# 150mA CMOS Voltage Regulator IC
# Monolithic IC MM3376AX Series

## Outline

This IC is a regulator IC providing low supply current (1.7μA) and low input voltage (1.2~6V), developed using the CMOS process, and supports longer battery life with a chip enable function. In addition, it is ideal to be used for a constant voltage power supply for backup as it includes a reverse current protection function to automatically prevent a current (0.1μA max.) from reversely flowing to the input terminal side if a voltage exceeding the input terminal voltage ($V_{DD}$) is applied to the output terminal ($V_{OUT}$) by monitoring the voltages of the output terminal ($V_{OUT}$) and input terminal ($V_{DD}$).

## Features

| | | |
|---|---|---|
| 1. | Input voltage range | 1.2~6V |
| 2. | Output voltage range | 0.8~5.0V |
| 3. | Output voltage accuracy | $V_{OUT}$±2% |
| 4. | Maximum output current | 150mA |
| 5. | Supply current | 1.7μA typ.(No-Load Input Current)<br>0.6μA typ.(OFF) |
| 6. | Reverse current | 0.1μA max. |
| 7. | Output capacitor | 0.1μF |
| 8. | Dropout voltage | 30mV typ. / 50mV max. (Io=10mA 3.3V≦$V_{OUT}$≦5.0V) |
| 9. | Output short-circuit current | 60mA typ. |
| 10. | Line regulation | 0.05%V typ. (Io=1mA) |
| 11. | Load regulation | 30mV typ. / 90mV max. (Io=1~150mA) |

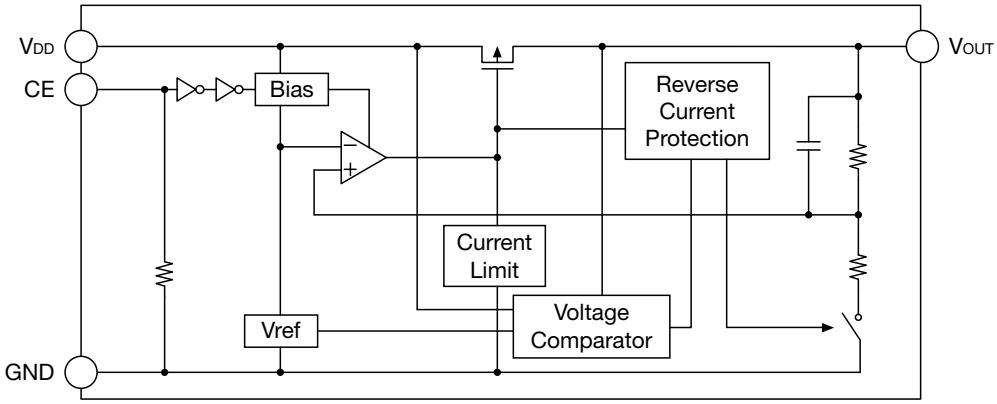
## Package

SOT-25A
SSON-4
SC-82

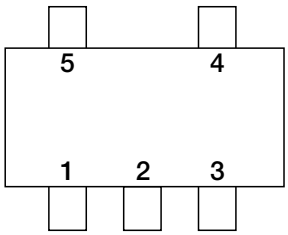
## Applications

1. Cellular Phones
2. Portable Games
3. PDAs
4. Digital still Cameras
5. Note PCs

## Block Diagram

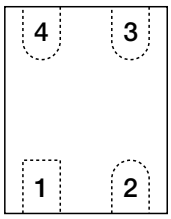



## Pin Assignment



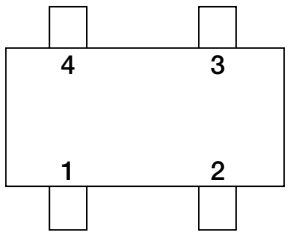

SOT-25A
(TOP VIEW)

| | |
|---|---|
| 1 | VDD |
| 2 | GND |
| 3 | CE |
| 4 | NC |
| 5 | VOUT |




SSON-4
(TOP VIEW)

| | |
|---|---|
| 1 | GND |
| 2 | CE |
| 3 | VDD |
| 4 | VOUT |




SC-82
(TOP VIEW)

| | |
|---|---|
| 1 | CE |
| 2 | GND |
| 3 | VOUT |
| 4 | VDD |

## Pin Description

### SOT-25A

| Pin No. | Pin name | Functions |
|---|---|---|
| 1 | $V_{DD}$ | Voltage–supply pin |
| 2 | GND | Ground pin |
| 3 | CE | ON/OFF–Control pin<br>CE: Low → OFF; High → ON<br>Connect CE pin with $V_{DD}$ pin, when it is not used. |
| 4 | NC | No connection |
| 5 | $V_{OUT}$ | Output pin |

### SSON-4

| Pin No. | Pin name | Functions |
|---|---|---|
| 1 | GND | Ground pin |
| 2 | CE | ON/OFF–Control pin<br>CE: Low → OFF; High → ON<br>Connect CE pin with $V_{DD}$ pin, when it is not used. |
| 3 | $V_{DD}$ | Voltage–supply pin |
| 4 | $V_{OUT}$ | Output pin |

### SC-82

| Pin No. | Pin name | Functions |
|---|---|---|
| 1 | CE | ON/OFF–Control pin<br>CE: Low → OFF; High → ON<br>Connect CE pin with $V_{DD}$ pin, when it is not used. |
| 2 | GND | Ground pin |
| 3 | $V_{OUT}$ | Output pin |
| 4 | $V_{DD}$ | Voltage-supply pin |

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

| Item | Symbol | Ratings | Units |
|---|---|---|---|
| Storage temperature | $T_{STG}$ | −55~+150 | °C |
| Supply voltage | $V_{DD}$ | 6.5 | V |
| CE input voltage | $V_{CE}$ | −0.3~6.5 | V |
| Output voltage | $V_{OUT}$ | −0.3~6.5 | V |
| Output current | $I_{OUT}$ | 200 | mA |
| Power dissipation | Pd | 350(Note1) (SOT–25A) | mW |
| | | 330(Note2) (SSON–4B) | |
| | | 240(Note3) (SC–82ABB) | |

Note1 : With PC Board of glass epoxy.
Note2 : With PC Board of glass epoxy 110 × 40 × 0.8$^{t}$mm
Note3 : With PC Boad of glass epoxy (The tab pin is not connected with PC Boad.) 100 × 100 × 1.6$^{t}$mm

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

| Item | Symbol | Ratings | Units |
|---|---|---|---|
| Operating ambient temperature | $T_{JOP}$ | −40~85 | °C |
| Operating voltage | $V_{OP}$ | Vo+0.3~6 | V |
| Output current | $I_{OUT}$ | 0~150 | mA |

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

| Item | Symbol | Measurement conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Input current (OFF) | $I_{DD}$off | $V_{CE}$=0V | | 0.6 | 1.2 | µA |
| No-load input current | $I_{DD}$ | $I_{OUT}$=0mA | | 1.7 | 3.5 | µA |
| Output voltage | $V_{OUT}$ | $I_{OUT}$=1mA | ×0.98 | | ×1.02 | V |
| Line regulation | $V_{LINE}$ | $I_{OUT}$=1mA<br>$V_{OUT}$(typ.)+1V≦$V_{DD}$≦6V | | 0.05 | 0.20 | %/V |
| Load regulation | $V_{LOAD}$ | 1mA≦$I_{OUT}$≦150mA | | 30 | 90 | mV |
| Dropout voltage | Vio | Please refer to another page | | | | V |
| Output short-circuit current (Note4) | Ilim | $V_{OUT}$=0V | | 60 | | mA |
| $V_{OUT}$ temperature coefficient (Note4) | $\Delta V_{OUT}/\Delta T_{OP}$ | $I_{OUT}$=30mA<br>−40≦$T_{OP}$≦85°C | | ±100 | | ppm/°C |
| CE pin current | $I_{CE}$ | | | 0.5 | | µA |
| CE H threshold voltage | $V_{CEH}$ | | 1.0 | | $V_{DD}$ | V |
| CE L threshold voltage | $V_{CEL}$ | | 0 | | 0.3 | V |
| Reverse current | $I_{REV}$ | $V_{OUT}$>0.5V, 0V≦$V_{DD}$≦6V | | | 0.1 | µA |

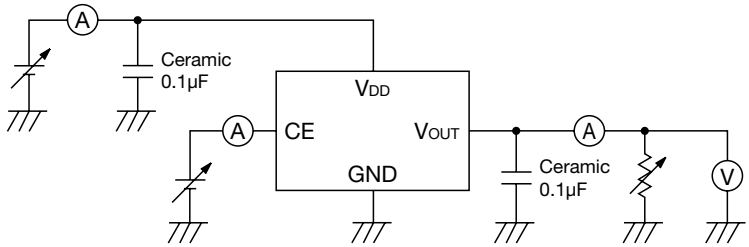
Note4 : The item is guaranteed by design.

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

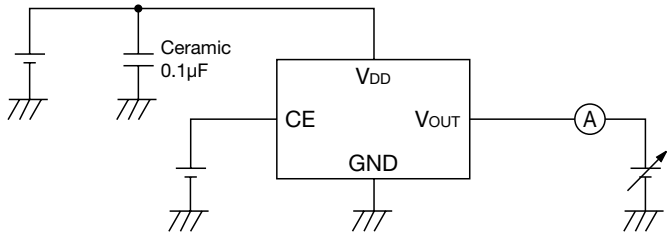
| Model No. | Item | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Output voltage | | | | Dropout voltage | | | |
| | $V_{OUT}$ (V) | | | | Vio (V) | | | |
| | Measurement conditions | Min. | Typ. | Max. | Measurement conditions | Min. | Typ. | Max. |
| MM3376A08NRE | $I_{OUT}$=1mA | 0.770 | 0.8 | 0.830 | (Note5) | | | |
| MM3376A09NRE | | 0.870 | 0.9 | 0.930 | | | | |
| MM3376A10NRE | | 0.970 | 1.0 | 1.030 | | | | |
| MM3376A11NRE | | 1.070 | 1.1 | 1.130 | | | | |
| MM3376A12NRE | | 1.170 | 1.2 | 1.230 | | | | |
| MM3376A13NRE | | 1.270 | 1.3 | 1.330 | | | | |
| MM3376A14NRE | | 1.370 | 1.4 | 1.430 | | | | |
| MM3376A15NRE | | 1.470 | 1.5 | 1.530 | $I_{OUT}$=10mA 1.5V≦$V_{OUT}$≦1.9V | | 0.12 | 0.15 |
| MM3376A16NRE | | 1.568 | 1.6 | 1.632 | | | | |
| MM3376A17NRE | | 1.666 | 1.7 | 1.734 | | | | |
| MM3376A18NRE | | 1.764 | 1.8 | 1.836 | | | | |
| MM3376A19NRE | | 1.862 | 1.9 | 1.938 | | | | |
| MM3376A20NRE | | 1.960 | 2.0 | 2.040 | $I_{OUT}$=10mA 2.0V≦$V_{OUT}$≦2.4V $V_{DD}=V_{OUT}$–0.2V | | 0.08 | 0.12 |
| MM3376A21NRE | | 2.058 | 2.1 | 2.142 | | | | |
| MM3376A22NRE | | 2.156 | 2.2 | 2.244 | | | | |
| MM3376A23NRE | | 2.254 | 2.3 | 2.346 | | | | |
| MM3376A24NRE | | 2.352 | 2.4 | 2.448 | | | | |
| MM3376A25NRE | | 2.450 | 2.5 | 2.550 | $I_{OUT}$=10mA 2.5V≦$V_{OUT}$≦2.9V $V_{DD}=V_{OUT}$–0.2V | | 0.06 | 0.08 |
| MM3376A26NRE | | 2.548 | 2.6 | 2.652 | | | | |
| MM3376A27NRE | | 2.646 | 2.7 | 2.754 | | | | |
| MM3376A28NRE | | 2.744 | 2.8 | 2.856 | | | | |
| MM3376A29NRE | | 2.842 | 2.9 | 2.958 | | | | |
| MM3376A30NRE | | 2.940 | 3.0 | 3.060 | $I_{OUT}$=10mA 3.0V≦$V_{OUT}$≦3.2V $V_{DD}=V_{OUT}$–0.2V | | 0.05 | 0.07 |
| MM3376A31NRE | | 3.038 | 3.1 | 3.162 | | | | |
| MM3376A32NRE | | 3.136 | 3.2 | 3.264 | | | | |
| MM3376A33NRE | | 3.234 | 3.3 | 3.366 | $I_{OUT}$=10mA 3.3V≦$V_{OUT}$≦5.0V $V_{DD}=V_{OUT}$–0.2V | | 0.03 | 0.05 |
| MM3376A34NRE | | 3.332 | 3.4 | 3.468 | | | | |
| MM3376A35NRE | | 3.430 | 3.5 | 3.570 | | | | |
| MM3376A36NRE | | 3.528 | 3.6 | 3.672 | | | | |
| MM3376A37NRE | | 3.626 | 3.7 | 3.774 | | | | |
| MM3376A38NRE | | 3.724 | 3.8 | 3.876 | | | | |
| MM3376A39NRE | | 3.822 | 3.9 | 3.978 | | | | |
| MM3376A40NRE | | 3.920 | 4.0 | 4.080 | | | | |
| MM3376A41NRE | | 4.018 | 4.1 | 4.182 | | | | |
| MM3376A42NRE | | 4.116 | 4.2 | 4.284 | | | | |
| MM3376A43NRE | | 4.214 | 4.3 | 4.386 | | | | |
| MM3376A44NRE | | 4.312 | 4.4 | 4.488 | | | | |
| MM3376A45NRE | | 4.410 | 4.5 | 4.590 | | | | |
| MM3376A46NRE | | 4.508 | 4.6 | 4.692 | | | | |
| MM3376A47NRE | | 4.606 | 4.7 | 4.794 | | | | |
| MM3376A48NRE | | 4.704 | 4.8 | 4.896 | | | | |
| MM3376A49NRE | | 4.802 | 4.9 | 4.998 | | | | |
| MM3376A50NRE | | 4.900 | 5.0 | 5.100 | | | | |

Note5 : The item is not guaranteed in the model less than $V_{OUT}$=1.4V .

## Measuring Circuit

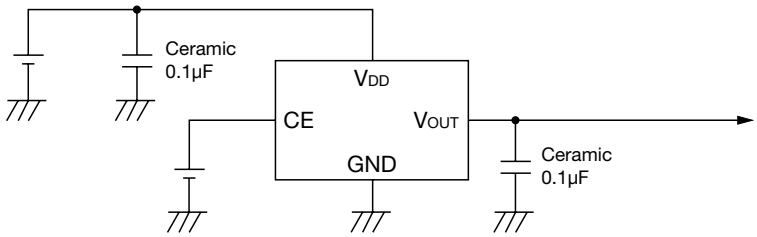



Basic Measuring Circuit




Reverse Current Measuring Circuit

## Application Circuit

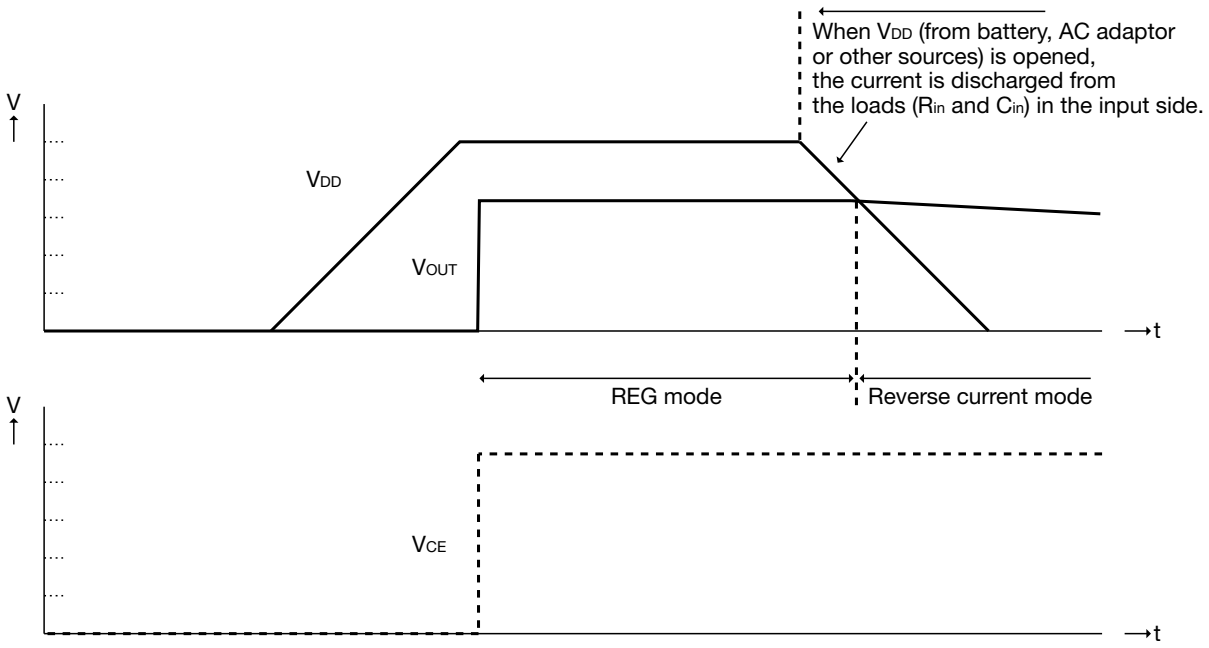



· Note

1. The output capacitor is required between output and GND to prevent oscillation.
2. 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 0.1μF and B temperature characteristics.
3. The wire of Vcc and GND is required to print full ground plane for noise and stability.
4. The input capacitor must be connected a distance of less than 1cm from input pin.
5. Be careful because it becomes easy to overshoot output voltage at the time of input voltage starting when an output capacitance is smaller than 0.47μF.

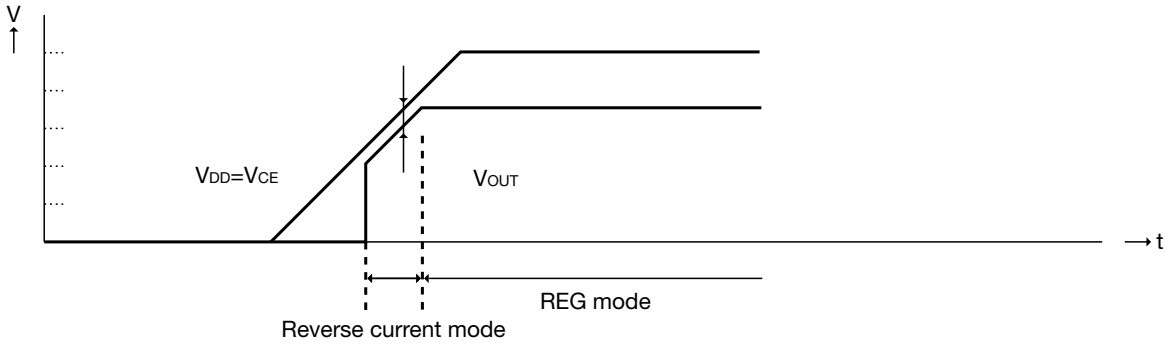
## Timing Chart

### 1) Reverse current mode




### 2) During the input voltage build-up

When $V_{CE}$ terminal is shorted to $V_{DD}$.

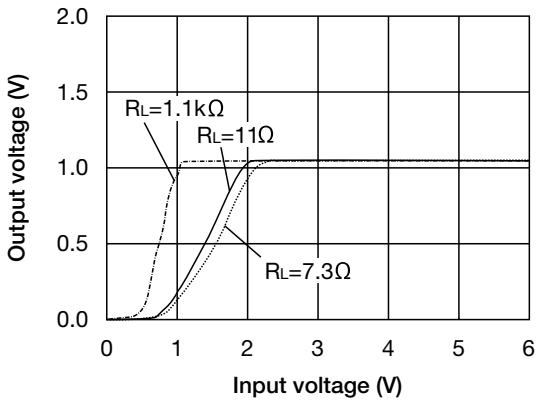



While voltage is building up in the input side,
this IC operates in the reverse current mode when
⊿V (Difference between input and output voltages)
is 30mV (Reverse current mode threshold voltage) or less.

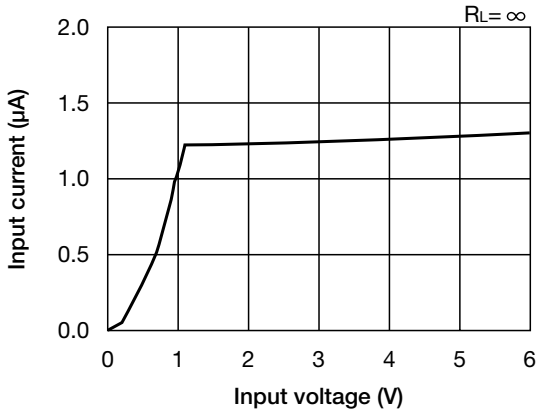
## Characteristics (Vo=1.1V)

(Except where noted otherwise Ta=25°C, $V_{DD}$=$V_{OUT}$ (typ.) +1V, $V_{CE}$=$V_{DD}$, Cin=0.1µF, Co=0.1µF)

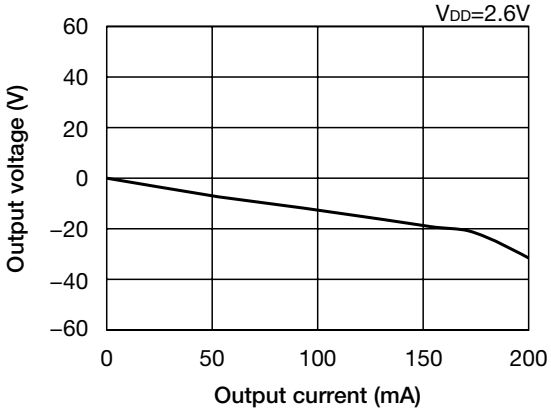
### Input voltage - Output voltage



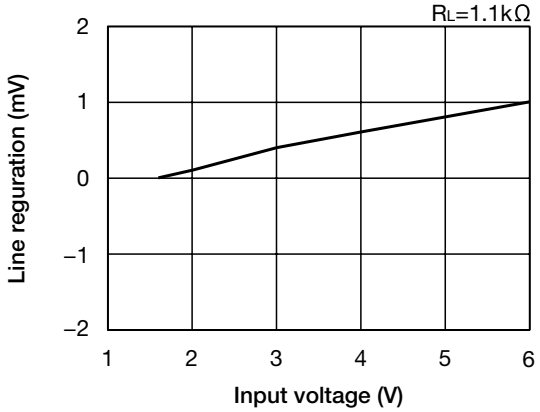

### Input current - Input voltage



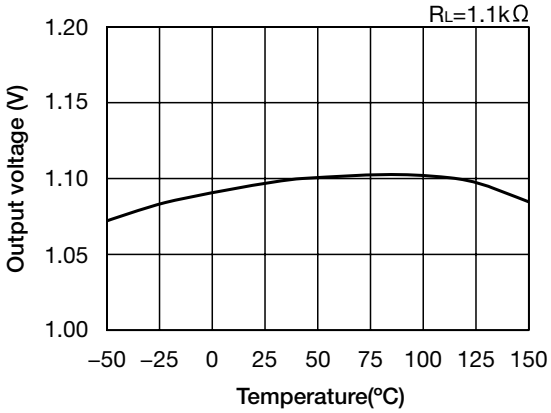

### Load regulation



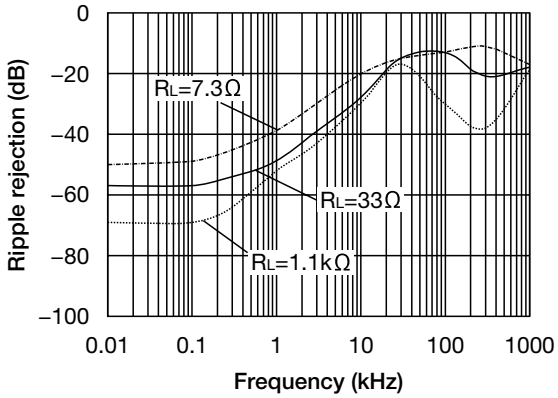

### Line regulation




### Temperature - output voltage



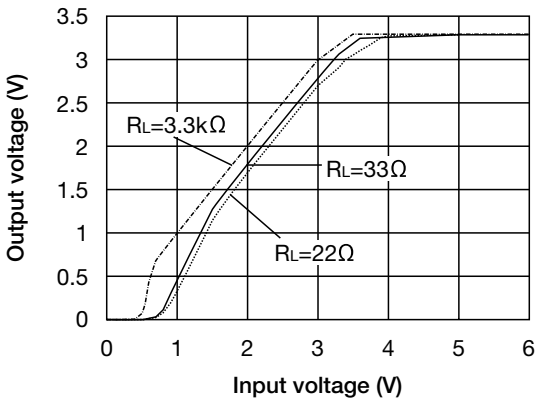

### Ripple rejection



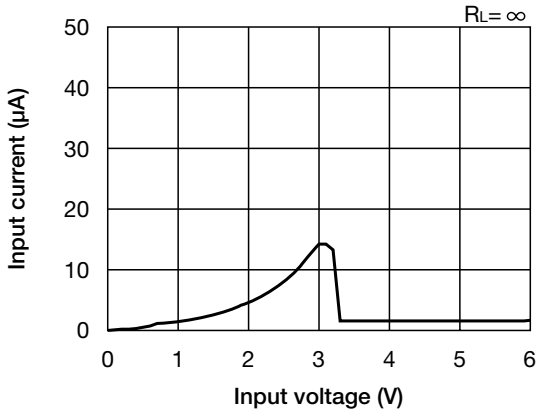
## Characteristics (Vo=3.3V)

(Except where noted otherwise Ta=25°C, $V_{DD}$=$V_{OUT}$ (typ.) +1V, $V_{CE}$=$V_{DD}$, Cin=0.1µF, Co=0.1µF)

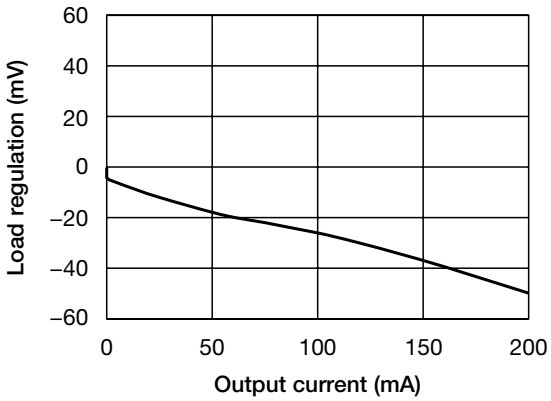
### Input voltage - Output voltage



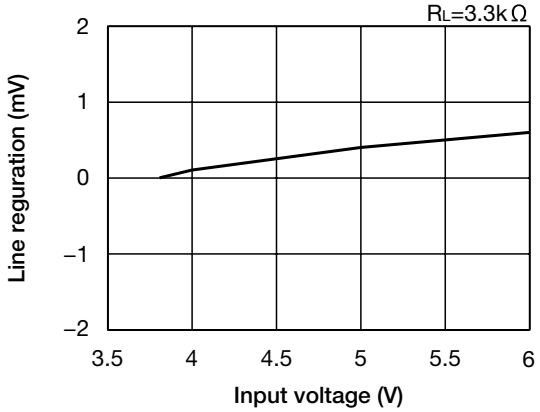

### Input current - Input voltage



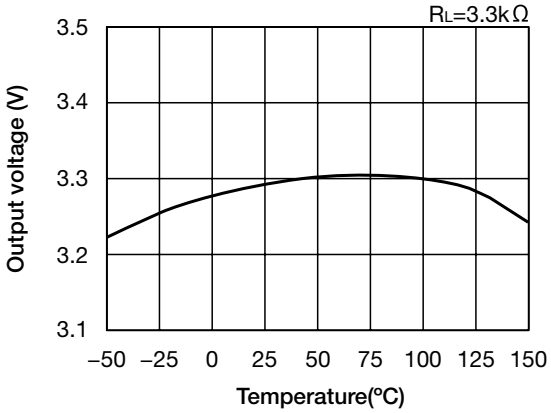

### Load regulation



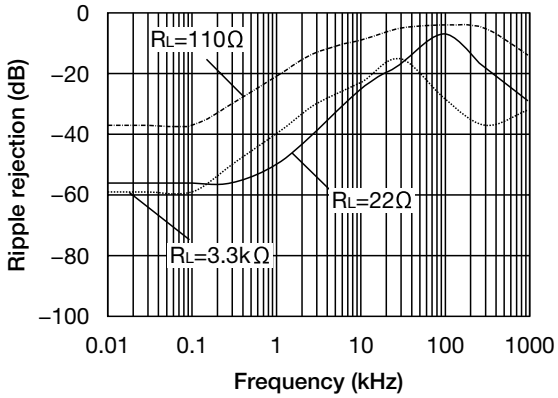

### Line regulation




### Temperature - output voltage



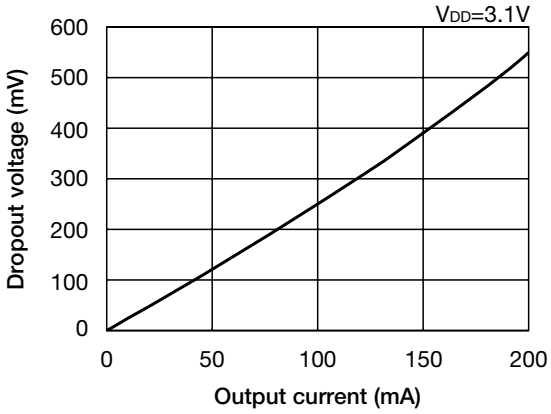

### Ripple rejection



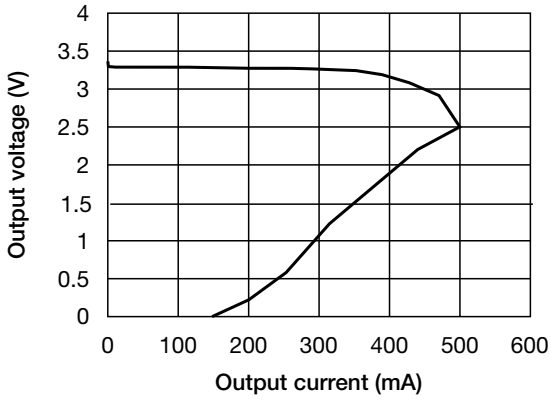
# Characteristics (Vo=3.3V)

(Except where noted otherwise Ta=25°C, $V_{DD}$=$V_{OUT}$ (typ.) +1V, $V_{CE}$=$V_{DD}$, Cin=0.1µF, Co=0.1µF)

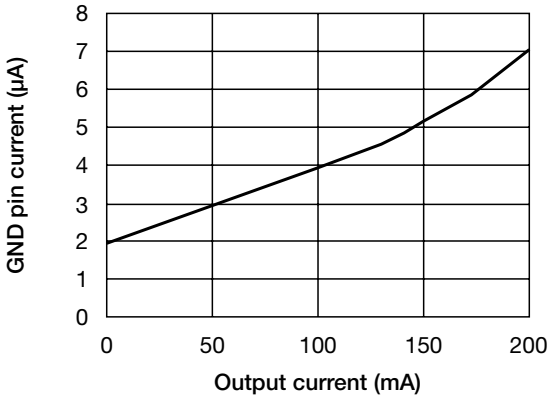
## Dropout voltage



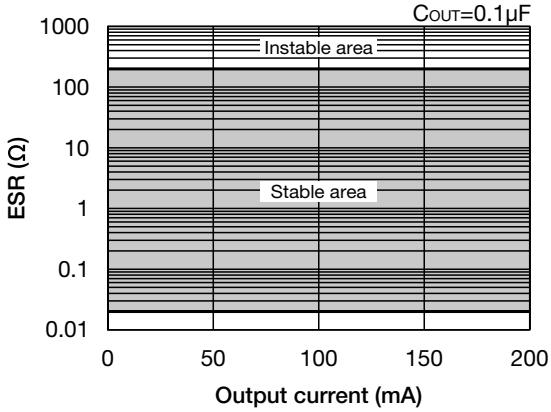

## Current limit



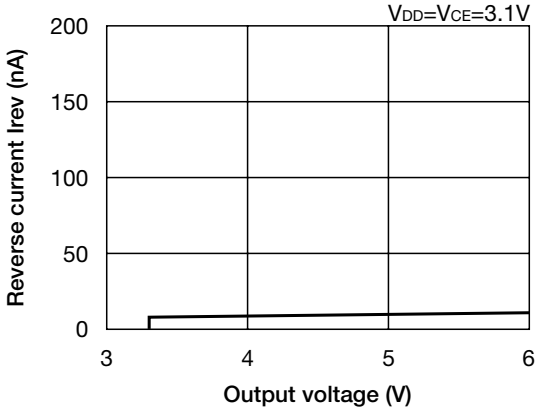

## GND pin current




## ESR stable area



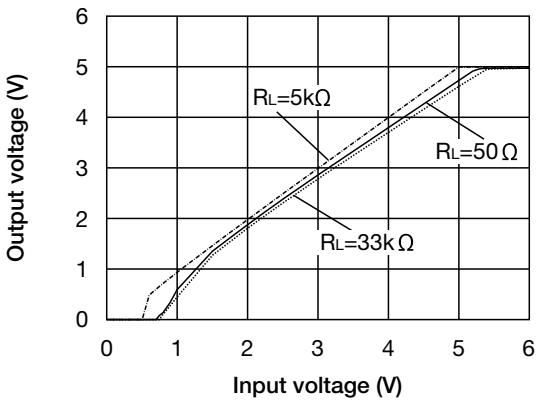

## Reverse current characteristics



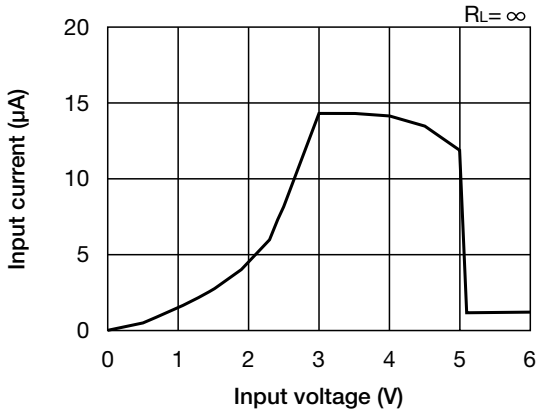
## Characteristics (Vo=5.0V)

(Except where noted otherwise Ta=25°C, $V_{DD}$=$V_{OUT}$ (typ.) +1V, $V_{CE}$=$V_{DD}$, Cin=0.1µF, Co=0.1µF)

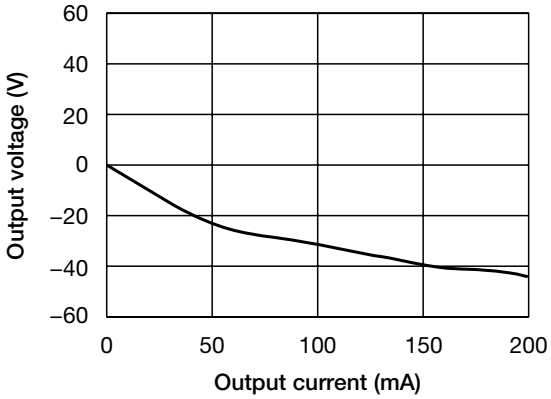
### Input voltage - Output voltage



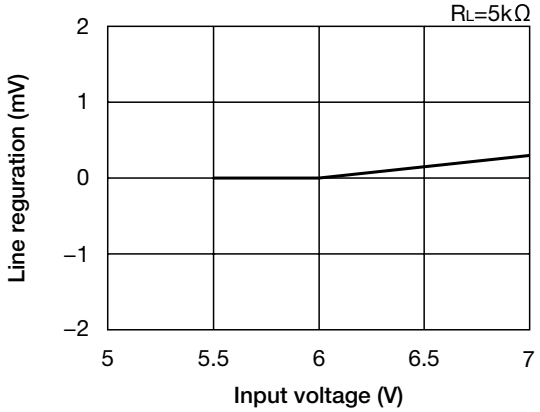

### Input current - Input voltage



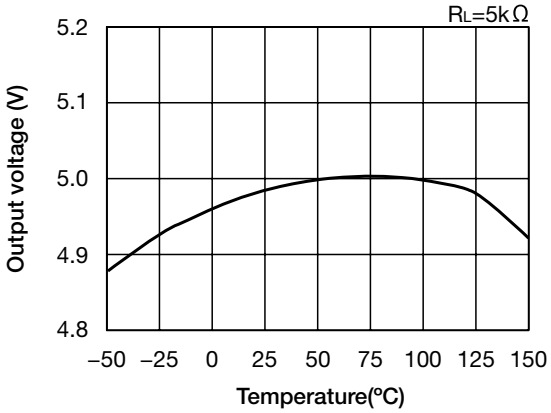

### Load regulation




### Line regulation




### Temperature - output voltage




### Ripple rejection