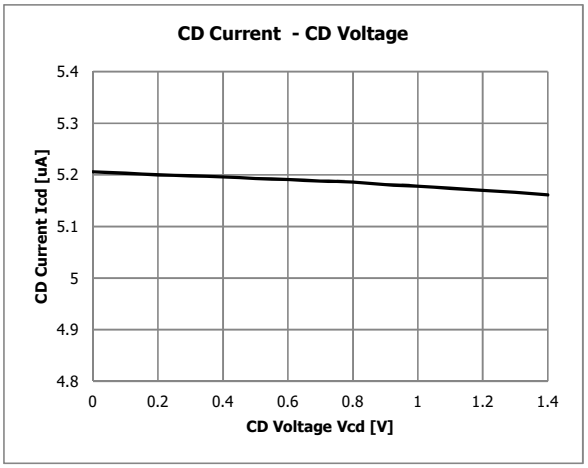
(VDD=12V, VCE=2.5V, Io=1mA, Ta=25℃, unless otherwise specified)

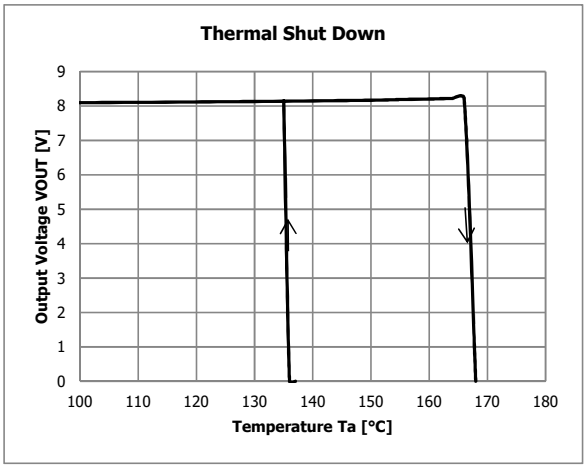












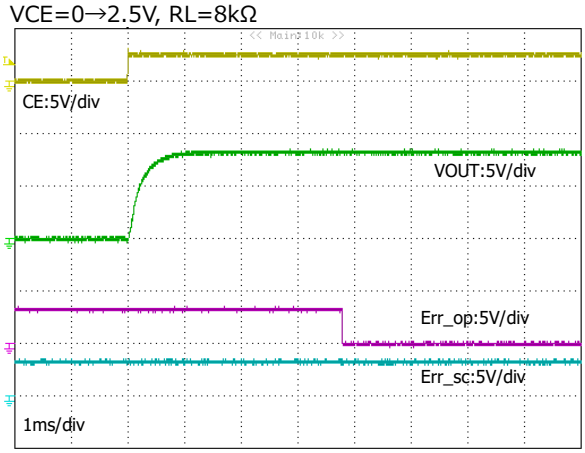
Typical Performance Characteristics

(VDD=12V, VCE=2.5V, Io=1mA, Ta=25℃, unless otherwise specified)

■ Turn On Transient Response

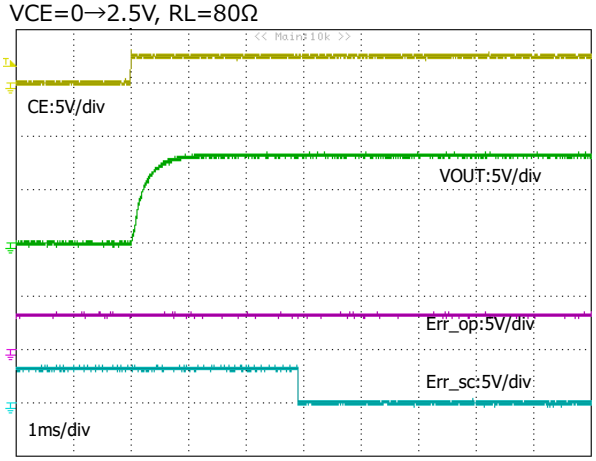
Open Detect(Io=1mA)

VCE=0→2.5V, RL=8kΩ



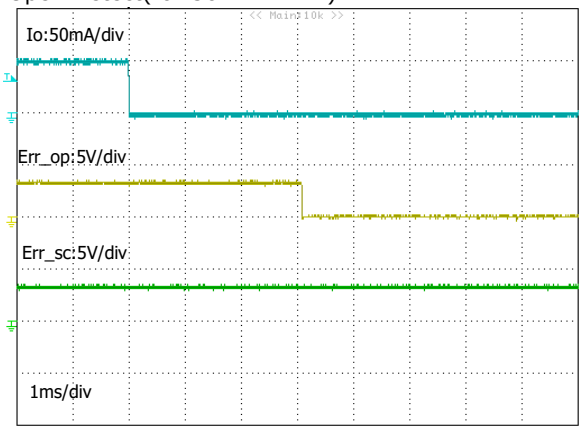
Short Detect(Io=100mA)

VCE=0→2.5V, RL=80Ω

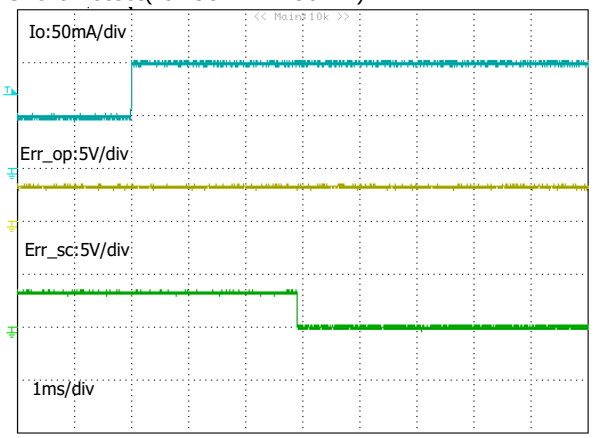


■ Load Transient Response (Err_op, Err_sc)

Open Detect(Io=50mA→1mA)

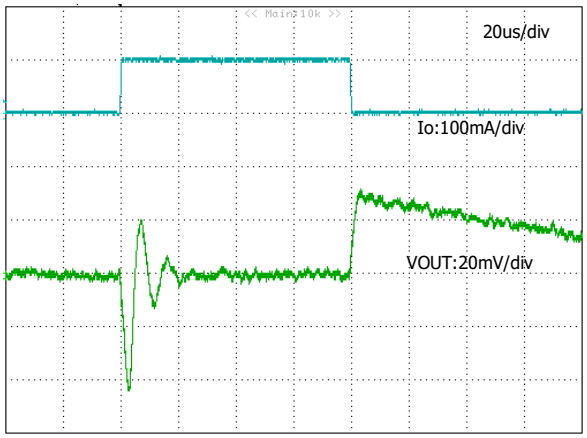


Short Detect(Io=50mA→100mA)

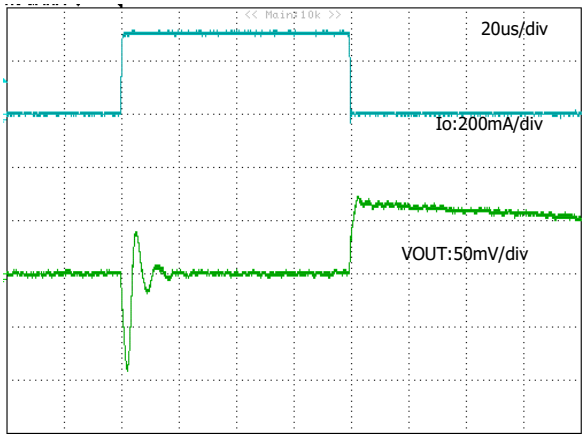


■ Load Transient Response (VOUT)

Io=1mA⇔100mA



Io=1mA⇔300mA



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