

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

October 2, 2003 V6

|                                   |                                                                       |
|-----------------------------------|-----------------------------------------------------------------------|
| ■ Low Power Consumption           | : 90 $\mu$ A (TYP.)                                                   |
| ■ Dropout Voltage                 | : 200mV @ 100mA<br>: 400mV @ 200mA                                    |
| ■ Maximum Output Current          | : more than 500mA (600mA limit)<br>( $2.5V \leq V_{ROUT} \leq 4.9V$ ) |
| ■ Highly Accurate                 | : $\pm 2\%$                                                           |
| ■ VR Setting Output Voltage Range | : 0.9V ~ 5.1V                                                         |
| ■ Detect Voltage Setting Range    | : 0.9V ~ 5.5V ( $V_{IN} : \geq 2.0V$ )                                |
| ■ Low ESR capacitor compatible    |                                                                       |

## ■ APPLICATIONS

- CD-ROM, CD-R/RW drive
- DVD drive
- HDD drive
- Cameras, Video recorders
- Portable AV equipment
- Battery powered equipment

## ■ GENERAL DESCRIPTION

The XC6405 series are precise, low noise, high speed, high current, positive voltage low dropout regulators with built-in voltage detector. They are fabricated using Torex's CMOS process. Performance features of the series includes high ripple rejection and low dropout voltage, and the series features a voltage reference, an error amplifier, a current limiter and a phase compensation circuit plus a driver transistor. Detect voltage is selectable in 100mV increments within the range of 0.9V to 5.5V and the LDO output voltage is selectable within a range of 0.9V to 5.1V, also in 100mV increments.

The series is also compatible with low ESR ceramic capacitors which give added output stability. This stability can be maintained even during load fluctuations due to the excellent transient response of the series.

The current limiter's foldback circuit also operates as a short circuit protection for the output current limiter and the output pin.

The series provides options to the user to select from a variety of circuit features, such as detector monitoring, detector output logic, CE and EN pin input logic, internal pull-up / down resistance, and power ready.

The IC's internal regulator circuit can be placed in stand-by mode via the EN function (XC6405 A to C series). The whole IC can be put in to stand-by mode via the CE function with the XC6405D series (semi-custom). In the stand-by mode, power consumption is greatly reduced. The XC6405 A and B series features the toggle operation function. The regulator output can be OFF when the XC6405B series detects voltage (semi-custom).

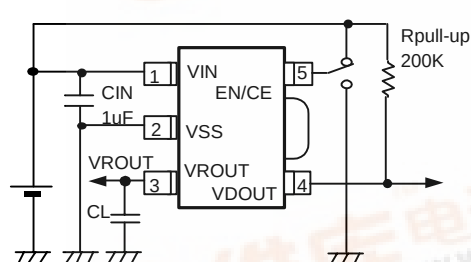
The XC6405E series can monitor another power source by using the VSEN pin (semi-custom).

The XC6405F series can delay the detector output: the delay time can be controlled by the use of an external capacitor (semi-custom).

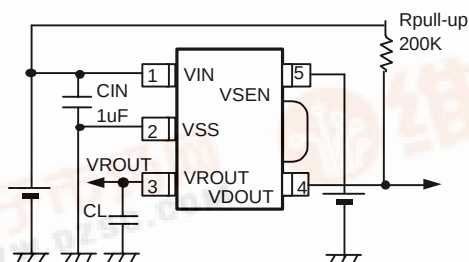
## ■ FEATURES

|                                 |                                                                        |
|---------------------------------|------------------------------------------------------------------------|
| Maximum Output Current          | more than 500mA<br>(600mA limit)<br>( $2.5V \leq V_{ROUT} \leq 4.9V$ ) |
| Dropout Voltage                 | 200mV ( $I_{ROUT}=100mA$ )                                             |
| Operating Voltage Range         | 2.0V ~ 6.0V                                                            |
| VR Setting Output Voltage Range | 0.9V ~ 5.1V<br>(100mV step, $\pm 2\%$ )                                |
| Detect Voltage Setting Range    | 0.9V ~ 5.5V<br>(100mV step, $\pm 2\%$ )                                |
|                                 | When monitoring VIN more than 2.0V                                     |
| VR.VD Temperature Coefficient   | $\pm 100ppm/^{\circ}C$ (TYP.)                                          |
| Low Power Consumption           | 90 $\mu$ A (TYP.)                                                      |
| High Ripple Rejection           | 65dB (@10kHz)                                                          |
| Ultra Small Packages            | SOT-25 (SOT-23-5)<br>SOT-89-5                                          |
| Operating Temperature Range     | - 40 ~ 85 $^{\circ}C$                                                  |
| Low ESR Capacitor Compatible    |                                                                        |

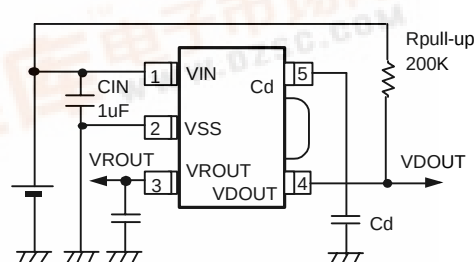
## ■ TYPICAL APPLICATION CIRCUITS



XC6405A ~ D Series



XC6405E Series

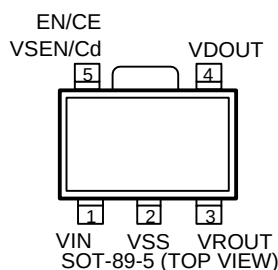
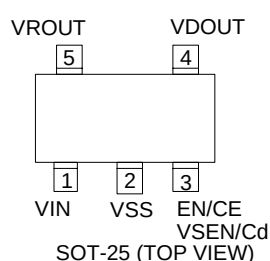


XC6405F Series

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## PIN CONFIGURATION



## PIN ASSIGNMENT

| PIN NUMBER |          | PIN NAME | FUNCTION                   |
|------------|----------|----------|----------------------------|
| SOT-25     | SOT-89-5 |          |                            |
| 1          | 1        | VIN      | Power Input                |
| 2          | 2        | VSS      | Ground                     |
| 3          | 5        | EN       | VR ON / OFF Control        |
| 3          | 5        | CE       | ON / OFF Control           |
| 3          | 5        | VSEN     | VD Monitoring              |
| 3          | 5        | Cd       | Delay Capacitor Connection |
| 4          | 4        | VDOUT    | VD Output                  |
| 5          | 3        | VROUT    | VR Output                  |

## SELECTION GUIDE

### 1. TOGGLE FUNCTION, VD SELF-SATURATION AS OPTION

| SERIES      | TOGGLE FUNCTION (BUILT-IN)                  |
|-------------|---------------------------------------------|
| XC6405A     | VD with Toggle Function                     |
| XC6405B     | VD with Toggle Function and Self-Saturation |
| XC6405C ~ F | VD with no Toggle Function                  |

### 2. STAND-BY MODE FUNCTION AS OPTION

| SERIES      | STAND-BY MODE FUNCTION         |
|-------------|--------------------------------|
| XC6405A ~ C | VR with Stand-by mode function |
| XC6405D     | Chip Stand-by mode function    |
| XC6405E, F  | No Stand-by mode function      |

### 3. CE / EN INPUT LOGIC, INTERNAL PULL-UP/DOWN AS OPTION (\* : A ~ D Series)

| SERIES         | CE INPUT LOGIC                |
|----------------|-------------------------------|
| XC6405 * A ~ D | Active HIGH with pull down    |
| XC6405 * E ~ K | Active HIGH with no pull down |
| XC6405 * L ~ P | Active LOW with pull up       |
| XC6405 * R ~ U | Active LOW with no pull up    |

### 4. VD SENSE AS OPTION (\* : A ~ D and F Series)

| SERIES                                | VD SENSE PIN |
|---------------------------------------|--------------|
| XC6405 * A, B, E, F, L, M, R, S, V, X | VIN          |
| XC6405 * C, D, H, K, N, P, T, U, Y, Z | VOUT         |
| XC6405 E V ~ Z                        | VSEN         |

### 5. VD OUTPUT LOGIC AS OPTION

| SERIES      | VD OUTPUT LOGIC FUNCTION |
|-------------|--------------------------|
| XC6405A ~ F | Detect L or Detect H     |

### 6. VD DELAY FUNCTION AS OPTION

| SERIES      | DELAY FUNCTION                         |
|-------------|----------------------------------------|
| XC6405A ~ E | No Delay                               |
| XC6405F     | Delay time adjustable by connecting Cd |

# XC6405 Series

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## ■ ORDERING INFORMATION

### XC6405 ①②③④⑤⑥

| PIN NUMBER | FUNCTION                                                                                                                                                                                                                                                        | PIN NUMBER | FUNCTION                                                                                         |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------------------|
| ①          | Optional Functions :<br>A : Toggle and EN Function (Preliminary *)<br>B : Toggle, EN Function,<br>VD signal/VR OFF function (Preliminary *)<br>C : EN Function (Preliminary *)<br>D : CE Function (Preliminary *)<br>E : VSEN Pin (Preliminary *)<br>F : Cd Pin | ⑤          | Packaging Types:<br><br>M : SOT-25<br><br>P : SOT-89-5                                           |
| ②          | Types :<br>As in the chart below.                                                                                                                                                                                                                               | ⑥          | Taping Direction:<br><br>R : Embossed Tape, Standard feed<br><br>L : Embossed Tape, Reverse feed |
| ③④         | Internally set sequential number relating to output voltage and detect voltage (refer to the chart on page 4.)<br><br>VR Setting Output Voltage Range : 0.9V ~ 5.1V<br>Detect Voltage Setting Range : 0.9V ~ 5.5V<br>100mV step increments are available        |            |                                                                                                  |

PIN NUMBER : ② Types

| ② | EN / CE FUNCTION | EN / CE LOGIC | PULL UP/DOWN RESISTANCE | VD SENSE PIN | VD OUTPUT LOGIC | PIN NUMBER ① |
|---|------------------|---------------|-------------------------|--------------|-----------------|--------------|
| A | Function         | Active HIGH   | Pull-down Function      | VIN          | Detect L        | A ~ D Series |
| B | Function         | Active HIGH   | Pull-down Function      | VIN          | Detect H        |              |
| C | Function         | Active HIGH   | Pull-down Function      | VROUT        | Detect L        |              |
| D | Function         | Active HIGH   | Pull-down Function      | VROUT        | Detect H        |              |
| E | Function         | Active HIGH   | Nonfunctional           | VIN          | Detect L        |              |
| F | Function         | Active HIGH   | Nonfunctional           | VIN          | Detect H        |              |
| H | Function         | Active HIGH   | Nonfunctional           | VROUT        | Detect L        |              |
| K | Function         | Active HIGH   | Nonfunctional           | VROUT        | Detect H        |              |
| L | Function         | Active LOW    | Pull-up Function        | VIN          | Detect L        |              |
| M | Function         | Active LOW    | Pull-up Function        | VIN          | Detect H        |              |
| N | Function         | Active LOW    | Pull-up Function        | VROUT        | Detect L        |              |
| P | Function         | Active LOW    | Pull-up Function        | VROUT        | Detect H        |              |
| R | Function         | Active LOW    | Nonfunctional           | VIN          | Detect L        |              |
| S | Function         | Active LOW    | Nonfunctional           | VIN          | Detect H        |              |
| T | Function         | Active LOW    | Nonfunctional           | VROUT        | Detect L        |              |
| U | Function         | Active LOW    | Nonfunctional           | VROUT        | Detect H        |              |
| V | Nonfunctional    | -             | -                       | VIN / VSEN   | Detect L        | E & F Series |
| X | Nonfunctional    | -             | -                       | VIN / VSEN   | Detect H        |              |
| Y | Nonfunctional    | -             | -                       | VROUT        | Detect L        | F Series     |
| Z | Nonfunctional    | -             | -                       | VROUT        | Detect H        |              |

\* The XC6405A, XC6405B, XC6405C, XC6405D, XC6405E series are under development. For further detail, please ask your sales contacts.

# XC6405 Series

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## ■ ORDERING INFORMATION

○ Pin Number    ③, ④    Type    (80 ~ 99 : Standard voltage products)

| ③ ④ | VROUT | VDOUT | ③ ④ | VROUT | VDOUT | ③ ④ | VROUT | VDOUT | ③ ④ | VROUT | VDOUT |
|-----|-------|-------|-----|-------|-------|-----|-------|-------|-----|-------|-------|
| 01  | 2.20  | 1.80  | 21  |       |       |     |       |       | 80  | 1.80  | 1.60  |
| 02  | 3.30  | 3.80  | 22  |       |       |     |       |       | 81  | 2.80  | 3.10  |
| 03  | 3.30  | 4.20  | 23  |       |       |     |       |       | 82  | 1.80  | 2.00  |
| 04  | 3.00  | 2.60  | 24  |       |       |     |       |       | 83  | 2.50  | 2.80  |
| 05  | 3.30  | 4.00  | 25  |       |       |     |       |       | 84  | 2.85  | 3.20  |
| 06  | 3.30  | 3.60  | 26  |       |       |     |       |       | 85  | 3.00  | 3.30  |
| 07  | 1.80  | 2.30  | 27  |       |       |     |       |       | 86  | 3.50  | 3.80  |
| 08  | 3.30  | 3.10  | 28  |       |       |     |       |       | 87  | 3.00  | 4.20  |
| 09  | 3.30  | 3.00  | 29  |       |       |     |       |       | 88  | 3.30  | 4.00  |
| 10  | 3.30  | 2.80  | 30  |       |       |     |       |       | 89  |       |       |
| 11  | 2.60  | 3.90  | 31  |       |       |     |       |       | 90  |       |       |
| 12  | 3.30  | 3.70  | 32  |       |       |     |       |       | 91  |       |       |
| 13  | 1.80  | 3.60  | 33  |       |       |     |       |       | 92  |       |       |
| 14  |       |       | 34  |       |       |     |       |       | 93  |       |       |
| 15  |       |       | 35  |       |       |     |       |       | 94  |       |       |
| 16  |       |       | 36  |       |       |     |       |       | 95  |       |       |
| 17  |       |       | 37  |       |       |     |       |       | 96  |       |       |
| 18  |       |       | 38  |       |       |     |       |       | 97  |       |       |
| 19  |       |       | 39  |       |       |     |       |       | 98  |       |       |
| 20  |       |       | 40  |       |       |     |       |       | 99  |       |       |

For the other voltages, please ask your sales contacts.

○ Ordering Example (Standard Products)

| PRODUCT NAME | PRODUCT DESCRIPTION                             | VOLTAGE |       |
|--------------|-------------------------------------------------|---------|-------|
|              |                                                 | VROUT   | VDOUT |
| XC6405CH80MR | EN function, Active HIGH, VROUT Sense, Detect L | 1.80    | 1.60  |
| XC6405CE81MR | EN function, Active HIGH, VIN Sense, Detect L   | 2.80    | 3.10  |
| XC6405DE82MR | CE function, Active HIGH, VIN Sense, Detect L   | 1.80    | 2.00  |
| XC6405DE83MR | CE function, Active HIGH, VIN Sense, Detect L   | 2.50    | 2.80  |
| XC6405DE84MR | CE function, Active HIGH, VIN Sense, Detect L   | 2.85    | 3.20  |
| XC6405DE85MR | CE function, Active HIGH, VIN Sense, Detect L   | 3.00    | 3.30  |
| XC6405DE86MR | CE function, Active HIGH, VIN Sense, Detect L   | 3.50    | 3.80  |
| XC6405FV87MR | Cd function, VIN Sense, Detect L                | 3.00    | 4.20  |
| XC6405FV88MR | Cd function, VIN Sense, Detect L                | 3.30    | 4.00  |
| XC6405DE89MR | CE function, Active HIGH, VIN Sense, Detect L   | 1.20    | 2.00  |
| XC6405DE90MR | CE function, Active HIGH, VIN Sense, Detect L   | 1.30    | 2.00  |
| XC6405DE91MR | CE function, Active HIGH, VIN Sense, Detect L   | 1.50    | 2.00  |

Except for the standard products, minimum ordering quantity is 15K.

# XC6405 Series

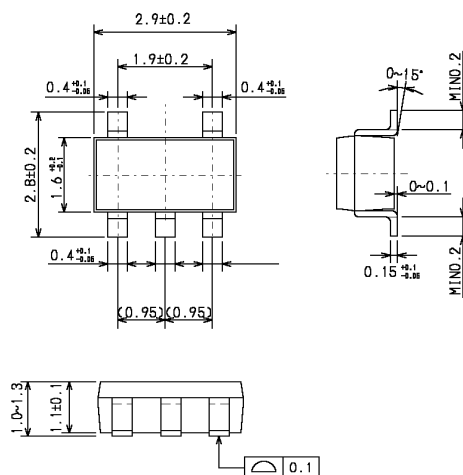
*High Current, High Speed LDO Regulators, Voltage Detector Function*

# XC6405 Series

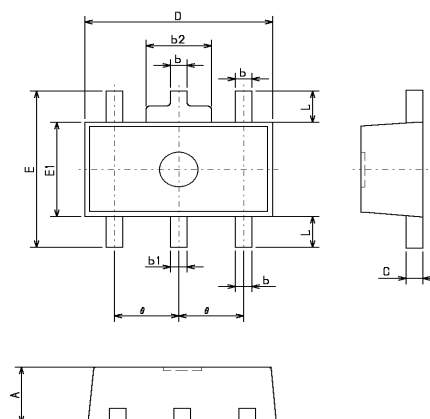
*High Current, High Speed LDO Regulators, Voltage Detector Function*

## ■ PACKAGING INFORMATION

○ SOT-25



○ SOT-89-5



| SYMBOLS | DIMENSIONS IN MILLIMETER |      |      |
|---------|--------------------------|------|------|
|         | MIN                      | NOM  | MAX  |
| A       | 1.40                     | 1.50 | 1.60 |
| b       | 0.36                     | 0.42 | 0.48 |
| b1      | 0.41                     | 0.47 | 0.53 |
| b2      | 1.40                     | 1.60 | 1.75 |
| C       | 0.38                     | 0.40 | 0.43 |
| D       | 4.40                     | 4.50 | 4.60 |
| E       | —                        | —    | 4.25 |
| E1      | 2.40                     | 2.50 | 2.60 |
| e       | 1.40                     | 1.50 | 1.60 |
| f       | 0.80                     | —    | —    |

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER                       | SYMBOL             | RATINGS              | UNITS |
|---------------------------------|--------------------|----------------------|-------|
| Input Voltage                   | VIN                | 7.0                  | V     |
| VR Output Current               | VRIOU              | 700                  | mA    |
| VR Output Voltage               | VROUT              | VSS -0.3 ~ VIN +0.3  | V     |
| VD Output Current               | VDIOU              | 50                   | mA    |
| VD Output Voltage               | VDOUT              | VSS -0.3 ~ 7.0       | V     |
| VCE / VSEN / Cd<br>Pin Voltage  | VCE /<br>VSEN / Cd | VSS -0.3 ~ VIN + 0.3 | V     |
| Continuous<br>Power Dissipation | SOT-25             | Pd                   | 250   |
|                                 | SOT-89-5           |                      | 500   |
| Operating Temperature Range     | Topr               | - 40 ~ + 85          | °C    |
| Storage Temperature Range       | Tstg               | - 55 ~ + 125         | °C    |

## ■ ELECTRICAL CHARACTERISTICS XC6405 Series

Ta=25°C

|                   | PARAMETER                                         | SYMBOL                                         | CONDITIONS                                                                                                                                               | MIN    | TYP           | MAX    | UNITS    | CIRCUIT |
|-------------------|---------------------------------------------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------|--------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage (note 2, 3)                     | VROUT(E)                                       | IROUT=30mA                                                                                                                                               | x 0.98 | VROUT(T)      | x 1.02 | V        | ①       |
|                   | VR Maximum Output Current<br>(0.9 ~ 2.4V product) | IROUTMAX                                       | VIN=VROUT(T)+2.0V                                                                                                                                        | 400    |               |        | mA       | ①       |
|                   | VR Maximum Output Current<br>(2.5 ~ 4.9V product) | IROUTMAX                                       | VIN=VROUT(T)+2.0V<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                        | 500    |               |        | mA       | ①       |
|                   | VR Load Regulation                                | ΔVROUT                                         | 1mA≤IROUT≤100mA                                                                                                                                          |        | 15            | 50     | mV       | ①       |
|                   | VR Dropout Voltage (note 4)                       | Vdif1                                          | IROUT=30mA                                                                                                                                               |        | E-1 (page 15) |        | mV       | ①       |
|                   |                                                   | Vdif2                                          | IROUT=100mA                                                                                                                                              |        | E-2 (page 15) |        | mV       | ①       |
|                   | Supply Current<br>(No Pull-up Resistor)           | IDD                                            | VIN=VEN=VROUT(T)+1.0V,<br>VROUT≤0.9V VIN=2.0V                                                                                                            |        | 90            | 145    | μA       | ②       |
|                   | Supply Current<br>(With Pull-up Resistor)         | IDD                                            | VIN=VEN=VROUT(T)+1.0V,<br>VROUT≤0.9V VIN=2.0V                                                                                                            |        | 100           | 165    | μA       | ②       |
|                   | VR Line Regulation                                | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$  | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |        | 0.01          | 0.20   | % / V    | ①       |
|                   | Input Voltage                                     | VIN                                            |                                                                                                                                                          | 2.0    |               | 6.0    | V        | -       |
|                   | VR Output Voltage<br>Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta Topr \cdot VROUT}$ | IROUT=30mA<br>-40°C≤Topr≤85°C                                                                                                                            |        | ±100          |        | ppm / °C | ①       |
|                   | VR Ripple Rejection Rate                          | PSRR                                           | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |        | 65            |        | dB       | ③       |
|                   | VR Current Limiter<br>(2.4V or less)              | IRlim                                          | VIN=VROUT(T)+2.0V                                                                                                                                        |        | 600           |        | mA       | ①       |
|                   | VR Current Limiter<br>(2.5V or more)              | IRlim                                          | VIN=VROUT(T)+2.0V<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                        | 500    | 600           |        | mA       | ①       |
|                   | Short-Circuit Current                             | IRshort                                        | VIN=VROUT(T)+2.0V<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                        |        | 50            |        | mA       | ①       |

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

### XC6405 Series

Ta=25°C

|                                     | PARAMETER                                     | SYMBOL                                        | CONDITIONS                                                                         | MIN                              | TYP                                  | MAX                                  | UNITS    | CIRCUIT |
|-------------------------------------|-----------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------|----------------------------------|--------------------------------------|--------------------------------------|----------|---------|
| VOLTAGE DETECTOR                    | VD Detect Voltage (note 7, 8)                 | VDF (E)                                       |                                                                                    | x 0.98                           | VDF (T)                              | x 1.02                               | V        | ④       |
|                                     | VD Hysteresis Range (note 7)                  | VHYS                                          |                                                                                    | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                    | VDF (T)<br>x 0.08                    | V        | ④       |
|                                     | VD Supply Current                             | IDDVD                                         | VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                 |                                  | 10.0<br>12.0<br>14.5<br>17.5<br>19.0 | 19.0<br>20.0<br>24.0<br>26.0<br>29.0 | μA       | ②       |
|                                     | VD Output Current (note 9)                    | IDOUT                                         | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0   |                                      | mA       | ⑤       |
|                                     | VD Detect Voltage Temperature Characteristics | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$ | -40°C ≤ Topr ≤ 85°C                                                                |                                  | ±100                                 |                                      | ppm / °C | ④       |
| <b>SWITCH (NO PULL-UP RESISTOR)</b> |                                               |                                               |                                                                                    |                                  |                                      |                                      |          |         |
|                                     | CE/EN "High" Level Voltage                    | VCE/EN H                                      |                                                                                    | 1.60                             |                                      | VIN                                  | V        | ①       |
|                                     | CE/EN "Low" Level Voltage                     | VCE/EN L                                      |                                                                                    |                                  |                                      | 0.25                                 | V        | ①       |
|                                     | CE/EN "High" Level Current                    | ICE/EN H                                      | VCE/EN=VIN=VROUT(T)+1.0V                                                           | -0.10                            |                                      | 20                                   | μA       | ②       |
|                                     | CE/EN "Low" Level Current                     | ICE/EN L                                      | VIN=VROUT(T)+1.0V, VCE/EN=VSS                                                      | -0.10                            |                                      | 0.10                                 | μA       | ②       |
| <b>OPTION</b>                       |                                               |                                               |                                                                                    |                                  |                                      |                                      |          |         |
|                                     | Delay Resistance                              | Rdelay                                        | VIN=6.0V<br>Delay Resistance=6.0V/Delay Current                                    | 300                              | 500                                  | 700                                  | kΩ       | ⑥       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4)  $V_{dif} = \{VIN1^{(NOTE6)} - VROUT1^{(NOTE5)}\}$

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(NOTE 9) VD Output Current value of Detect 'L' type equal to current value during detection

and that of Detect 'H' type equal to current value before detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

XC6405 AA / AD / AE / AH Series

Ta=25°C

|                   | PARAMETER                                      | SYMBOL                                            | CONDITIONS                                                                                                                                               | MIN                              | TYP                                | MAX                                  | UNITS    | CIRCUIT |
|-------------------|------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------|--------------------------------------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage (note 2, 3)                  | VROUT(E)                                          | IROUT=30mA                                                                                                                                               | x 0.98                           | VROUT(T)                           | x 1.02                               | V        | ①       |
|                   | VR Maximum Output Current (0.9 ~ 2.4V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V                                                                                                                                        | 400                              |                                    |                                      | mA       | ①       |
|                   | VR Maximum Output Current (2.5 ~ 4.9V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              |                                    |                                      | mA       | ①       |
|                   | VR Load Regulation                             | ΔVROUT                                            | 1mA≤IROUT≤100mA                                                                                                                                          |                                  | 15                                 | 50                                   | mV       | ①       |
|                   | VR Dropout Voltage (note 4)                    | Vdif1                                             | IROUT=30mA                                                                                                                                               | E-1 (page 15)                    |                                    |                                      | mV       | ①       |
|                   |                                                | Vdif2                                             | IROUT=100mA                                                                                                                                              | E-2 (page 15)                    |                                    |                                      | mV       | ①       |
|                   | Supply Current (AA / AD Series)                | IDD                                               | VIN=VEN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.0V                                                                                                      |                                  | 90                                 | 145                                  | μA       | ②       |
|                   | Supply Current (AE / AH Series)                | IDD                                               | VIN=VEN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.1V                                                                                                      |                                  | 100                                | 165                                  | μA       | ②       |
|                   | VR Line Regulation                             | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$     | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |                                  | 0.01                               | 0.20                                 | % / V    | ①       |
|                   | Input Voltage                                  | VIN                                               |                                                                                                                                                          | 2.0                              |                                    | 6.0                                  | V        |         |
|                   | VR Output Voltage Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta T_{opr} \cdot VROUT}$ | IROUT=30mA<br>-40°C≤T <sub>opr</sub> ≤85°C                                                                                                               |                                  | ±100                               |                                      | ppm / °C | ①       |
|                   | VR Ripple Rejection Rate                       | PSRR                                              | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |                                  | 65                                 |                                      | dB       | ③       |
|                   | VR Current Limiter (2.4V or less)              | IRlim                                             | VIN=VROUT(T)+2.0V                                                                                                                                        |                                  | 600                                |                                      | mA       | ①       |
|                   | VR Current Limiter (2.5V or more)              | IRlim                                             | VIN=VROUT(T)+2.0V<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                        | 500                              | 600                                |                                      | mA       | ①       |
|                   | Short-circuit Current                          | IRshort                                           | VIN=VROUT(T)+2.0V<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                        |                                  | 50                                 |                                      | mA       | ①       |
| VOLTAGE DETECTOR  | VD Detect Voltage (note 7, 8)                  | VDF (E)                                           |                                                                                                                                                          | x 0.98                           | VDF (T)                            | x 1.02                               | V        | ④       |
|                   | VD Hysteresis Range (note 8)                   | VHYS                                              |                                                                                                                                                          | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                  | VDF (T)<br>x 0.08                    | V        | ④       |
|                   | VD Supply Current (note 9)                     | IDDVD                                             | VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                                       |                                  | 6.5<br>7.0<br>7.5<br>8.0<br>9.0    | 19.0<br>20.0<br>24.0<br>26.0<br>29.0 | μA       | ②       |
|                   | VD Output Current (note 10)                    | IDOUT                                             | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                       | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0 |                                      | mA       | ⑤       |
|                   | VD Detect Voltage Temperature Characteristics  | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$     | -40°C≤T <sub>opr</sub> ≤85°C                                                                                                                             |                                  | ±100                               |                                      | ppm / °C | ④       |



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ ELECTRICAL CHARACTERISTICS (Continued)

XC6405 AA / AD / AE / AH Series

Ta=25°C

|               | PARAMETER                                   | SYMBOL | CONDITIONS                 | MIN   | TYP | MAX  | UNITS | CIRCUIT |
|---------------|---------------------------------------------|--------|----------------------------|-------|-----|------|-------|---------|
| <b>SWITCH</b> |                                             |        |                            |       |     |      |       |         |
|               | EN "High" Level Voltage                     | VEN H  |                            | 1.60  |     | VIN  | V     | ①       |
|               | EN "Low" Level Voltage                      | VEN L  |                            |       |     | 0.25 | V     | ①       |
|               | EN "High" Level Current<br>(AA / AD Series) | IEN H  | VEN=VIN=VROUT(T)+1.0V      | -0.10 |     | 20   | μA    | ②       |
|               | EN "High" Level Current<br>(AE /AH Series)  | IEN H  | VEN=VIN=VROUT(T)+1.0V      | -0.10 |     | 0.10 | μA    | ②       |
|               | EN "Low" Level Current                      | IEN L  | VIN=VROUT(T)+1.0V, VEN=VSS | -0.10 |     | 0.10 | μA    | ②       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4)  $V_{dif} = \{VIN1^{(NOTE6)} - VROUT1^{(NOTE5)}\}$

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(NOTE 9) VD Supply Current = Supply Current when VEN=VSS

(NOTE 10) VD Output Current = Sink Current during detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

### XC6405 CA / CD / CE / CH Series

Ta=25°C

|                   | PARAMETER                                      | SYMBOL                                            | CONDITIONS                                                                                                                                               | MIN                              | TYP                                | MAX                                  | UNITS    | CIRCUIT |
|-------------------|------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------|--------------------------------------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage (note 2, 3)                  | VROUT(E)                                          | IROUT=30mA                                                                                                                                               | x 0.98                           | VROUT(T)                           | x 1.02                               | V        | ①       |
|                   | VR Maximum Output Current (0.9 ~ 2.4V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V                                                                                                                                        | 400                              |                                    |                                      | mA       | ①       |
|                   | VR Maximum Output Current (2.5 ~ 4.9V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              |                                    |                                      | mA       | ①       |
|                   | VR Load Regulation                             | ΔVROUT                                            | 1mA≤IROUT≤100mA                                                                                                                                          |                                  | 15                                 | 50                                   | mV       | ①       |
|                   | VR Dropout Voltage (note 4)                    | Vdif1                                             | IROUT=30mA                                                                                                                                               | E-1 (page 15)                    |                                    |                                      | mV       | ①       |
|                   |                                                | Vdif2                                             | IROUT=100mA                                                                                                                                              | E-2 (page 15)                    |                                    |                                      | mV       | ①       |
|                   | Supply Current (CA / CD Series)                | IDD                                               | VIN=VEN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.0V                                                                                                      |                                  | 90                                 | 145                                  | μA       | ②       |
|                   | Supply Current (CE / CH Series)                | IDD                                               | VIN=VEN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.0V                                                                                                      |                                  | 100                                | 165                                  | μA       | ②       |
|                   | VR Line Regulation                             | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$     | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |                                  | 0.01                               | 0.20                                 | % / V    | ①       |
|                   | Input Voltage                                  | VIN                                               |                                                                                                                                                          | 2.0                              |                                    | 6.0                                  | V        |         |
|                   | VR Output Voltage Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta T_{opr} \cdot VROUT}$ | IROUT=30mA<br>-40°C≤T <sub>opr</sub> ≤85°C                                                                                                               |                                  | ±100                               |                                      | ppm / °C | ①       |
|                   | VR Ripple Rejection Rate                       | PSRR                                              | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |                                  | 65                                 |                                      | dB       | ③       |
|                   | VR Current Limiter (2.4V or less)              | IRlim                                             | VIN=VROUT(T)+2.0V                                                                                                                                        |                                  | 600                                |                                      | mA       | ①       |
|                   | VR Current Limiter (2.5V or more)              | IRlim                                             | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              | 600                                |                                      | mA       | ①       |
|                   | Short-Circuit Current                          | IRshort                                           | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       |                                  | 50                                 |                                      | mA       | ①       |
| VOLTAGE DETECTOR  | VD Detect Voltage (note 7, 8)                  | VDF (E)                                           |                                                                                                                                                          | x 0.98                           | VDF (T)                            | x 1.02                               | V        | ④       |
|                   | VD Hysteresis Range (note 8)                   | VHYS                                              |                                                                                                                                                          | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                  | VDF (T)<br>x 0.08                    | V        | ④       |
|                   | VD Supply Current (note 9)                     | IDDVD                                             | VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                                       |                                  | 6.5<br>7.0<br>7.5<br>8.0<br>9.0    | 19.0<br>20.0<br>24.0<br>26.0<br>29.0 | μA       | ②       |
|                   | VD Output Current (note 10)                    | IDOUT                                             | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                       | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0 |                                      | mA       | ⑤       |
|                   | VD Detect Voltage Temperature Characteristics  | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$     | -40°C≤T <sub>opr</sub> ≤85°C                                                                                                                             |                                  | ±100                               |                                      | ppm / °C | ④       |

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ ELECTRICAL CHARACTERISTICS (Continued)

### XC6405 CA / CD / CE / CH Series

Ta=25°C

|               | PARAMETER                                   | SYMBOL | CONDITIONS                 | MIN   | TYP | MAX  | UNITS | CIRCUIT |
|---------------|---------------------------------------------|--------|----------------------------|-------|-----|------|-------|---------|
| <b>SWITCH</b> |                                             |        |                            |       |     |      |       |         |
|               | EN "High" Level Voltage                     | VEN H  |                            | 1.6   |     | VIN  | V     | ①       |
|               | EN "Low" Level Voltage                      | VEN L  |                            |       |     | 0.25 | V     | ①       |
|               | EN "High" Level Current<br>(CA / CD Series) | IEN H  | VEN=VIN=VROUT(T)+1.0V      | -0.10 |     | 20   | μA    | ②       |
|               | EN "High" Level Current<br>(CE /CH Series)  | IEN H  | VEN=VIN=VROUT(T)+1.0V      | -0.10 |     | 0.10 | μA    | ②       |
|               | EN "Low" Level Current                      | IEN L  | VIN=VROUT(T)+1.0V, VEN=VSS | -0.10 |     | 0.10 | μA    | ②       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4)  $V_{dif} = \{VIN1^{(NOTE6)} - VROUT1^{(NOTE5)}\}$

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(NOTE 9) VD Supply Current = Supply Current when VEN=VSS

(NOTE 10) VD Output Current = Sink Current during detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

### XC6405 DA / DD / DE / DH Series

Ta=25°C

|                   | PARAMETER                                      | SYMBOL                                            | CONDITIONS                                                                                                                                               | MIN                              | TYP                                | MAX               | UNITS    | CIRCUIT |
|-------------------|------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------|-------------------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage (note 2, 3)                  | VROUT(E)                                          | IROUT=30mA                                                                                                                                               | x 0.98                           | VROUT(T)                           | x 1.02            | V        | ①       |
|                   | VR Maximum Output Current (0.9 ~ 2.4V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V                                                                                                                                        | 400                              |                                    |                   | mA       | ①       |
|                   | VR Maximum Output Current (2.5 ~ 4.9V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V, When VROUT(T)≥4.0V, VIN=6.0V                                                                                                          | 500                              |                                    |                   | mA       | ①       |
|                   | VR Load Regulation                             | ΔVROUT                                            | 1mA≤IROUT≤100mA                                                                                                                                          |                                  | 15                                 | 50                | mV       | ①       |
|                   | VR Dropout Voltage (note 4)                    | Vdif1                                             | IROUT=30mA                                                                                                                                               | E-1 (page 15)                    |                                    |                   | mV       | ①       |
|                   |                                                | Vdif2                                             | IROUT=100mA                                                                                                                                              | E-2 (page 15)                    |                                    |                   | mV       | ①       |
|                   | Supply Current (DA / DD Series)                | IDD                                               | VIN=VCE=VROUT(T)+1.0V, When VROUT≤0.9V, VIN=2.0V                                                                                                         |                                  | 90                                 | 145               | μA       | ②       |
|                   | Supply Current (DE / DH Series)                | IDD                                               | VIN=VCE=VROUT(T)+1.0V, When VROUT≤0.9V, VIN=2.0V                                                                                                         |                                  | 100                                | 165               | μA       | ②       |
|                   | Stand-by Current (DA / DD / DE / DH Series)    | IDD                                               | VIN=VROUT(T)+1.0V, VCE=0V, When VROUT≤0.9V, VIN=2.0V                                                                                                     |                                  | 0.01                               | 0.10              | % / V    | ②       |
|                   | VR Line Regulation                             | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$     | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |                                  | 0.01                               | 0.20              | % / V    | ①       |
|                   | Input Voltage                                  | VIN                                               |                                                                                                                                                          | 2.0                              |                                    | 6.0               | V        |         |
|                   | VR Output Voltage Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta T_{opr} \cdot VROUT}$ | IROUT=30mA<br>-40°C≤T <sub>opr</sub> ≤85°C                                                                                                               |                                  | ±100                               |                   | ppm / °C | ①       |
|                   | VR Ripple Rejection Rate                       | PSRR                                              | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |                                  | 65                                 |                   | dB       | ③       |
|                   | VR Current Limiter (2.4V or less)              | IRlim                                             | VIN=VROUT(T)+2.0V                                                                                                                                        |                                  | 600                                |                   | mA       | ①       |
|                   | VR Current Limiter (2.5V or more)              | IRlim                                             | VIN=VROUT(T)+2.0V, When VROUT(T)≥4.0V, VIN=6.0V                                                                                                          | 500                              | 600                                |                   | mA       | ①       |
|                   | Short-Circuit Current                          | IRshort                                           | VIN=VROUT(T)+2.0V, When VROUT(T)≥4.0V, VIN=6.0V                                                                                                          |                                  | 50                                 |                   | mA       | ①       |
| VOLTAGE DETECTOR  | VD Detect Voltage (note 7, 8)                  | VDF (E)                                           |                                                                                                                                                          | x 0.98                           | VDF (T)                            | x 1.02            | V        | ④       |
|                   | VD Hysteresis Range (note 8)                   | VHYS                                              |                                                                                                                                                          | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                  | VDF (T)<br>x 0.08 | V        | ④       |
|                   | VD Output Current (note 9)                     | IDOUT                                             | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                       | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0 |                   | mA       | ⑤       |
|                   | VD Detect Voltage Temperature Characteristics  | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$     | -40°C≤T <sub>opr</sub> ≤85°C                                                                                                                             |                                  | ±100                               |                   | ppm / °C | ④       |
|                   |                                                |                                                   |                                                                                                                                                          |                                  |                                    |                   |          |         |
| SWITCH            | CE "High" Level Voltage                        | VCE H                                             |                                                                                                                                                          | 1.6                              |                                    | VIN               | V        | ①       |
|                   | CE "Low" Level Voltage                         | VCE L                                             |                                                                                                                                                          |                                  |                                    | 0.25              | V        | ①       |
|                   | CE "High" Level Current (DA / DD Series)       | ICE H                                             | VCE=VIN=VROUT(T)+1.0V                                                                                                                                    | -0.10                            |                                    | 20                | μA       | ②       |
|                   | CE "High" Level Current (DE / DH Series)       | ICE H                                             | VCE=VIN=VROUT(T)+1.0V                                                                                                                                    | -0.10                            |                                    | 0.10              | μA       | ②       |
|                   | CE "Low" Level Current                         | ICE L                                             | VIN=VROUT(T)+1.0V, VCE=VSS                                                                                                                               | -0.10                            |                                    | 0.10              | μA       | ②       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4) Vdif={VIN1<sup>(NOTE6)(NOTE5)</sup>}

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(NOTE 9) VD Output Current = Sink Current during detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

XC6405 EV / EX Series

Ta=25°C

|                   | PARAMETER                                         | SYMBOL                                            | CONDITIONS                                                                                                                                               | MIN                              | TYP                                | MAX               | UNITS    | CIRCUIT |
|-------------------|---------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------|-------------------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage                                 | VROUT(E)                                          | IROUT=30mA                                                                                                                                               | x 0.98                           | VROUT(T)                           | x 1.02            | V        | ①       |
|                   | VR Maximum Output Current<br>(0.9 ~ 2.4V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V                                                                                                                                        | 400                              |                                    |                   | mA       | ①       |
|                   | VR Maximum Output Current<br>(2.5 ~ 4.9V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              |                                    |                   | mA       | ①       |
|                   | VR Load Regulation                                | ΔVROUT                                            | 1mA≤IROUT≤100mA                                                                                                                                          |                                  | 15                                 | 50                | mV       | ①       |
|                   | VR Dropout Voltage                                | Vdif1                                             | IROUT=30mA                                                                                                                                               | E-1 (page 15)                    |                                    |                   | mV       | ①       |
|                   |                                                   | Vdif2                                             | IROUT=100mA                                                                                                                                              | E-2 (page 15)                    |                                    |                   | mV       | ①       |
|                   | Supply Current<br>(EV / EX Series)                | IDD                                               | VIN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.0V                                                                                                          |                                  | 90                                 | 145               | μA       | ②       |
|                   | VR Line Regulation                                | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$     | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |                                  | 0.01                               | 0.20              | % / V    | ①       |
|                   | Input Voltage                                     | VIN                                               |                                                                                                                                                          | 2.0                              |                                    | 6.0               | V        |         |
|                   | VR Output Voltage<br>Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta T_{opr} \cdot VROUT}$ | IROUT=30mA<br>-40°C≤T <sub>opr</sub> ≤85°C                                                                                                               |                                  | ±100                               |                   | ppm / °C | ①       |
|                   | Ripple Rejection Rate                             | PSRR                                              | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |                                  | 65                                 |                   | dB       | ③       |
|                   | VR Current Limiter<br>(2.4V or less)              | IRlim                                             | VIN=VROUT(T)+2.0V                                                                                                                                        |                                  | 600                                |                   | mA       | ①       |
|                   | VR Current Limiter<br>(2.5V or more)              | IRlim                                             | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              | 600                                |                   | mA       | ①       |
|                   | Short-Circuit Current                             | IRshort                                           | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       |                                  | 50                                 |                   | mA       | ①       |
| VOLTAGE DETECTOR  | VD Detect Voltage                                 | VDF (E)                                           |                                                                                                                                                          | x 0.98                           | VDF (T)                            | x 1.02            | V        | ④       |
|                   | VD Hysteresis Range                               | VHYS                                              |                                                                                                                                                          | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                  | VDF (T)<br>x 0.08 | V        | ④       |
|                   | VD Output Current<br>(note 9)                     | IDOUT                                             | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                       | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0 |                   | mA       | ⑤       |
|                   | VD Detect Voltage<br>Temperature Characteristics  | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$     | -40°C≤T <sub>opr</sub> ≤85°C                                                                                                                             |                                  | ±100                               |                   | ppm / °C | ④       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4) Vdif=[VIN1<sup>(NOTE6)</sup>-VROUT1<sup>(NOTE5)</sup>]

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) less than 1.5V.

(NOTE 9) VD Output Current = Sink Current during detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ELECTRICAL CHARACTERISTICS (Continued)

XC6405 FV / FX / FY / FZ Series

Ta=25°C

|                   | PARAMETER                                      | SYMBOL                                            | CONDITIONS                                                                                                                                               | MIN                              | TYP                                | MAX               | UNITS    | CIRCUIT |
|-------------------|------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------|-------------------|----------|---------|
| VOLTAGE REGULATOR | VR Output Voltage (note 2, 3)                  | VROUT(E)                                          | IROUT=30mA                                                                                                                                               | x 0.98                           | VROUT(T)                           | x 1.02            | V        | ①       |
|                   | VR Maximum Output Current (0.9 ~ 2.4V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V                                                                                                                                        | 400                              |                                    |                   | mA       | ①       |
|                   | VR Maximum Output Current (2.5 ~ 4.9V product) | IROUTMAX                                          | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              |                                    |                   | mA       | ①       |
|                   | VR Load Regulation                             | ΔVROUT                                            | 1mA≤IROUT≤100mA                                                                                                                                          |                                  | 15                                 | 50                | mV       | ①       |
|                   | VR Dropout Voltage (note 4)                    | Vdif1                                             | IROUT=30mA                                                                                                                                               | E-1 (page 15)                    |                                    |                   | mV       | ①       |
|                   |                                                | Vdif2                                             | IROUT=100mA                                                                                                                                              | E-2 (page 15)                    |                                    |                   | mV       | ①       |
|                   | Supply Current (FV / FX / FY / FZ Series)      | IDD                                               | VIN=VROUT(T)+1.0V,<br>When VROUT≤0.9V, VIN=2.0V                                                                                                          |                                  | 90                                 | 145               | μA       | ②       |
|                   | VR Line Regulation                             | $\frac{\Delta VROUT}{\Delta VIN \cdot VROUT}$     | VROUT(T)+1.0V≤VIN≤6.0V<br>When VROUT≤0.9V, 2.0V≤VIN≤6.0V<br>IROUT=30mA<br>When VROUT≤1.75V, IROUT=10mA                                                   |                                  | 0.01                               | 0.20              | % / V    | ①       |
|                   | Input Voltage                                  | VIN                                               |                                                                                                                                                          | 2.0                              |                                    | 6.0               | V        |         |
|                   | VR Output Voltage Temperature Characteristics  | $\frac{\Delta VROUT}{\Delta T_{opr} \cdot VROUT}$ | IROUT=30mA<br>-40°C≤Topr≤85°C                                                                                                                            |                                  | ±100                               |                   | ppm / °C | ①       |
|                   | Ripple Rejection Rate                          | PSRR                                              | VIN=[VROUT(T)+1.0]V+0.5Vp-pAC<br>When VROUT(T) ≤ 1.25V<br>⇒ VIN=2.25V+0.5Vp-pAC<br>When VROUT(T) ≥ 4.75V<br>⇒ VIN=5.75V+0.5Vp-pAC<br>IROUT=50mA, f=10kHz |                                  | 65                                 |                   | dB       | ③       |
|                   | VR Current Limiter (2.4V or less)              | IRlim                                             | VIN=VROUT(T)+2.0V                                                                                                                                        |                                  | 600                                |                   | mA       | ①       |
|                   | VR Current Limiter (2.5V or more)              | IRlim                                             | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       | 500                              | 600                                |                   | mA       | ①       |
|                   | Short-Circuit Current                          | IRshort                                           | VIN=VROUT(T)+2.0V,<br>When VROUT(T)≥4.0V, VIN=6.0V                                                                                                       |                                  | 50                                 |                   | mA       | ①       |
| VOLTAGE DETECTOR  | VD Detect Voltage (note 7, 8)                  | VDF (E)                                           |                                                                                                                                                          | x 0.98                           | VDF (T)                            | x 1.02            | V        | ④       |
|                   | VD Hysteresis Range (note 8)                   | VHYS                                              |                                                                                                                                                          | VDF (T)<br>x 0.02                | VDF (T)<br>x 0.05                  | VDF (T)<br>x 0.08 | V        | ④       |
|                   | VD Output Current (note 9)                     | IDOUT                                             | VDOUT = 0.5V<br>VIN = 2.0V<br>VIN = 3.0V<br>VIN = 4.0V<br>VIN = 5.0V<br>VIN = 6.0V                                                                       | 3.0<br>4.0<br>5.0<br>7.0<br>10.0 | 6.0<br>8.0<br>10.0<br>12.0<br>15.0 |                   | mA       | ⑤       |
|                   | VD Detect Voltage Temperature Characteristics  | $\frac{\Delta VDF}{\Delta T_{opr} \cdot VDF}$     | -40°C≤Topr≤85°C                                                                                                                                          |                                  | ±100                               |                   | ppm / °C | ④       |
|                   | Delay Resistance                               | Rdelay                                            | VIN=6.0V, Cd=0V<br>Delay Resistance=6.0V/Delay Current                                                                                                   | 300                              | 500                                | 700               | kΩ       | ⑥       |

(NOTE 1) Unless otherwise stated, VIN=VOUT(T)+1.0V

(NOTE 2) VROUT(T)=Specified VR Output Voltage

(NOTE 3) VOUT(E)=Actual VR Output Voltage. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(i.e. the VR output voltage when "VROUT(T)+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

(NOTE 4) Vdif={VIN1<sup>(NOTE6)</sup>-VROUT1<sup>(NOTE5)</sup>}

(NOTE 5) A voltage equal to 98% of the VR Output Voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

(NOTE 6) VIN1=The Input Voltage when VOUT1, which appears as Input Voltage is gradually decreased.

(NOTE 7) VDF (T) : Specified Detect Voltage value

(NOTE 8) VDF (E) : Actual Detect Voltage value. Refer to the E-0 chart on page 15 for VDF(T) values less than 1.5V.

(NOTE 9) VD Supply Current = Sink Current during detection.

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ VR DROPOUT VOLTAGE

| SYMBOL                                                         | E-0                              |       | E-1                                   |       | E-1                                    |       |
|----------------------------------------------------------------|----------------------------------|-------|---------------------------------------|-------|----------------------------------------|-------|
| PARAMETER<br><br>SPECIFIED<br>DETECT VOLTAGE<br>OUTPUT VOLTAGE | OUTPUT VOLTAGE<br>DETECT VOLTAGE |       | DROPOUT VOLTAGE 1 (mV)<br>(IOUT=30mA) |       | DROPOUT VOLTAGE 2 (mV)<br>(IOUT=100mA) |       |
|                                                                | (V)                              |       | Ta=25°C                               |       | Ta=25°C                                |       |
|                                                                | VROUT / VDF                      |       | Vdif1                                 | Vdif1 | Vdif2                                  | Vdif2 |
|                                                                | MIN.                             | MAX.  | TYP.                                  | MAX.  | TYP.                                   | MAX.  |
| 0.90                                                           | 0.870                            | 0.930 | 1050                                  | 1100  | 1150                                   | 1200  |
| 1.00                                                           | 0.970                            | 1.030 | 1000                                  | 1100  | 1050                                   | 1200  |
| 1.10                                                           | 1.070                            | 1.130 | 900                                   | 1000  | 950                                    | 1100  |
| 1.20                                                           | 1.170                            | 1.230 | 800                                   | 900   | 850                                    | 1000  |
| 1.30                                                           | 1.270                            | 1.330 | 700                                   | 800   | 750                                    | 900   |
| 1.40                                                           | 1.370                            | 1.430 | 600                                   | 700   | 650                                    | 800   |
| 1.50                                                           | 1.470                            | 1.530 | 500                                   | 600   | 550                                    | 700   |
| 1.60                                                           | 1.568                            | 1.632 | 400                                   | 500   | 500                                    | 600   |
| 1.70                                                           | 1.666                            | 1.734 | 300                                   | 400   | 400                                    | 500   |
| 1.80                                                           | 1.764                            | 1.836 | 200                                   | 300   | 300                                    | 400   |
| 1.90                                                           | 1.862                            | 1.938 | 120                                   | 150   | 280                                    | 380   |
| 2.00                                                           | 1.960                            | 2.040 | 80                                    | 120   | 240                                    | 350   |
| 2.10                                                           | 2.058                            | 2.142 | 80                                    | 120   | 240                                    | 330   |
| 2.20                                                           | 2.156                            | 2.244 | 80                                    | 120   | 240                                    | 330   |
| 2.30                                                           | 2.254                            | 2.346 | 80                                    | 120   | 240                                    | 310   |
| 2.40                                                           | 2.352                            | 2.448 | 80                                    | 120   | 240                                    | 310   |
| 2.50                                                           | 2.450                            | 2.550 | 70                                    | 100   | 220                                    | 290   |
| 2.60                                                           | 2.548                            | 2.652 | 70                                    | 100   | 220                                    | 290   |
| 2.70                                                           | 2.646                            | 2.754 | 70                                    | 100   | 220                                    | 290   |
| 2.80                                                           | 2.744                            | 2.856 | 70                                    | 100   | 220                                    | 270   |
| 2.90                                                           | 2.842                            | 2.958 | 70                                    | 100   | 220                                    | 270   |
| 3.00                                                           | 2.940                            | 3.060 | 60                                    | 90    | 200                                    | 270   |
| 3.10                                                           | 3.038                            | 3.162 | 60                                    | 90    | 200                                    | 250   |
| 3.20                                                           | 3.136                            | 3.264 | 60                                    | 90    | 200                                    | 250   |
| 3.30                                                           | 3.234                            | 3.366 | 60                                    | 90    | 200                                    | 250   |
| 3.40                                                           | 3.332                            | 3.468 | 60                                    | 90    | 200                                    | 250   |
| 3.50                                                           | 3.430                            | 3.570 | 60                                    | 90    | 200                                    | 250   |
| 3.60                                                           | 3.528                            | 3.672 | 60                                    | 90    | 200                                    | 250   |
| 3.70                                                           | 3.626                            | 3.774 | 60                                    | 90    | 200                                    | 250   |
| 3.80                                                           | 3.724                            | 3.876 | 60                                    | 90    | 200                                    | 250   |
| 3.90                                                           | 3.822                            | 3.978 | 60                                    | 90    | 200                                    | 250   |
| 4.00                                                           | 3.920                            | 4.080 | 60                                    | 80    | 180                                    | 230   |
| 4.10                                                           | 4.018                            | 4.182 | 60                                    | 80    | 180                                    | 230   |
| 4.20                                                           | 4.116                            | 4.284 | 60                                    | 80    | 180                                    | 230   |
| 4.30                                                           | 4.214                            | 4.386 | 60                                    | 80    | 180                                    | 230   |
| 4.40                                                           | 4.312                            | 4.488 | 60                                    | 80    | 180                                    | 230   |
| 4.50                                                           | 4.410                            | 4.590 | 60                                    | 80    | 180                                    | 230   |
| 4.60                                                           | 4.508                            | 4.692 | 60                                    | 80    | 180                                    | 230   |
| 4.70                                                           | 4.606                            | 4.794 | 60                                    | 80    | 180                                    | 230   |
| 4.80                                                           | 4.704                            | 4.896 | 60                                    | 80    | 180                                    | 230   |
| 4.90                                                           | 4.802                            | 4.998 | 60                                    | 80    | 180                                    | 230   |
| 5.00                                                           | 4.900                            | 5.100 | 50                                    | 70    | 160                                    | 210   |
| 5.10                                                           | 4.998                            | 5.202 | 50                                    | 70    | 160                                    | 210   |
| 5.20                                                           | 5.096                            | 5.304 |                                       |       |                                        |       |
| 5.30                                                           | 5.194                            | 5.406 |                                       |       |                                        |       |
| 5.40                                                           | 5.292                            | 5.508 |                                       |       |                                        |       |
| 5.50                                                           | 5.390                            | 5.610 |                                       |       |                                        |       |

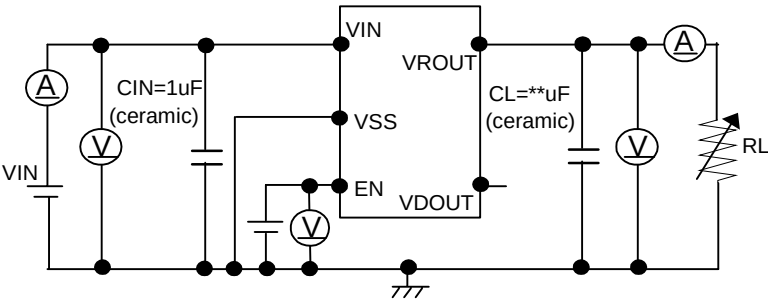
XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

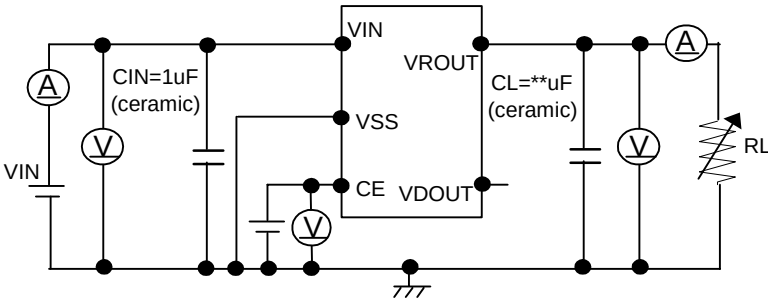
■ TEST CIRCUITS

○ Circuit ①

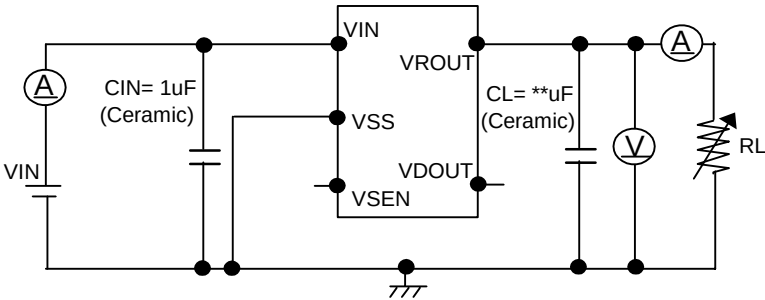
XC6405A ~ C Series



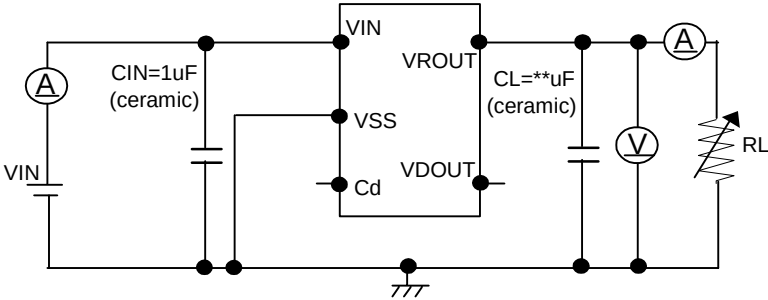
XC6405D Series



XC6405E Series



XC6405F Series



Output Capacitor Corresponding Chart

|       |                 |                 |                 |
|-------|-----------------|-----------------|-----------------|
| VROUT | 0.9 ~ 1.2V      | 1.3 ~ 1.7V      | 1.8V ~ 5.1V     |
| CL    | more than 4.7μF | more than 2.2μF | more than 1.0μF |



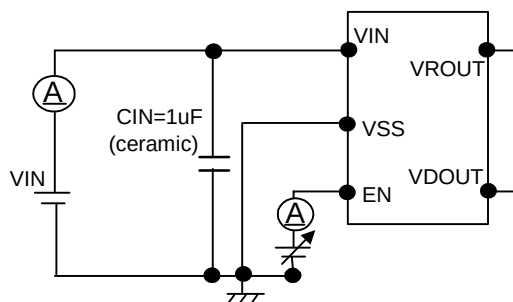
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

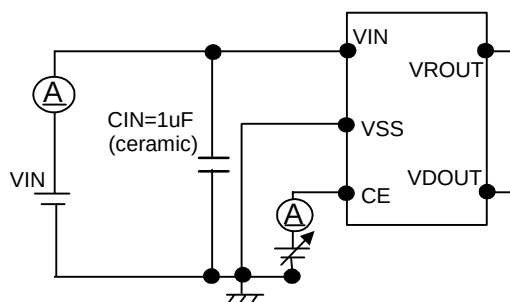
## ■ TEST CIRCUITS (Continued)

### ○ Circuit ②

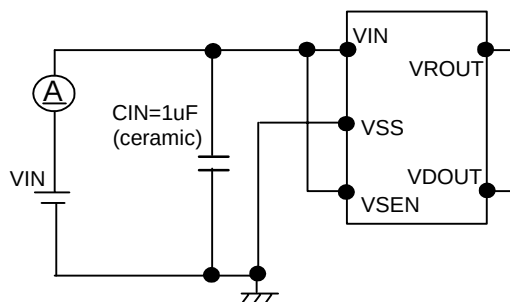
XC6405A ~ C Series



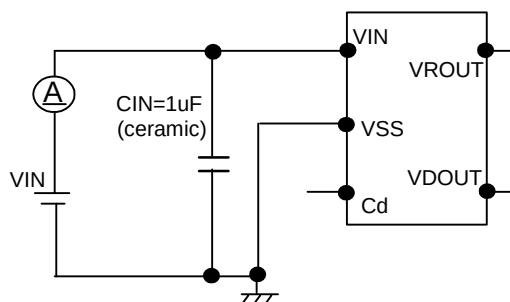
XC6405D Series



XC6405E Series



XC6405F Series



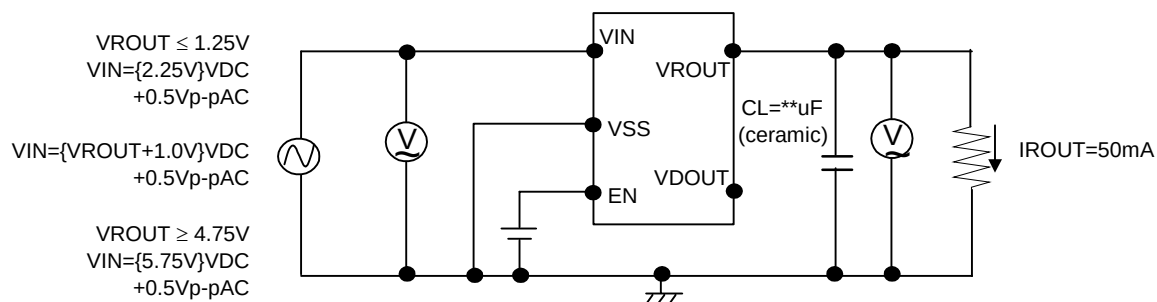
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

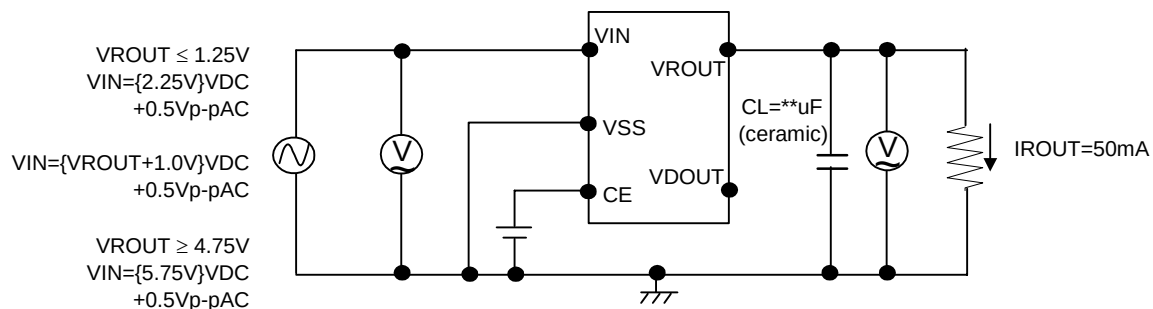
## ■ TEST CIRCUITS (Continued)

### ○ Circuit ③

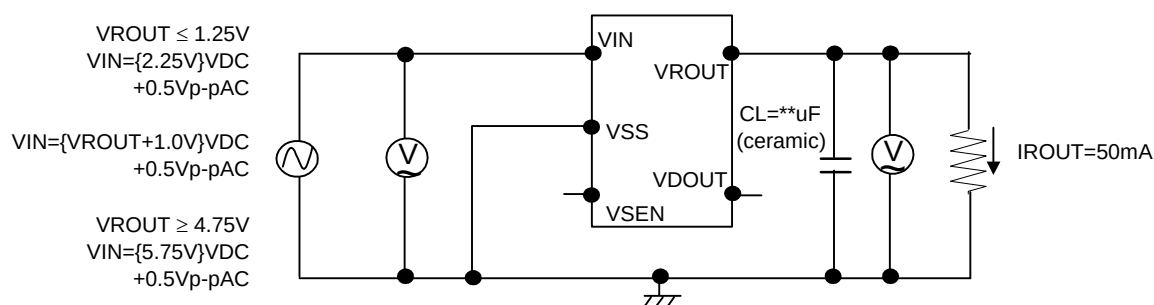
XC6405A ~ C Series



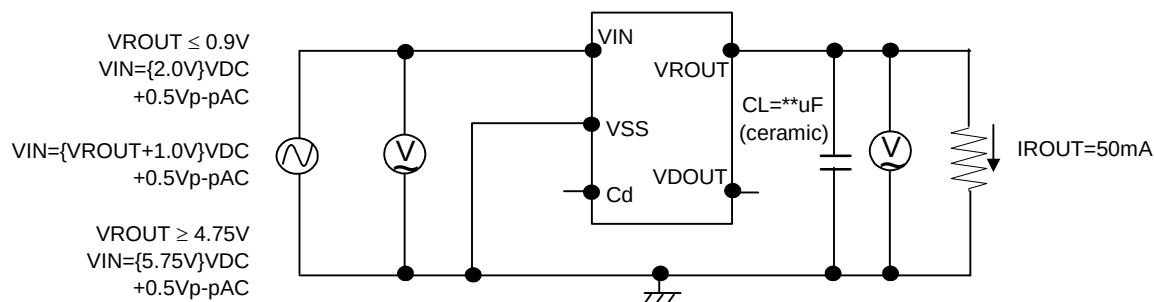
XC6405D Series



XC6405E Series



XC6405F Series



Output Capacitor Corresponding Chart

| VROUT | 0.9 ~ 1.2V      | 1.3 ~ 1.7V      | 1.8 ~ 5.1V      |
|-------|-----------------|-----------------|-----------------|
| CL    | more than 4.7μF | more than 2.2μF | more than 1.0μF |

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

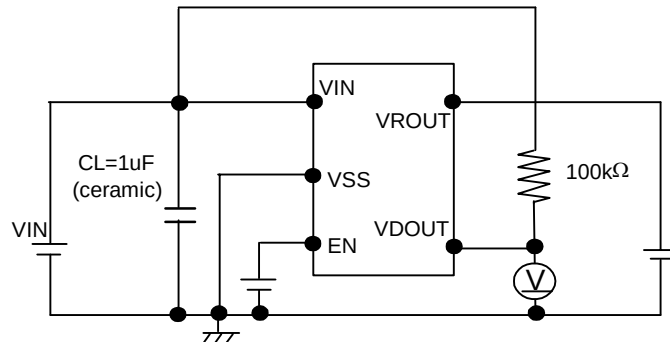
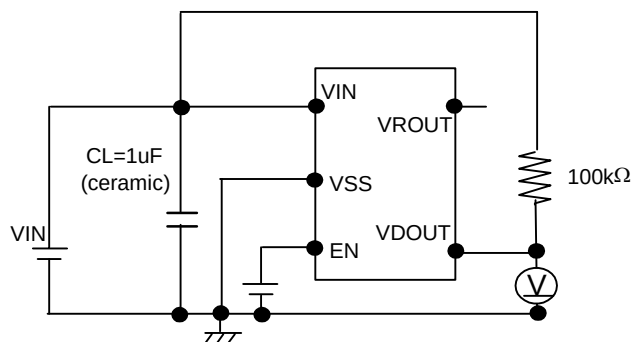
## ■ TEST CIRCUITS (Continued)

### ○ Circuit ④

XC6405A ~ C Series

[VD Sense, VIN type]

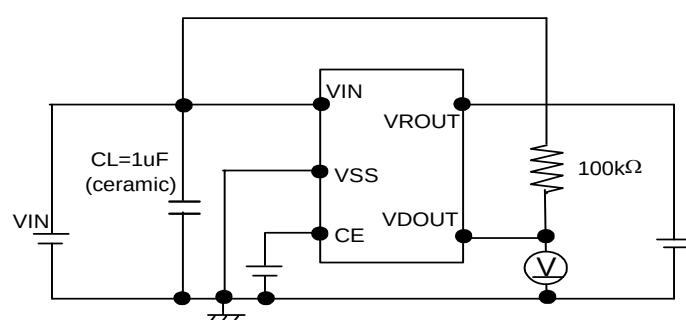
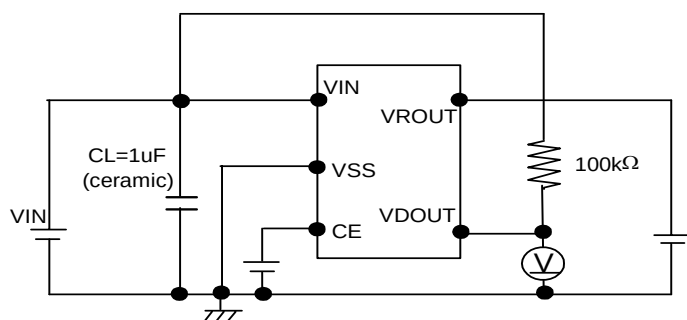
[VD Sense, VROUT type]



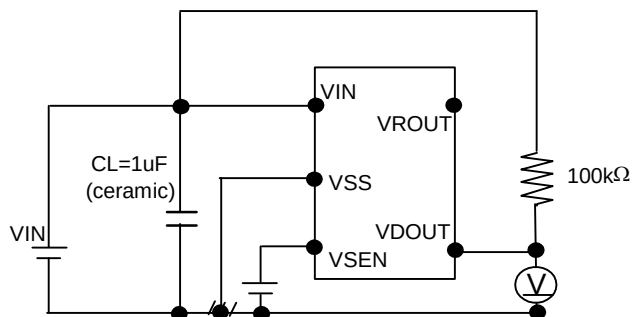
XC6405D Series

[VD Sense, VIN type]

[VD Sense, VROUT type]



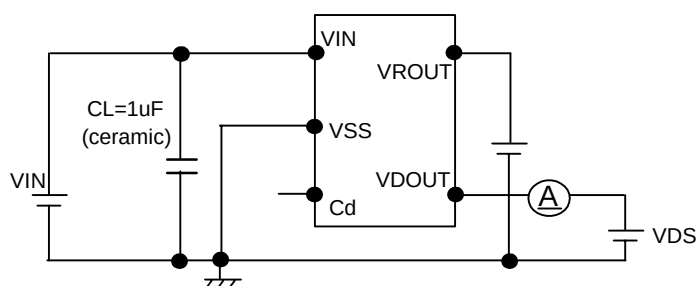
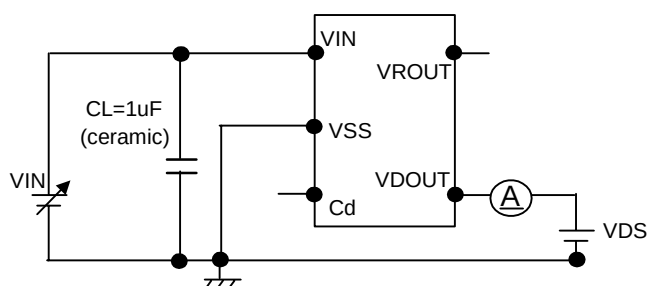
XC6405E Series



XC6405F Series

[VD Sense, VIN type]

[VD Sense, VROUT type]



# XC6405 Series

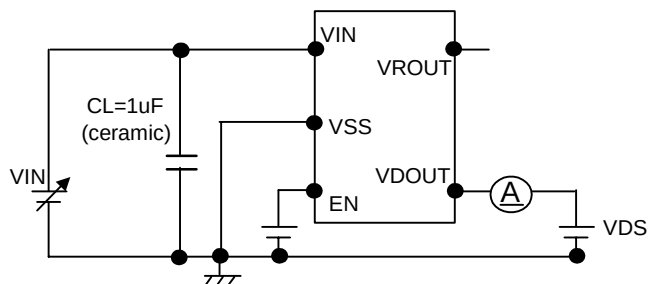
High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ TEST CIRCUITS (Continued)

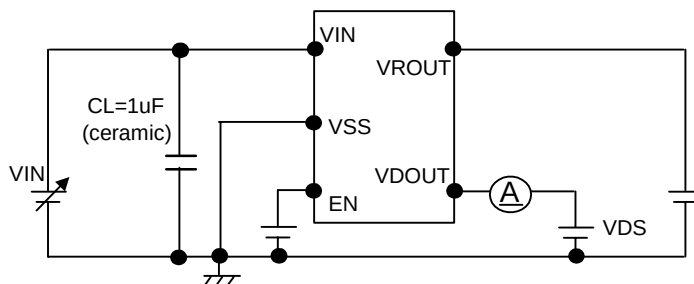
### ○ Circuit ⑤

XC6405A ~ C Series

[VD Sense, VIN type]

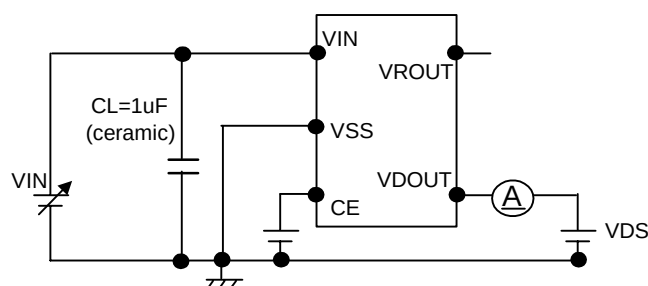


[VD Sense, VROUT type]

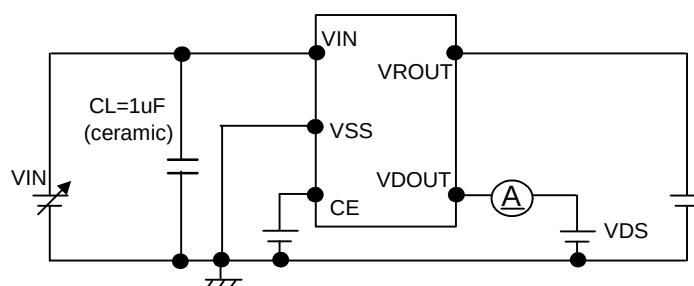


XC6405D Series

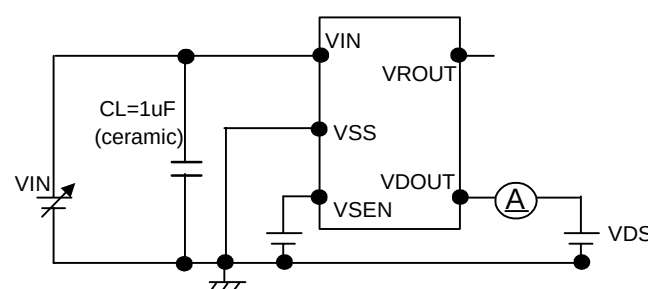
[VD Sense, VIN type]



[VD Sense, VROUT type]

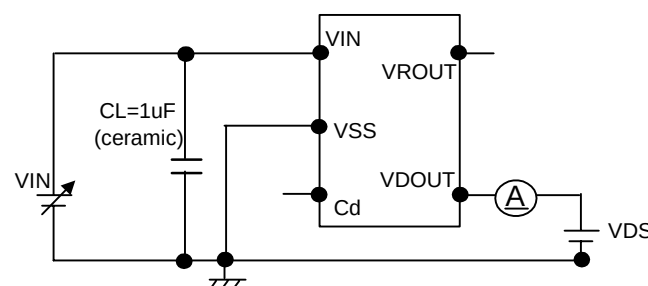


XC6405E Series

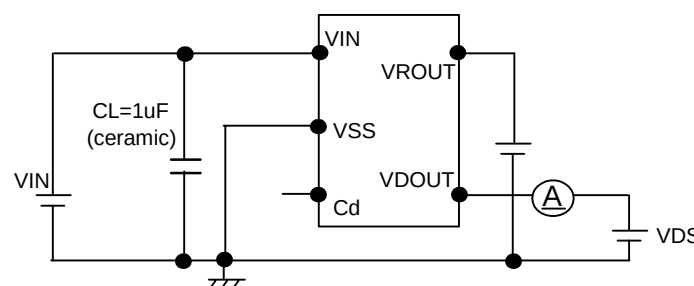


XC6405F Series

[VD Sense, VIN type]



[VD Sense, VROUT type]



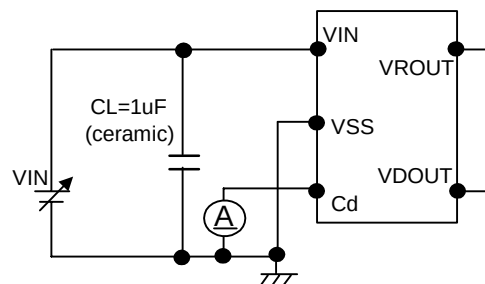
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

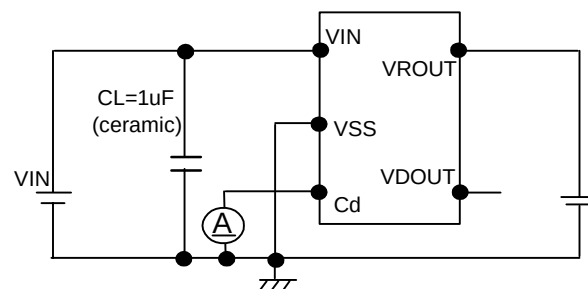
## ■ TEST CIRCUITS (Continued)

### ○ Circuit ⑥

XC6405F Series  
[VD Sense, VIN type]



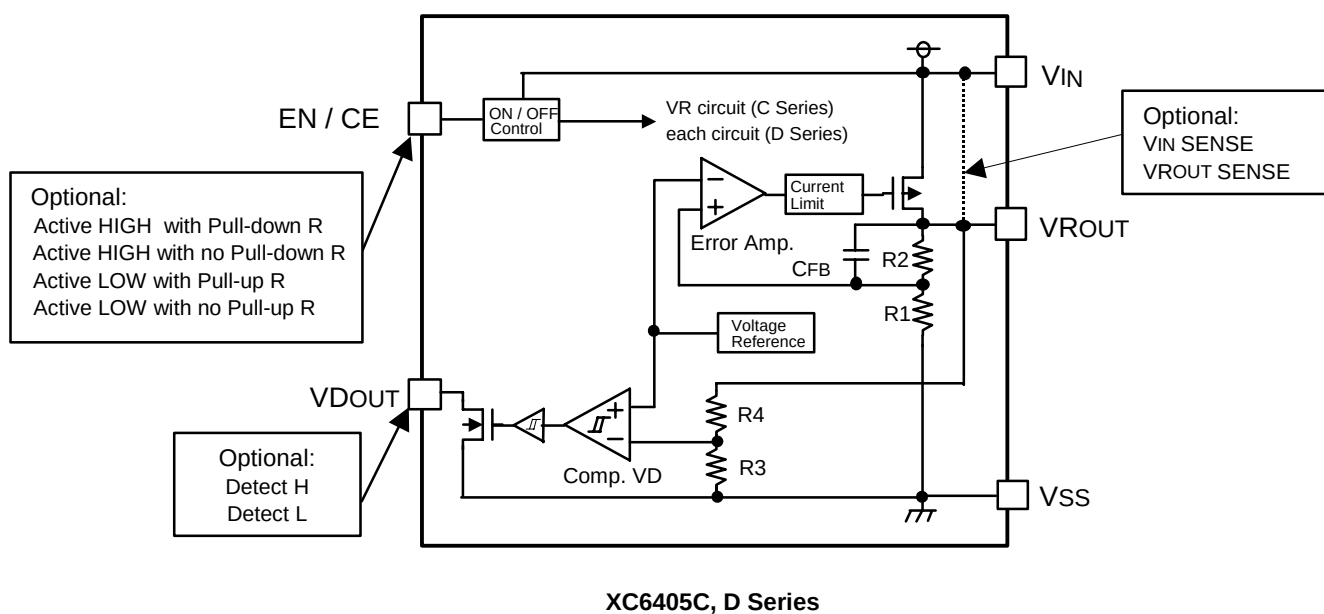
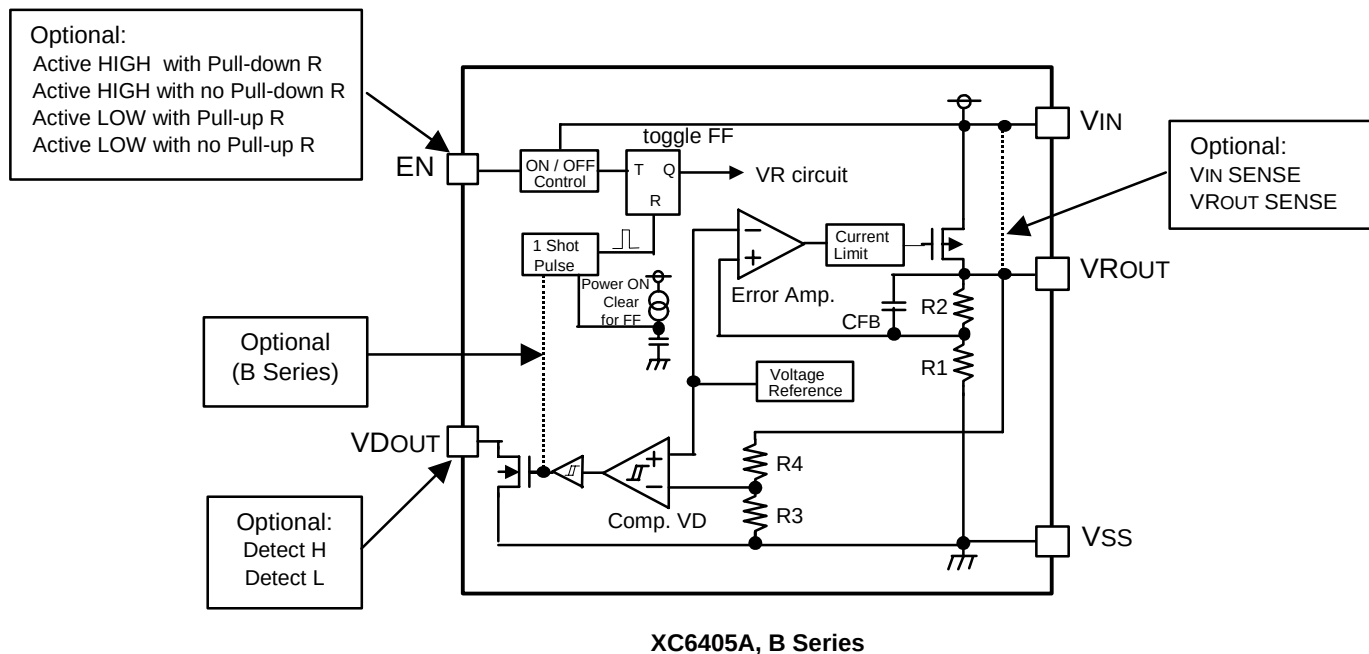
[VD Sense, VROUT type]



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

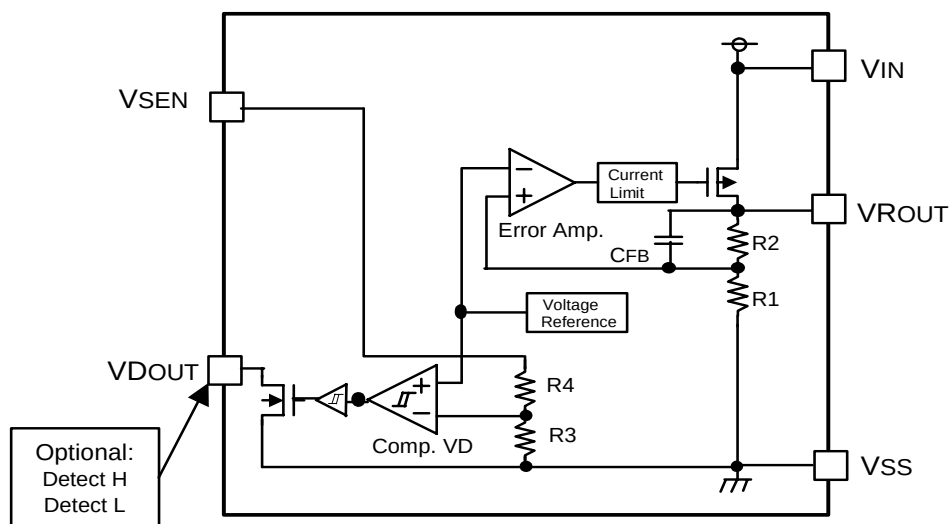
## ■ BLOCK DIAGRAMS



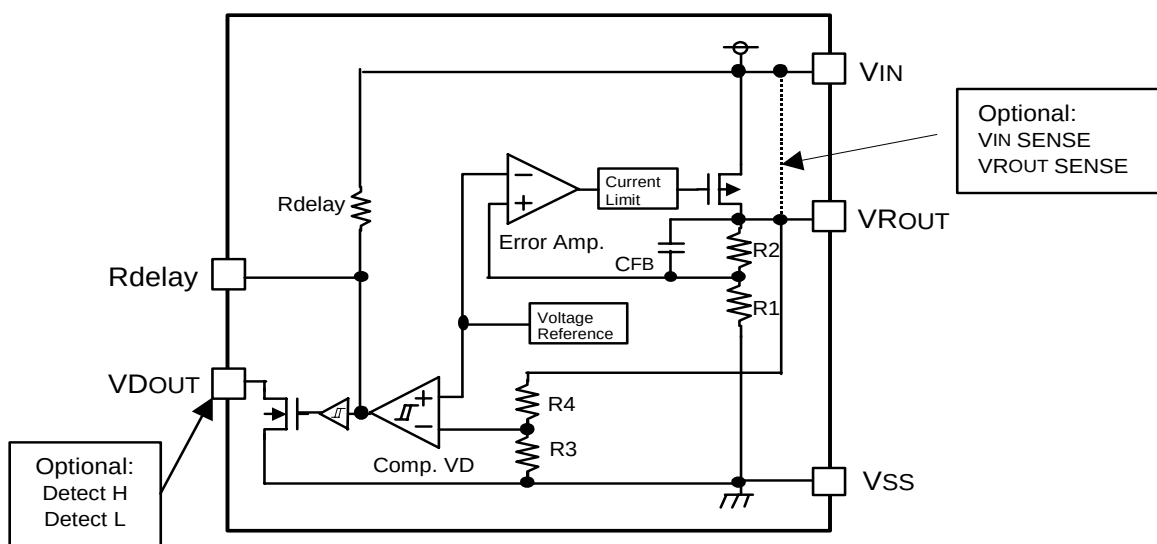
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ BLOCK DIAGRAMS (Continued)



XC6405E Series



XC6405F Series

# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ OPERATIONAL EXPLANATION

### <Output voltage regulator control>

The voltage, divided by resistors R1 & R2 which are connected to the VROUT pin is compared with the internal reference voltage by the error amplifier. The P-Channel MOSFET, which is connected to the VROUT pin, is then driven by the subsequent output signal. The output voltage at the VROUT pin is controlled & stabilized by negative feedback.

The current limit circuit and short circuit protection operate in relation to the level of output current. Further, the voltage regulator's internal circuitry can be shutdown via the EN or CE pin's signal.

### <Detector function with the XC6405 series>

The series' detector function monitors the voltage divided by resistors R3 & R4 which are connected to the VROUT pin or the VIN pin or the VSEN pin, as well as monitoring the voltage of the internal reference voltage source via the comparator. The VDSSEN pin has options (please refer to the Selection Guide, item 4 on page 2). A 'High' or 'Low' signal level can be output from the VDOUT pin when the VD pin voltage level goes below the detect voltage. The VD output logic has options (please refer to the Selection Guide, item 5 on page 2). As VDOUT is an open-drain N-channel output, a pull-up resistor of about 220KΩ is needed to achieve a voltage output. Because of hysteresis at the detector function, output at the VDOUT pin will invert when the detect voltage level increases above the release voltage (105% of the detect voltage). Even when the XC6405A, B, C, series are in stand-by mode, the voltage detector function operates and the output voltage at VDOUT will output according to the voltage level at VDSSENSE voltage.

For the XC6405A, B, C type, in stand-by, if a voltage of the recovery voltage is present at the VROUT pin (from another power source), the VDOUT pin will be high impedance mode, and the pull up voltage will be output at VDOUT. By connecting the Cdelay pin to a capacitor (Cd), the XC6405F series can apply a delay time to VDOUT voltage when releasing voltage. The delay time can be calculated from the internal resistance, Rdelay (500kΩ fixed) and the value of Cd as per the following equation.

$$\text{Delay Time} = C_{\text{delay}} \times R_{\text{delay}} \times 0.7$$

| Delay Time | Rdelay standard : 300 ~ 700kΩ | TYP : 500kΩ        |
|------------|-------------------------------|--------------------|
| Cdelay     | DELAY TIME (TYP.)             | DELAY TIME (TYP.)  |
| 0.01 μF    | 3.5 msec                      | 2.1 ~ 4.9 msec     |
| 0.022 μF   | 7.7 msec                      | 4.62 ~ 10.8 msec   |
| 0.047 μF   | 16.5 msec                     | 9.87 ~ 23.0 msec   |
| 0.1 μF     | 35 msec                       | 21.0 ~ 49.0 msec   |
| 0.22 μF    | 77 msec                       | 46.2 ~ 108.0 msec  |
| 0.47 μF    | 165 msec                      | 98.7 ~ 230.0 msec  |
| 1 μF       | 350 msec                      | 210.0 ~ 490.0 msec |

### <Low ESR Capacitors>

With the XC6405 series regulator, a stable output voltage is achievable even if low ESR capacitors are used, as a phase compensation circuit is built-in to the regulator. In order to ensure the effectiveness of the phase compensation, we suggest that an output capacitor (CL) be connected as close as possible, between the output pin (VROUT) and the VSS pin. Please use an output capacitor (CL) with a capacitance, based on the chart below. We also suggest an input capacitor (CIN) of 1μF : this should be connected between VIN and VSS in order to stabilize input power source.

Output Capacitor

| VROUT | 0.9 ~ 1.2V      | 1.3 ~ 1.7V      | 1.8 ~ 5.1V      |
|-------|-----------------|-----------------|-----------------|
| CL    | more than 4.7μF | more than 2.2μF | more than 1.0μF |

### <Current Limiter, Short-Circuit Protection>

The XC6405 series regulator offers a combination of current limit and circuit protection by means of a built-in fixed current limiter circuit and a foldback circuit. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, the output voltage drops further and output current decreases. When the output pin is shorted, a current of about 50mA flows.



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ OPERATIONAL EXPLANATION (Continued)

### <EN / CE Pin>

The IC's internal regulator circuitry can be shut down via the signal from the EN pin with the XC6405A, B, C series. In shutdown mode, output at the VROUT pin will be pulled down to the VSS level via R1 & R2. The whole IC's circuitry can be shut down via CE pin with the XC6405D series and power consumption can be reduced to around 0  $\mu$ A. While the voltage detector is in shutdown mode, the voltage detector output is in a post-detection state. When choosing Detect L, input current can be set by using the following formula.

$$\text{Input Current} = \text{VIN voltage} / \text{Pull Up Resistance}$$

In stand-by mode, the above input current can be reduced by connecting a pull-up resistor between VROUT and VDOUT.

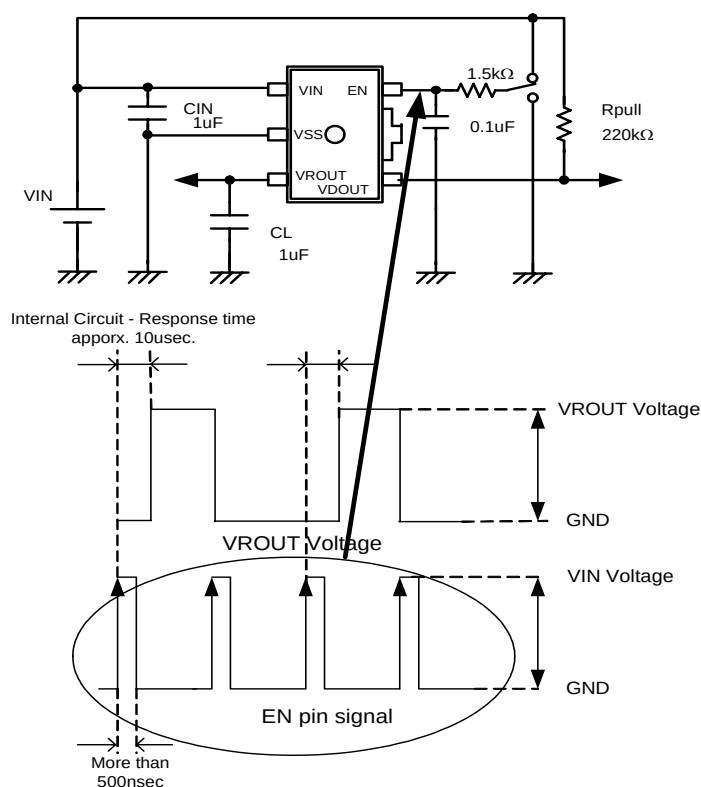
Note that as the XC6405\*E to K types of the XC6405A to D series are 'Active HIGH / No Pull Down' and XC6405\*R to U types of the XC6405A to D series are 'Active LOW / No Pull Up', operations will become unstable with the CE pin open (See the chart below).

| SERIES         | EN/CE INPUT LOGIC             | ( * A ~ D Series) |
|----------------|-------------------------------|-------------------|
| XC6405 * A ~ D | Active HIGH with pull down    |                   |
| XC6405 * E ~ K | Active HIGH with no pull down |                   |
| XC6405 * L ~ P | Active LOW with pull up       |                   |
| XC6405 * R ~ U | Active LOW with no pull up    |                   |

We suggest that you use this IC with either a VIN voltage or a VSS voltage input at the EN or CE pin. If this IC is used with the correct specifications for the EN or CE pin, the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry if a voltage other than VIN or VSS is applied.

### <Toggle Operation>

The XC6405 A and B series have a built-in toggle ON/OFF switch which repeats an on/off operation via the EN pin's leading edge signal when the EN logic is Active HIGH, and via the EN pin's falling edge signal when the EN logic is Active LOW (Please also refer the figure below). The EN input signal duration should be over 500nsec. If the EN input signal is less than 500nsec, it is possible that the circuit fails to respond and the toggle function does not operate. To operate the toggle function properly when the EN pin voltage noise is large, a RC filter should be used to reduce the noise in the signal to the EN pin. In the case where input delay time is required, it is possible to set the time constant by connecting an RC network to the EN pin.



EN Logic Active "HIGH"

# XC6405 Series

## High Current, High Speed LDO Regulators, Voltage Detector Function

### ■ OPERATIONAL EXPLANATION (Continued)

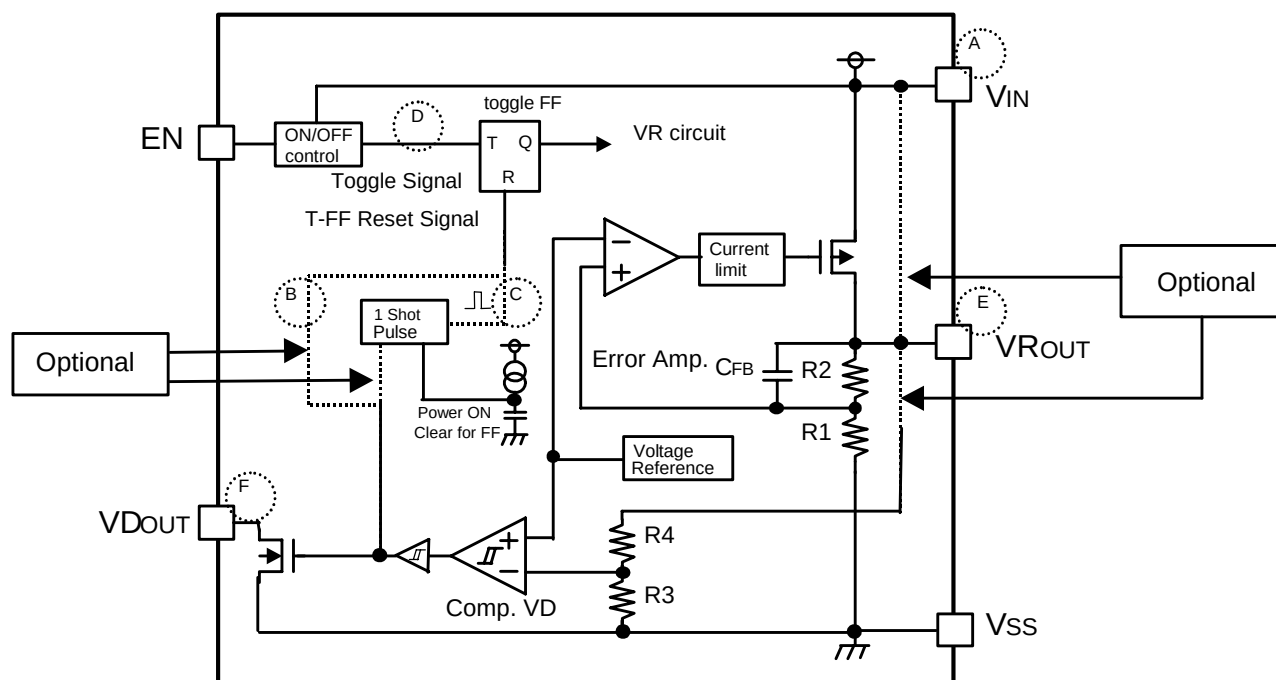
<Toggle Operation> (Continued)

For the XC6405B series, there are two types of toggle selection; one is a T-type flip-flop (T-FF) used for toggle operation which can be reset internally by a signal directly from the voltage detector (VIN Sense type only. See also the Selection Guide on page 2). The other type is where the reset is applied internally through a one shot pulse circuit (VIN, VROUT type only. See also the Selection Guide on page 2).

The type, which applies the reset directly via the signal from the voltage detector function, applies the voltage detector comparator's output signal (reset signal) to the reset of T-FF reset, and turns the VR output OFF when the input voltage decreases below the detect voltage due to battery consumption, etc.. In order to return the VR output, apply a voltage larger than the release voltage to VIN and input a toggle signal to the T-FF. In the case where input voltage is below the release voltage, the VR output does not return even though the toggle signal is input into the T-FF.

The type which applies the reset signal to the T-FF internally via a one-shot pulse circuit changes the voltage detector comparator output signal to a one-shot signal internally. Like the type which applies the reset directly via the signal from voltage detector function, this type also applies the reset to the T-FF and sets the VR output to OFF when the input voltage (VIN Sense type) and output voltage (VROUT Sense type) drop below the detect voltage level. This type can return the VR output by inputting a toggle signal, even when the Sense pin voltage (VIN or VROUT pin voltage) is below the release voltage.

Please refer to the block diagram below and the timing chart on the following page. Please choose the option suitable to the application.



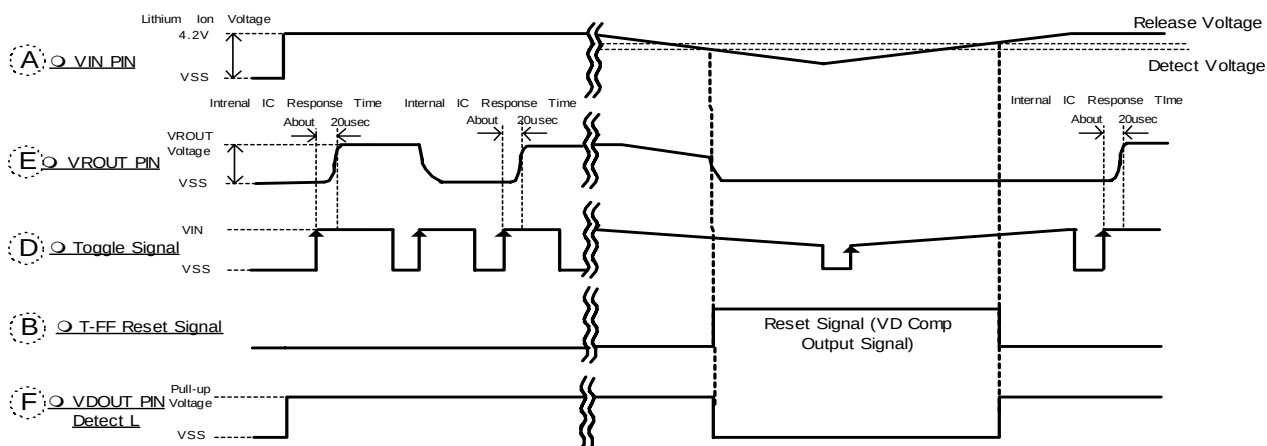
Block Diagram for XC6405B series Timing Chart

# XC6405 Series

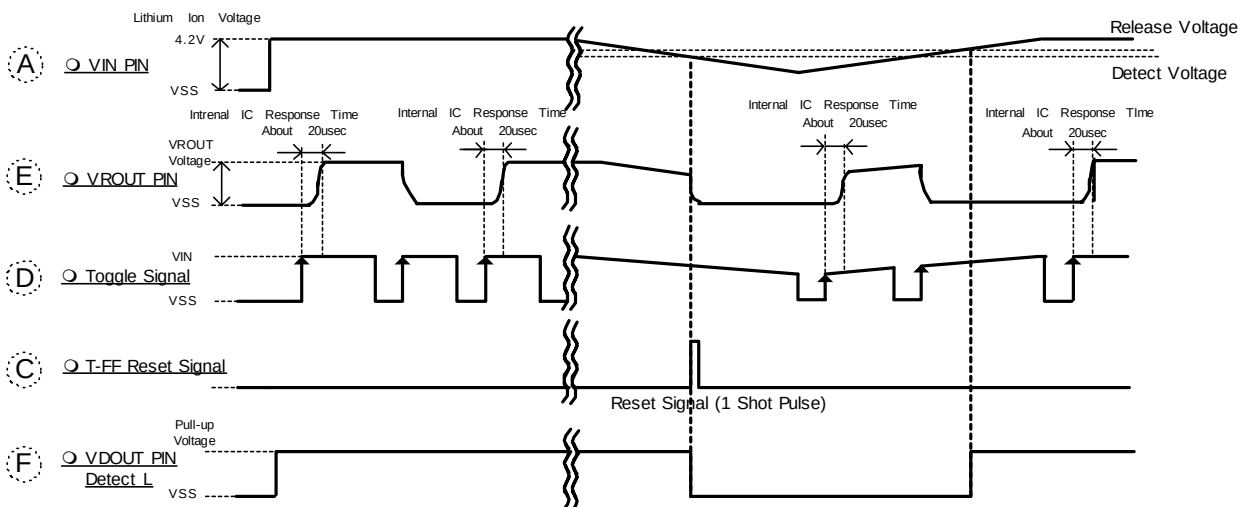
High Current, High Speed LDO Regulators, Voltage Detector Function

## ■ TIMING CHART

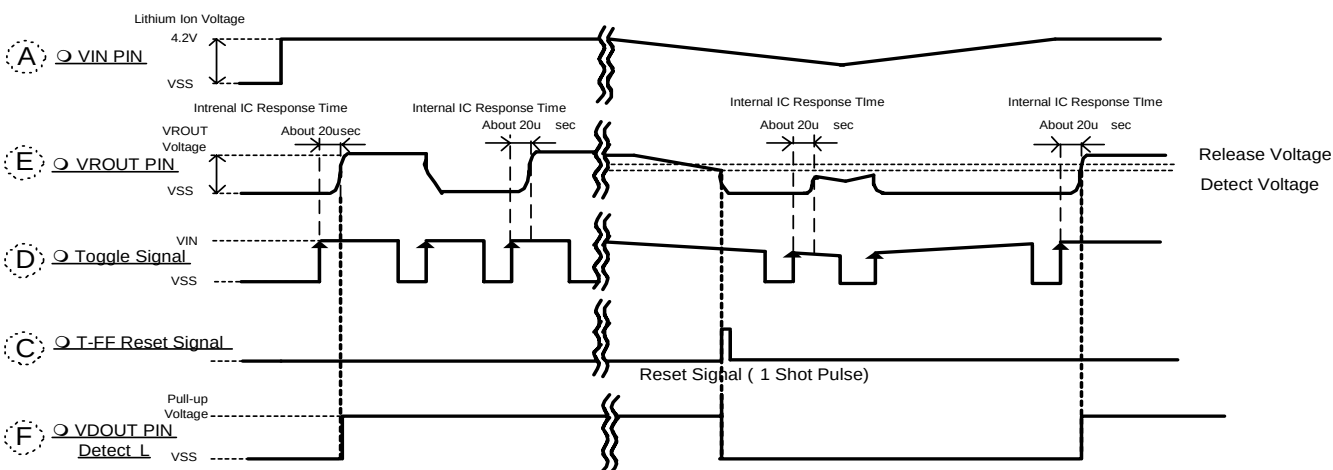
- Using the VD output level signal as the reset signal of T-FF (VD Sense = VIN PIN)



- Changing the VD output level signal into a one shot pulse to use T-FF as the reset signal (VD Sense = VIN PIN)



- Changing the VD output level signal into a one shot pulse to use T-FF as the reset signal (VD Sense = VROUT PIN)



The circled letters correspond to those shown on the block diagram on page 26.

# XC6405 Series

*High Current, High Speed LDO Regulators, Voltage Detector Function*

## ■ NOTES ON USE

1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current.  
Please strengthen VIN and VSS wiring in particular.
3. Please wire the input capacitor (CIN) and the output capacitor (CL) as close to the IC as possible.  
Should rapid input fluctuation or load fluctuation occur, please increase the capacitor value such as CIN or CL to stabilize the operation.

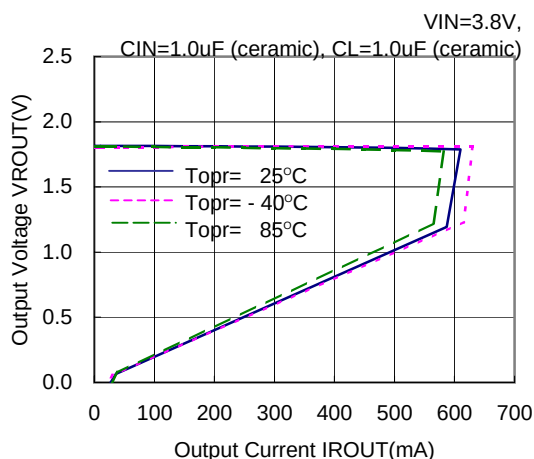
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

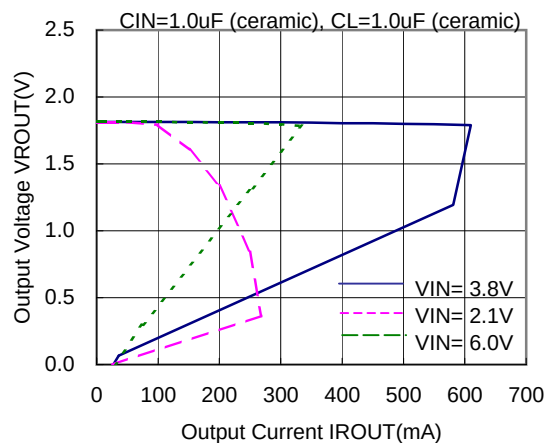
## ■ TYPICAL PERFORMANCE CHARACTERISTICS

(1) VR Output Voltage vs. VR Output Current

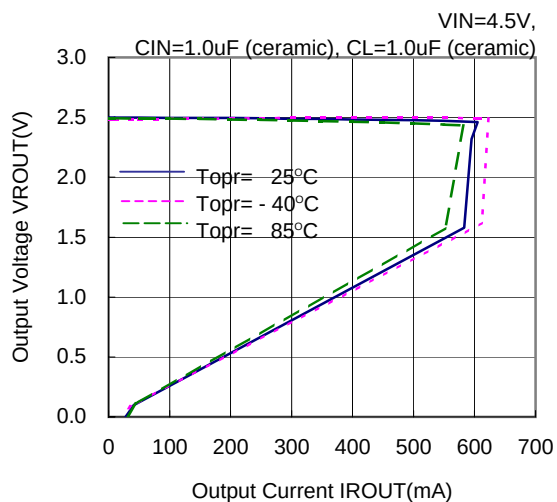
XC6405 Series (VR:1.8V)



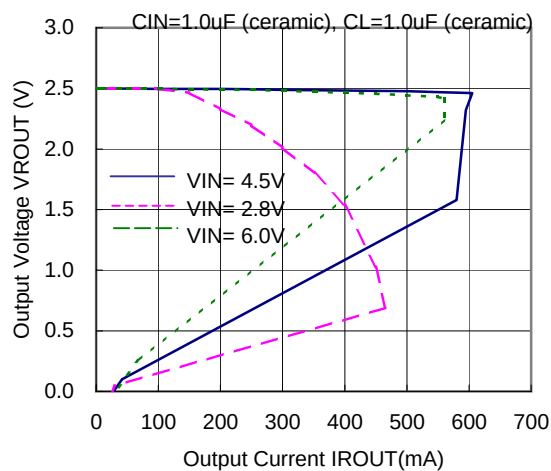
XC6405 Series (VR:1.8V)



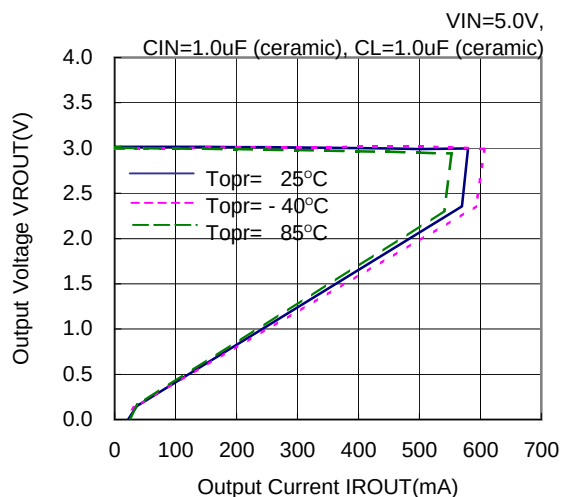
XC6405 Series (VR:2.5V)



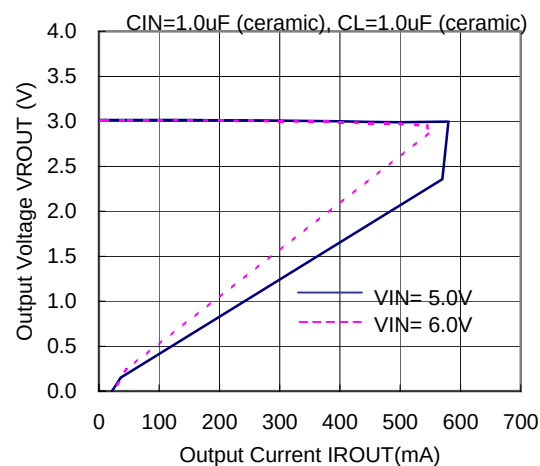
XC6405 Series (VR:2.5V)



XC6405 Series (VR:3.0V)



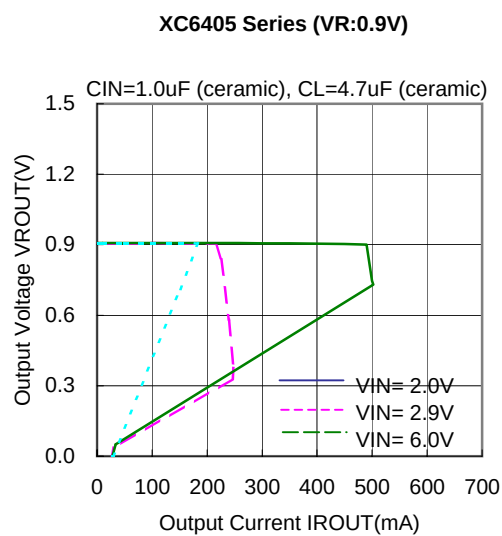
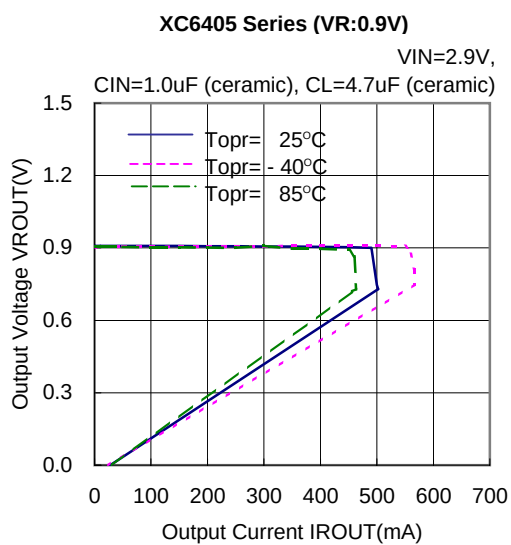
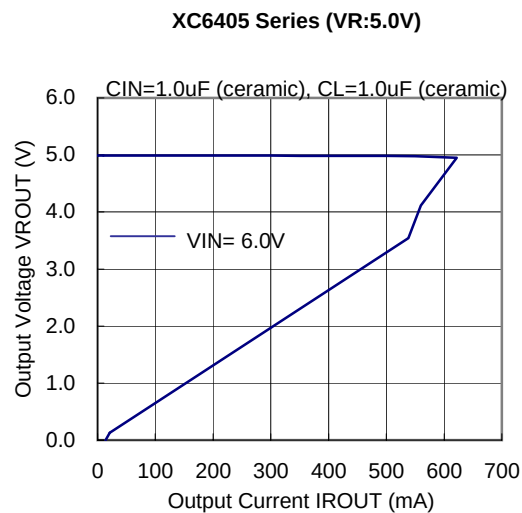
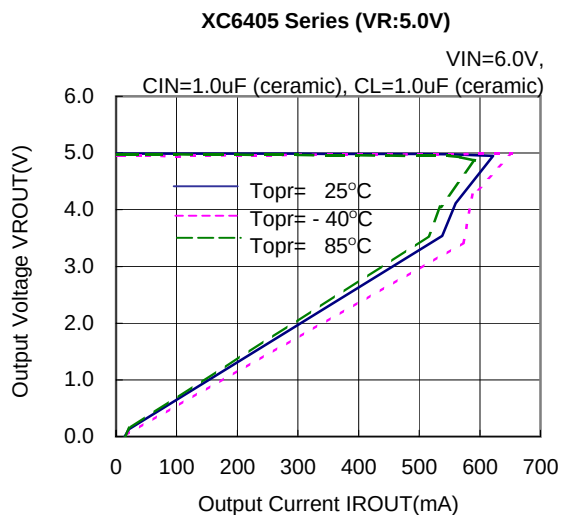
XC6405 Series (VR:3.0V)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

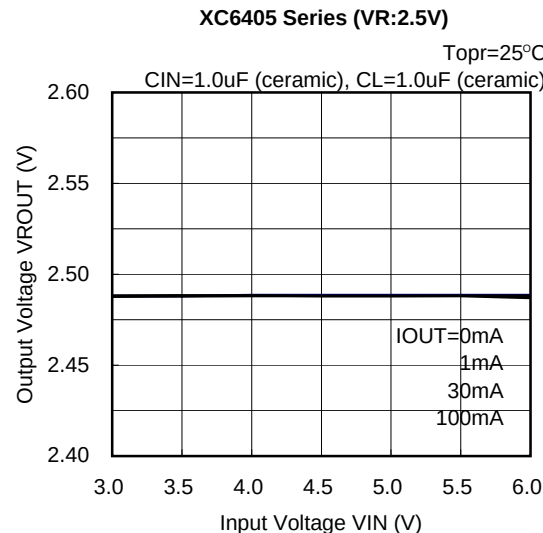
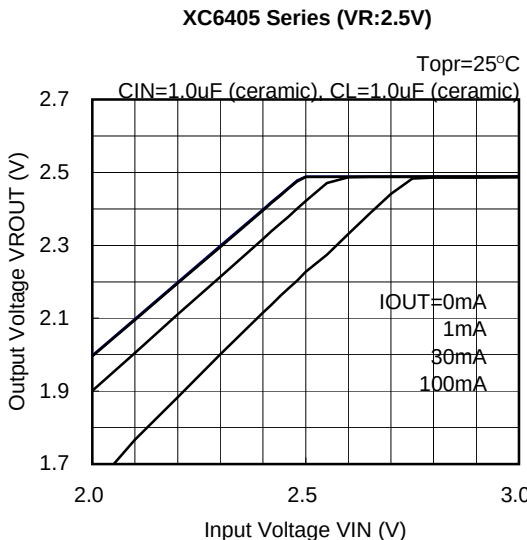
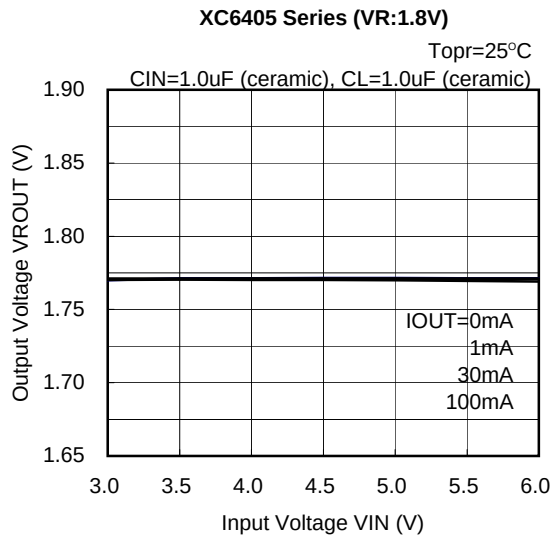
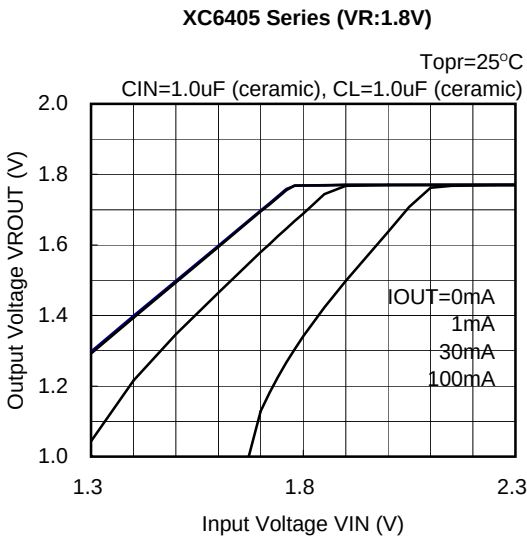
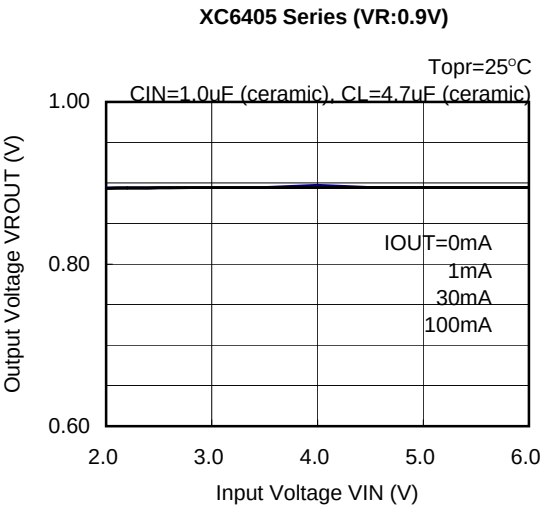
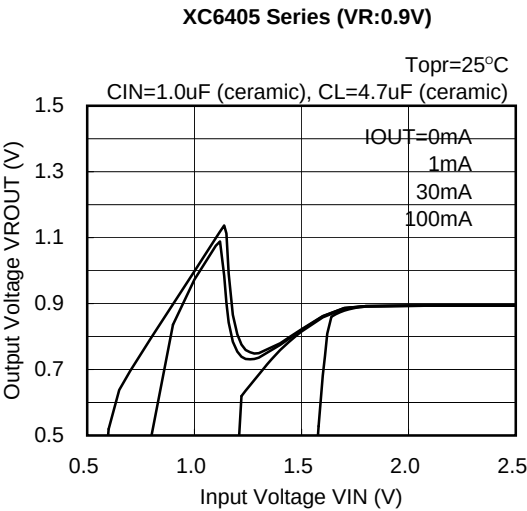
(1) VR Output Voltage vs. VR Output Current (Continued)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

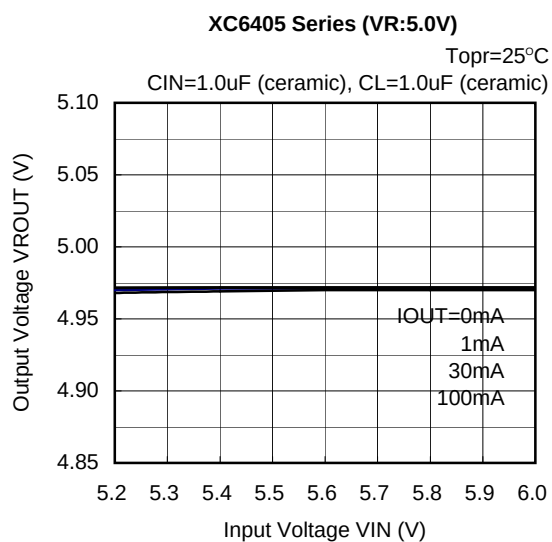
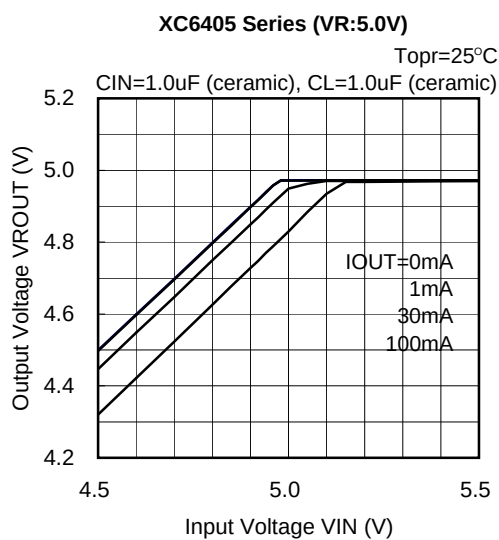
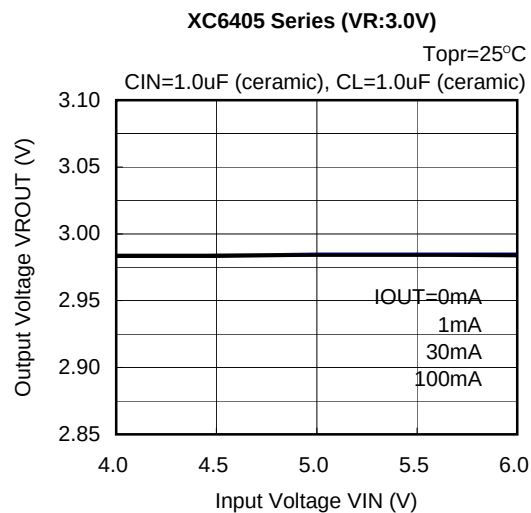
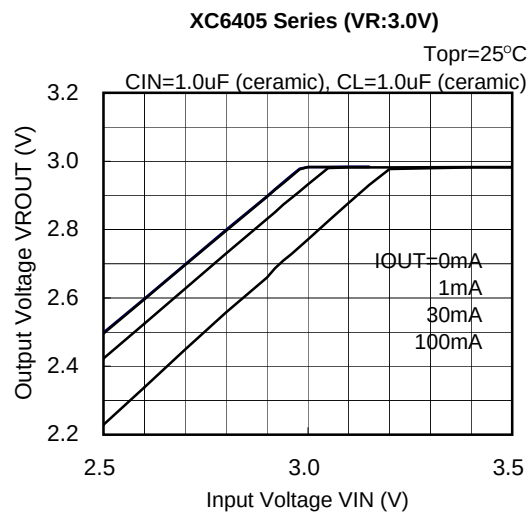
(2) VR Output Voltage vs. Input Voltage



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(2) VR Output Voltage vs. Input Voltage (Continued)



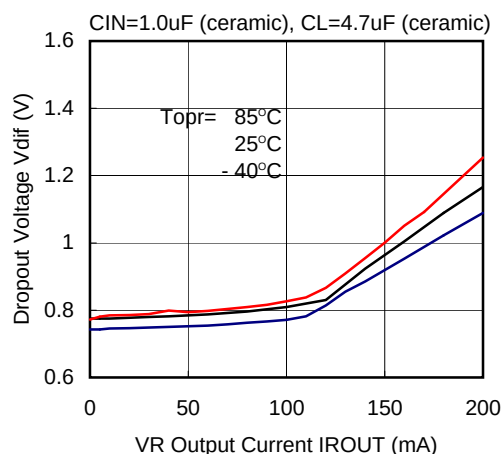


# XC6405 Series

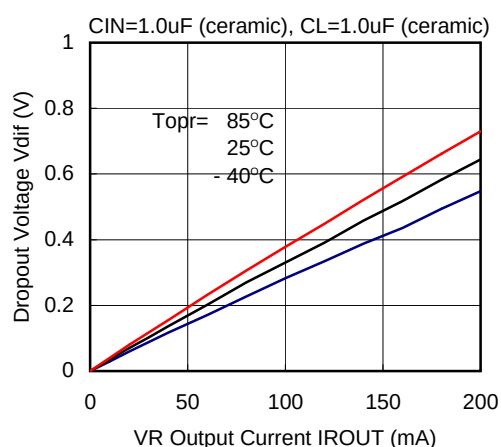
High Current, High Speed LDO Regulators, Voltage Detector Function

## (3) Dropout Voltage vs. VR Output Current

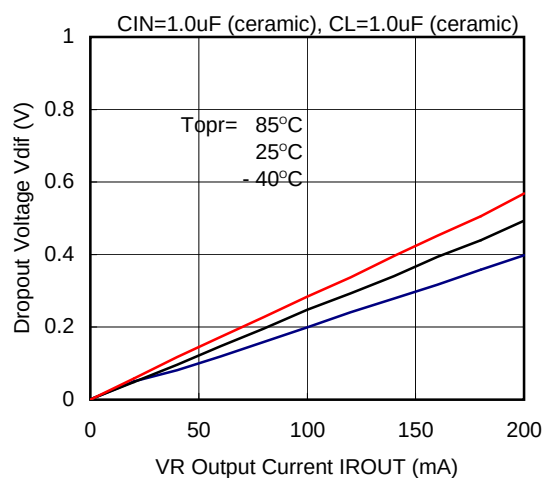
XC6405 Series (VR:0.9V)



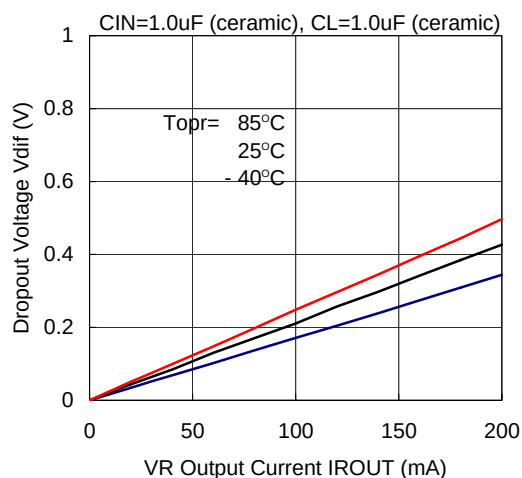
XC6405 Series (VR:1.8V)



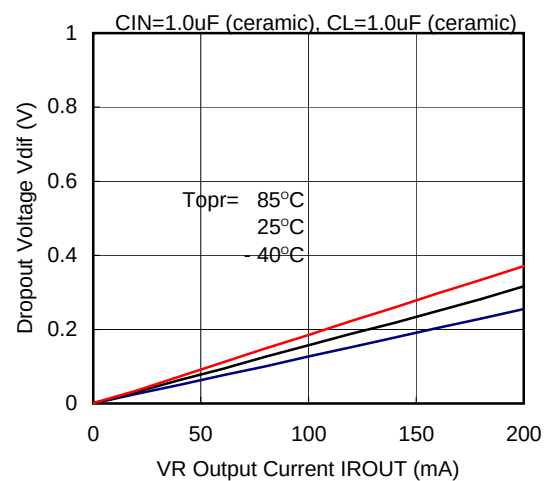
XC6405 Series (VR:2.5V)



XC6405 Series (VR:3.0V)



XC6405 Series (VR:5.0V)

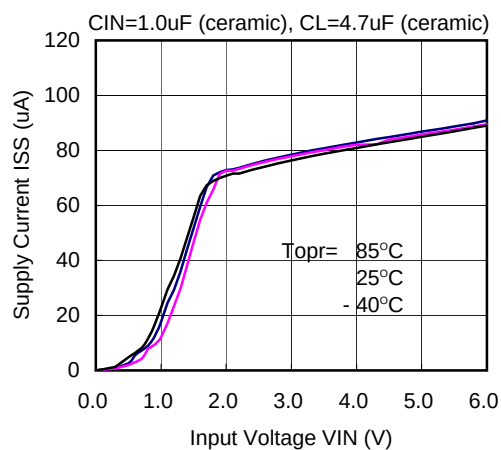


# XC6405 Series

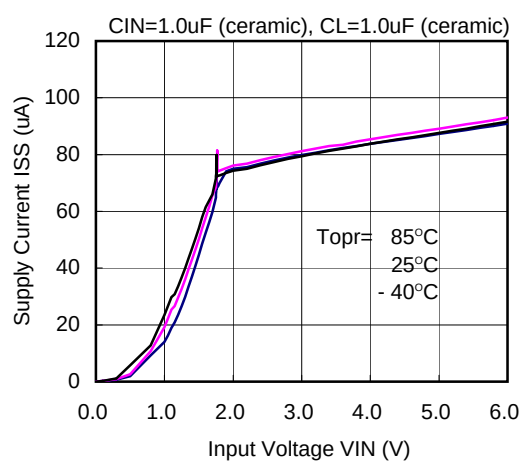
High Current, High Speed LDO Regulators, Voltage Detector Function

## (4) Supply Current vs. Input Voltage

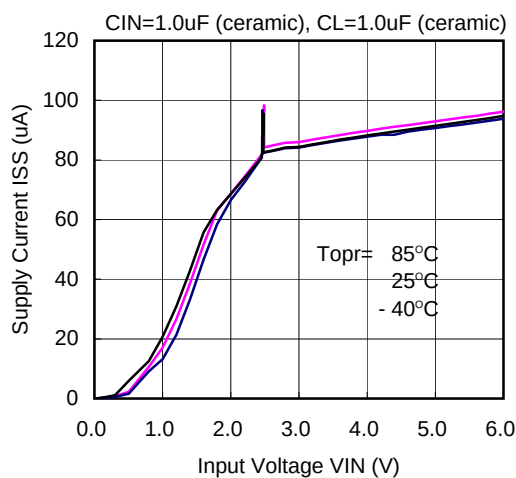
XC6405 Series (VR:0.9)



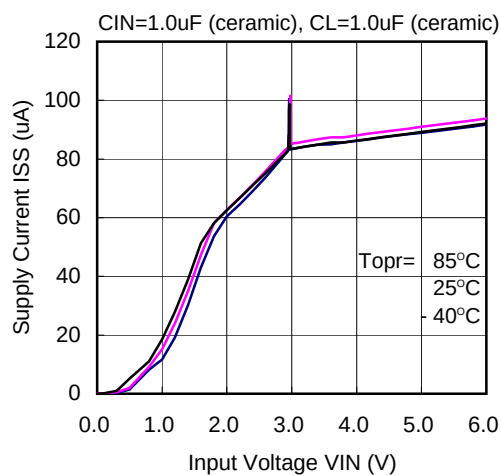
XC6403 Series (VR:1.8V)



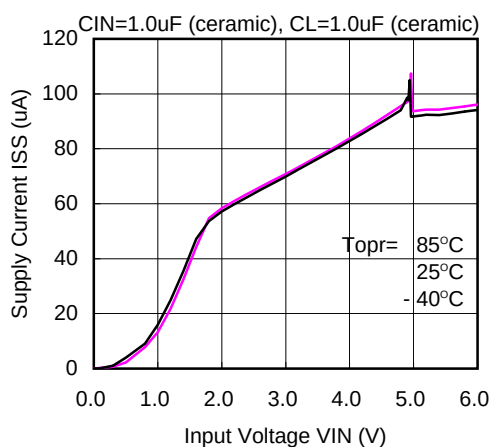
XC6405 Series (VR:2.5V)



XC6405 Series (VR:3.0V)



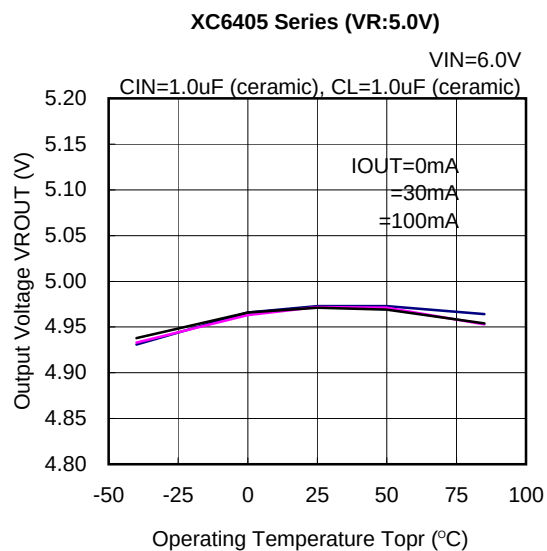
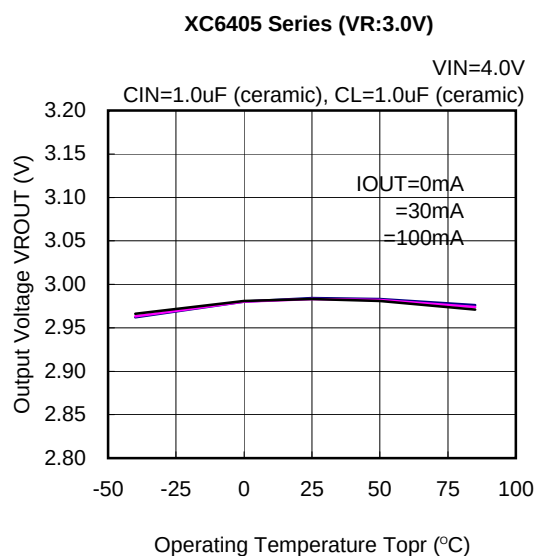
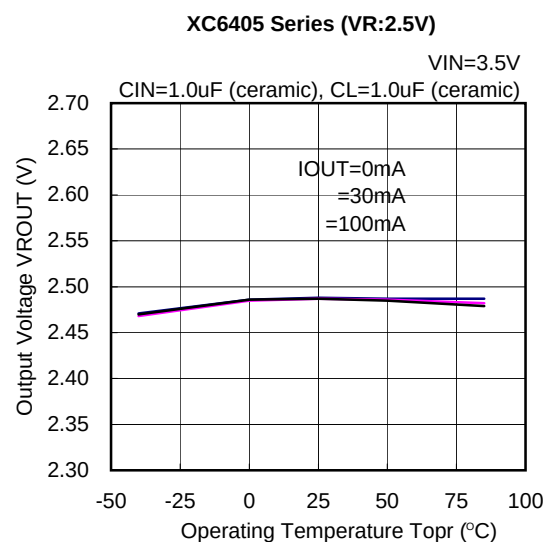
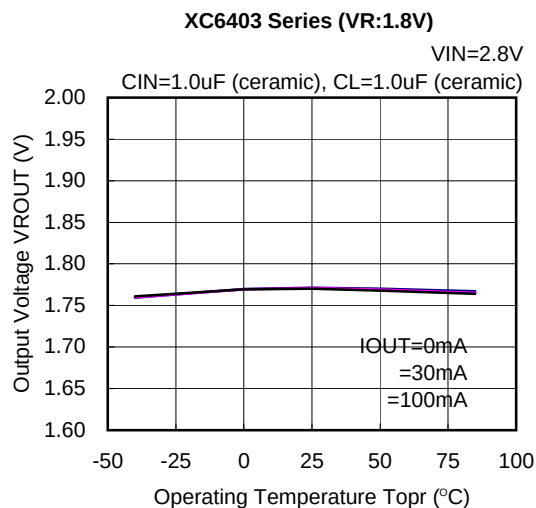
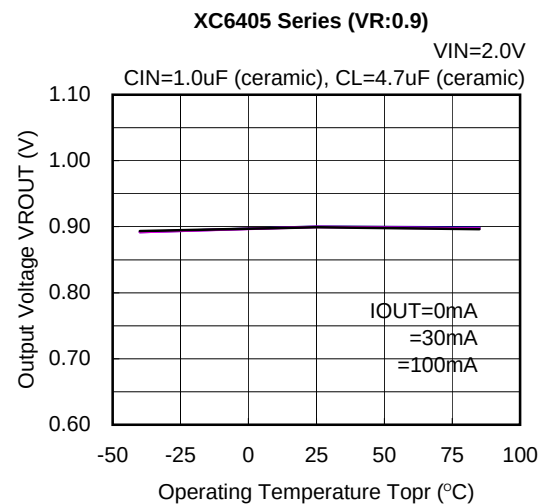
XC6405 Series (VR:5.0V)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(5) VR Output Voltage vs. Operating Temperature

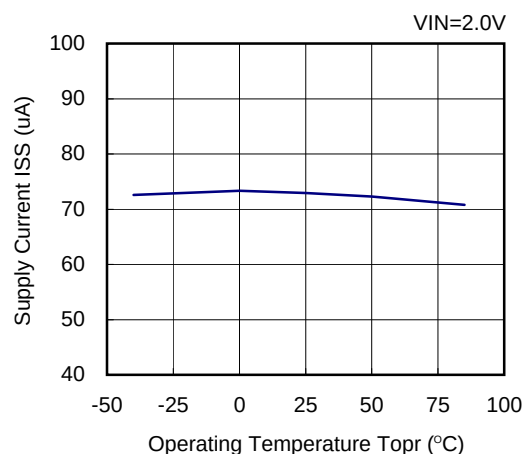


# XC6405 Series

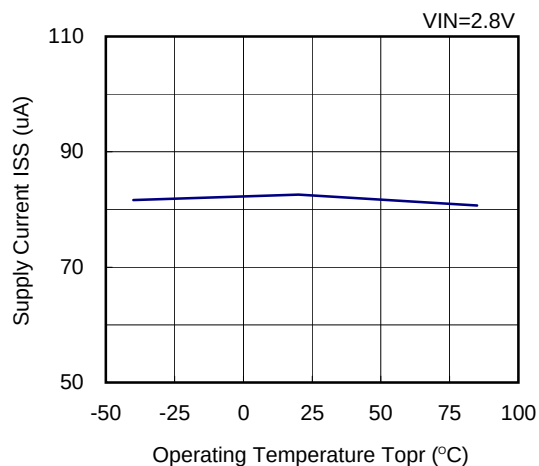
High Current, High Speed LDO Regulators, Voltage Detector Function

## (6) Supply Current vs. Operating Temperature

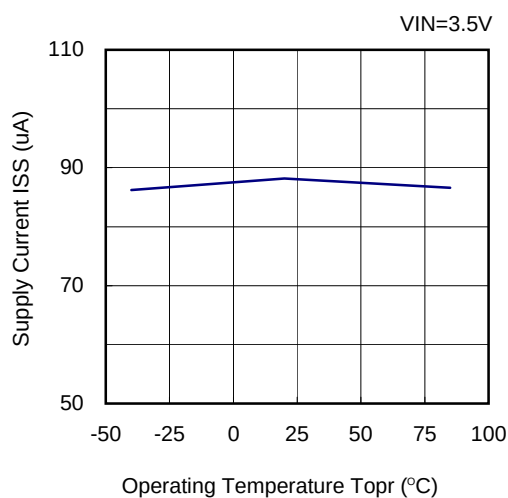
XC6405 Series (VR:0.9)



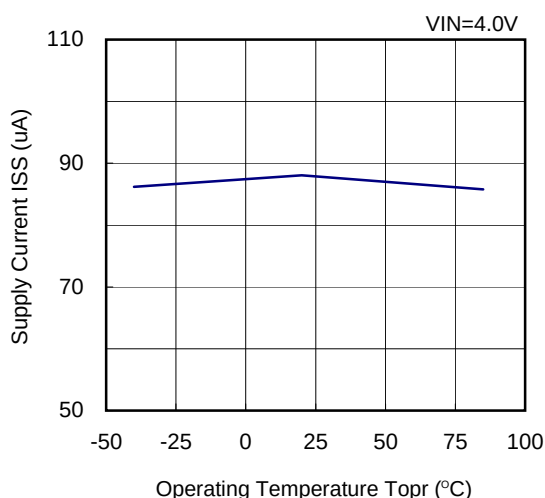
XC6403 Series (VR:1.8V)



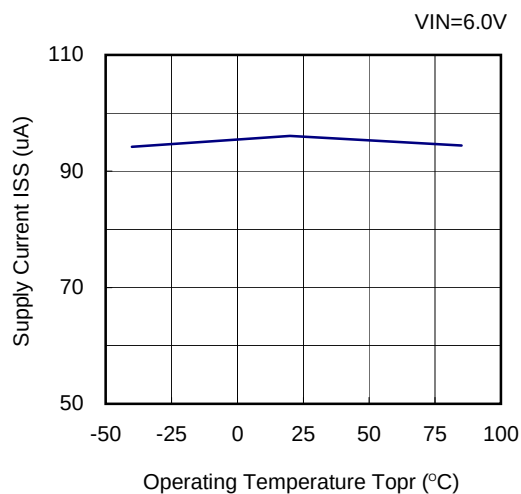
XC6405 Series (VR:2.5V)



XC6405 Series (VR:3.0V)



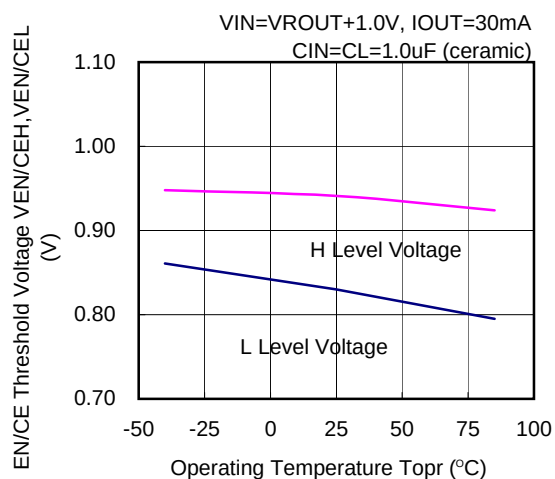
XC6405 Series (VR:5.0V)



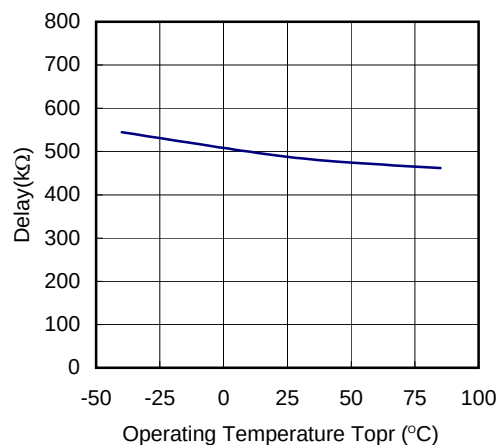
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

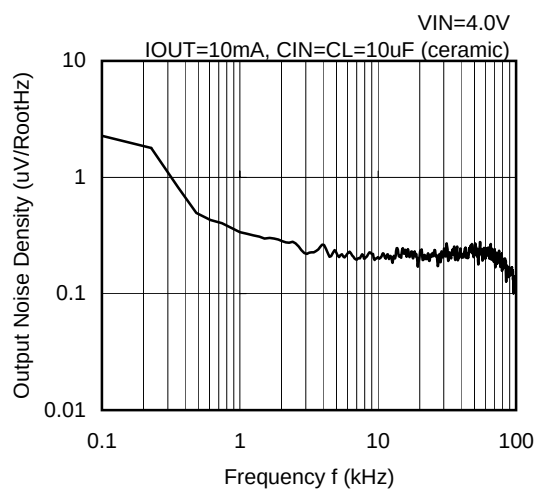
(7) EN/CE Threshold Voltage vs. Operating Temperature



(8) Rdelay vs. Operating Temperature



(9) Output Noise Density

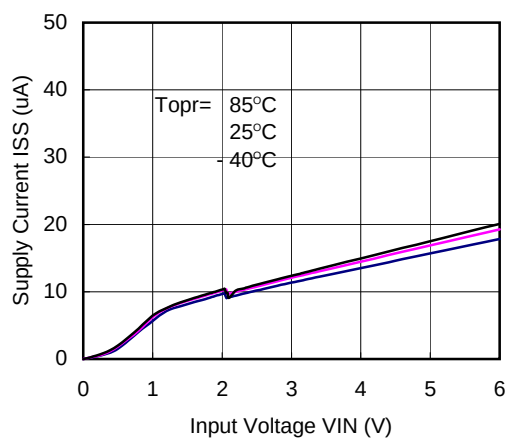


# XC6405 Series

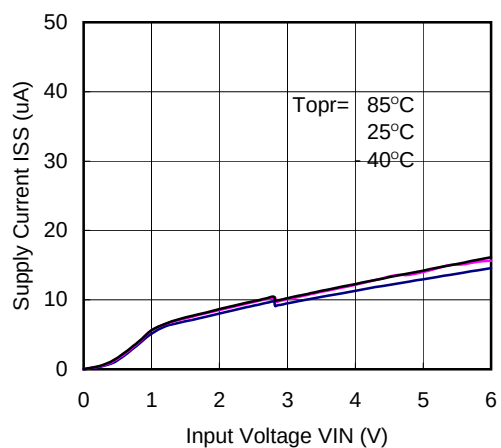
High Current, High Speed LDO Regulators, Voltage Detector Function

(10) VD Supply Current vs. Input Voltage (For A to C Series only)

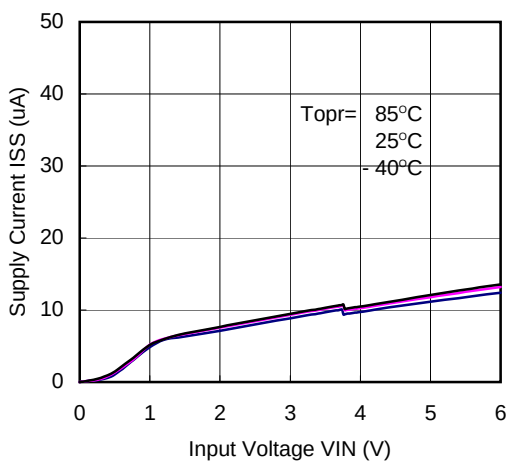
XC6405 Series (VD:2.0V)



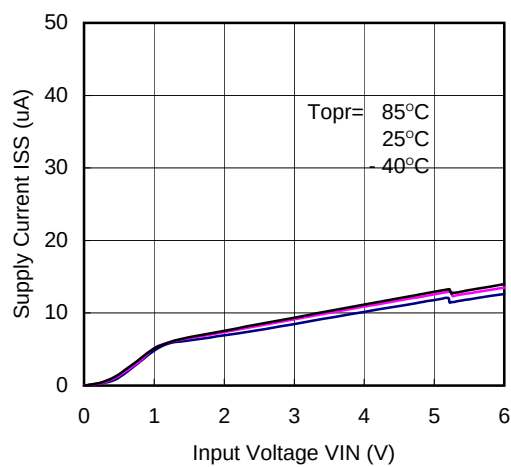
XC6405 Series (VD:2.7V)



XC6405 Series (VD:3.6V)



XC6405 Series (VD:5.0V)

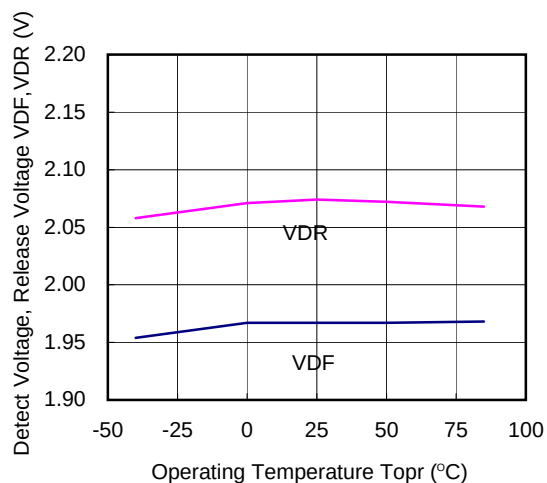


# XC6405 Series

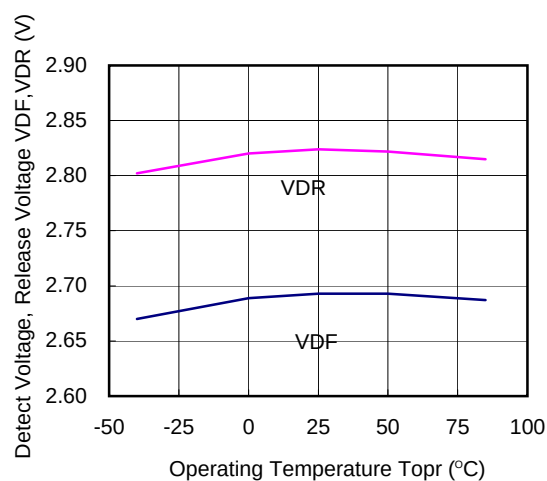
High Current, High Speed LDO Regulators, Voltage Detector Function

(11) Detect Voltage & Release Voltage vs. Operating Temperature

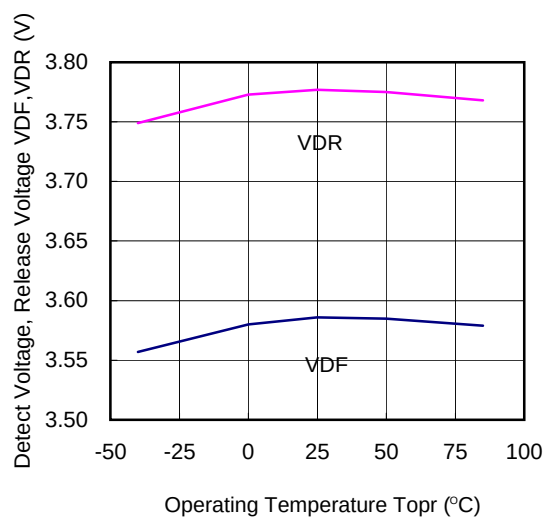
XC6405 Series (VD:2.0V)



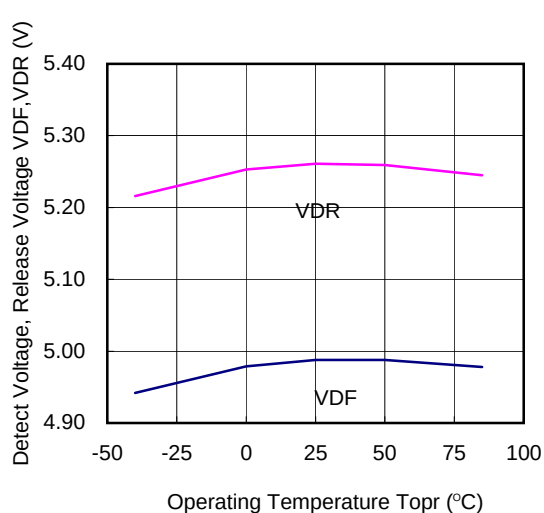
XC6405 Series (VD:2.7V)



XC6405 Series (VD:3.6V)



XC6405 Series (VD:5.0V)

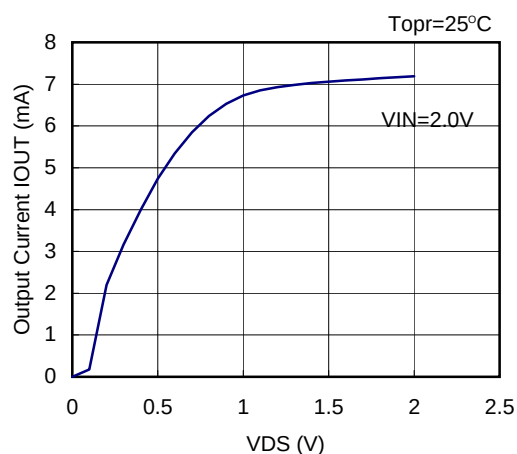


# XC6405 Series

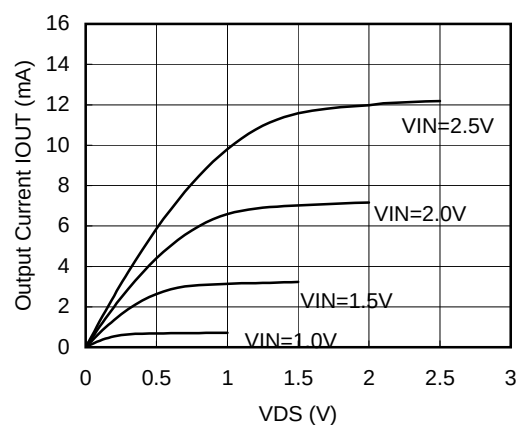
High Current, High Speed LDO Regulators, Voltage Detector Function

(12) VD N-ch Driver Tr. Output Current vs. VDS

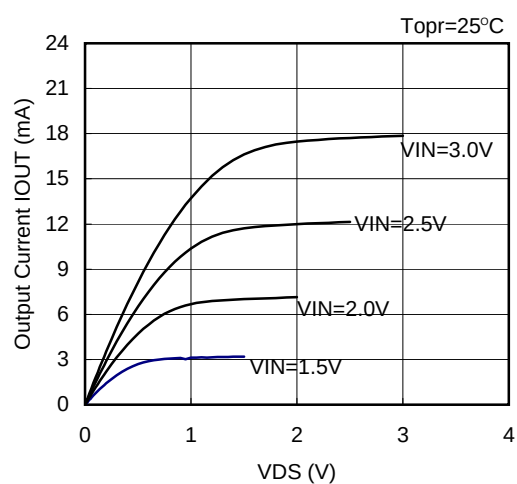
XC6405 Series (VD:2.0V)



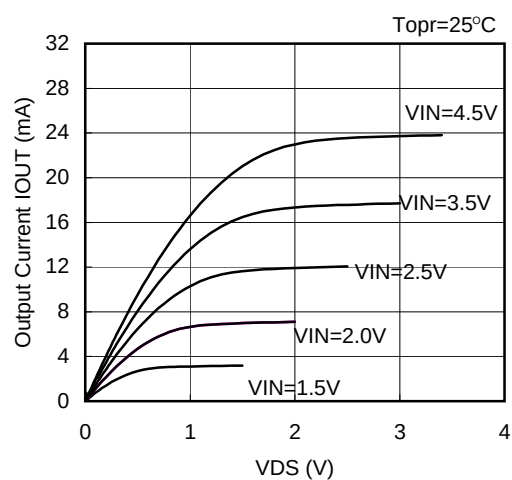
XC6405 Series (VD:2.7V)



XC6405 Series (VD:3.6V)



XC6405 Series (VD:5.0V)



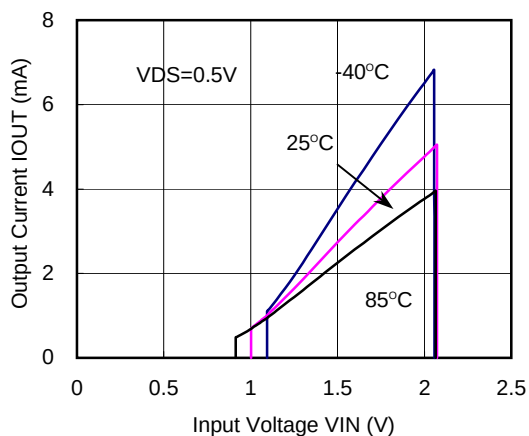


# XC6405 Series

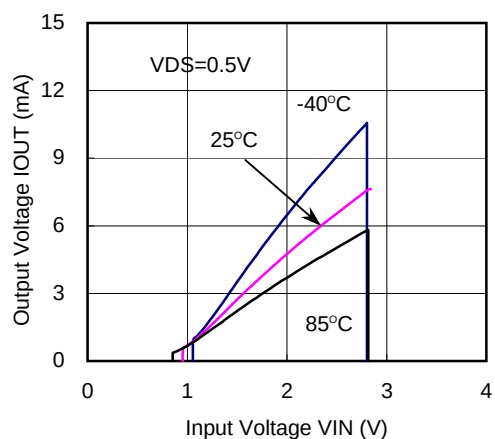
High Current, High Speed LDO Regulators, Voltage Detector Function

(13) VD N-ch Driver Tr. Output Current vs. Input Voltage

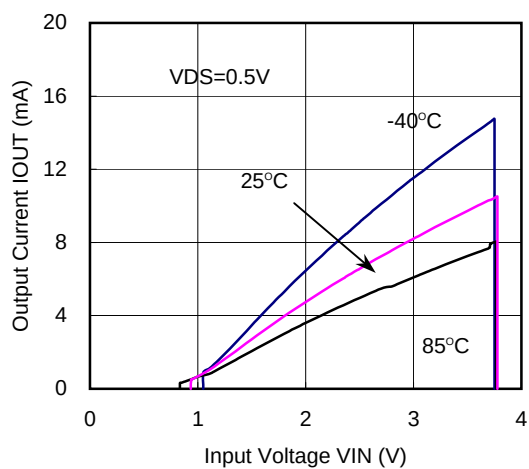
XC6405 Series (VD:2.0V)



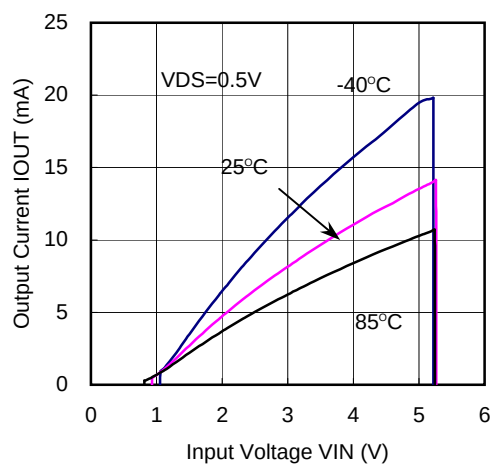
XC6405 Series (VD:2.7V)



XC6405 Series (VD:3.6V)



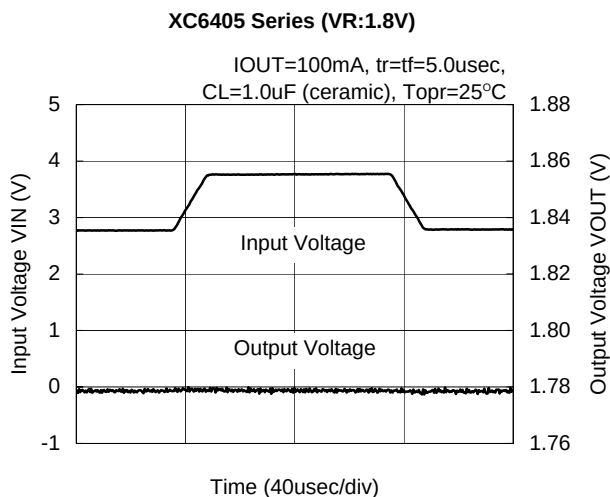
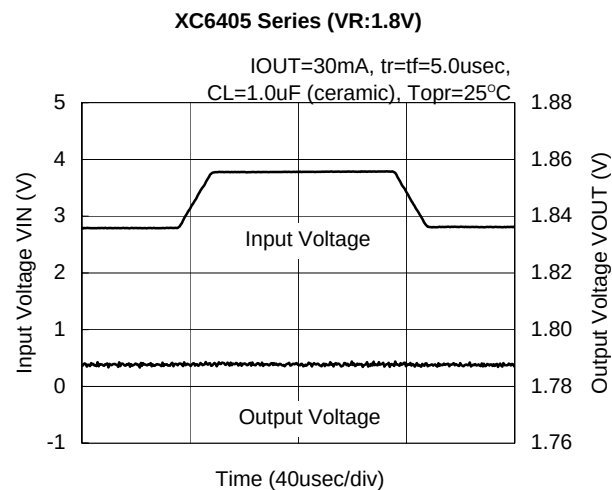
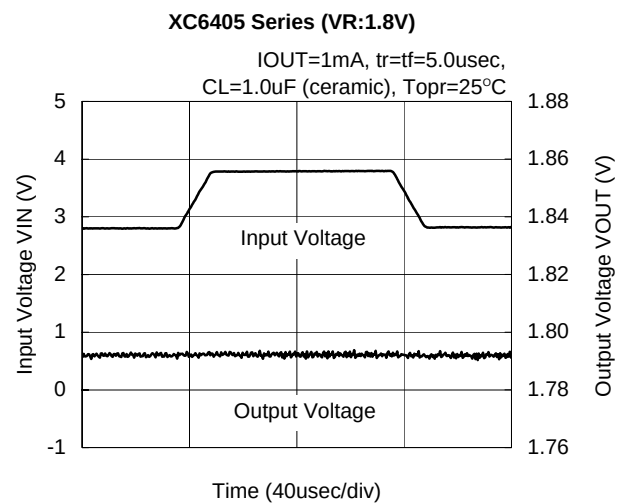
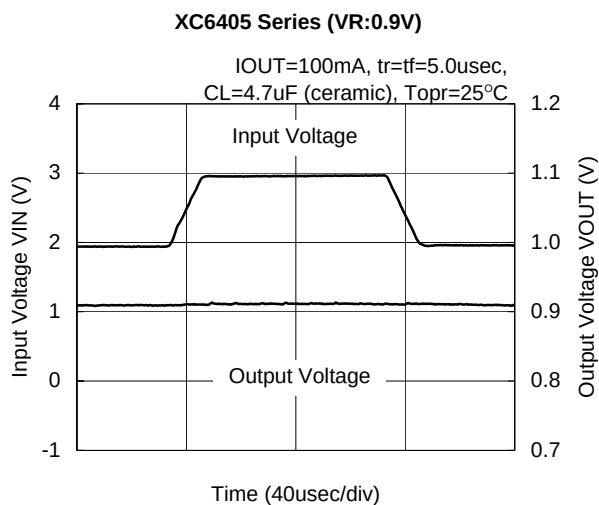
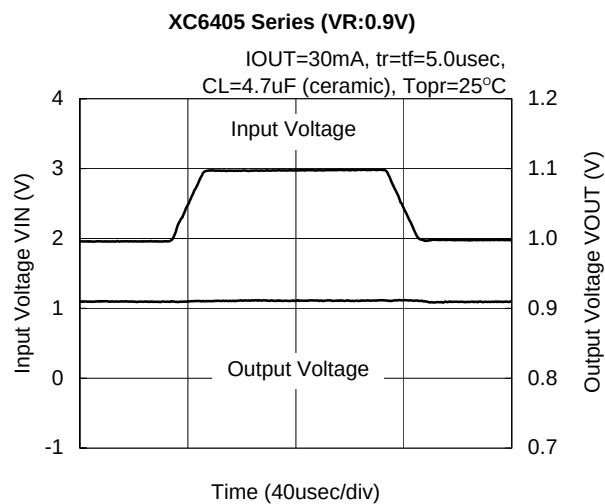
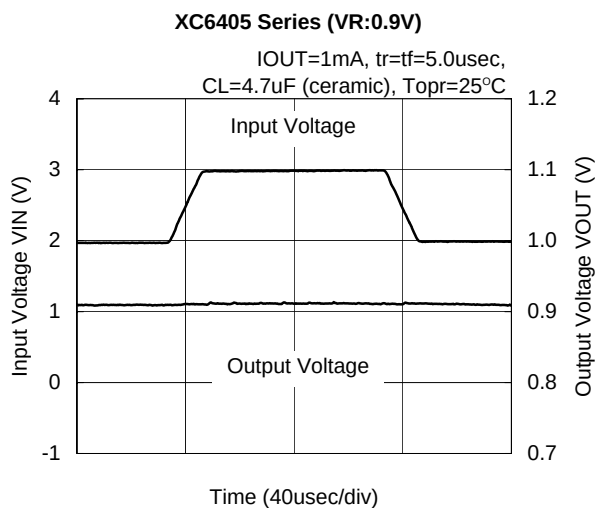
XC6405 Series (VD:5.0V)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(14) Input Transient Response

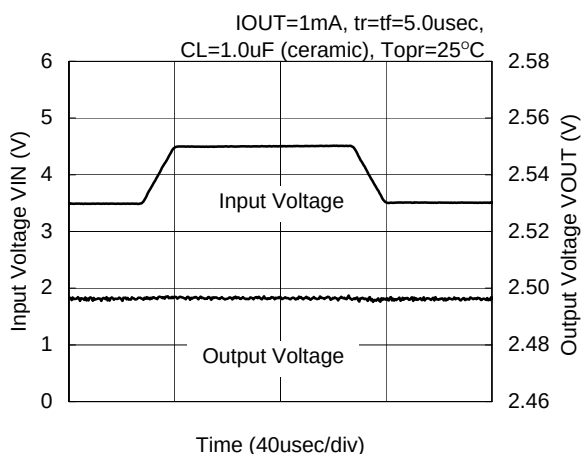


# XC6405 Series

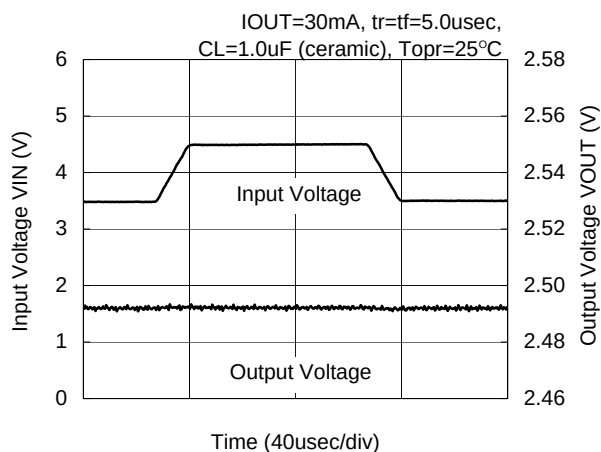
High Current, High Speed LDO Regulators, Voltage Detector Function

(14) Input Transient Response (Continued)

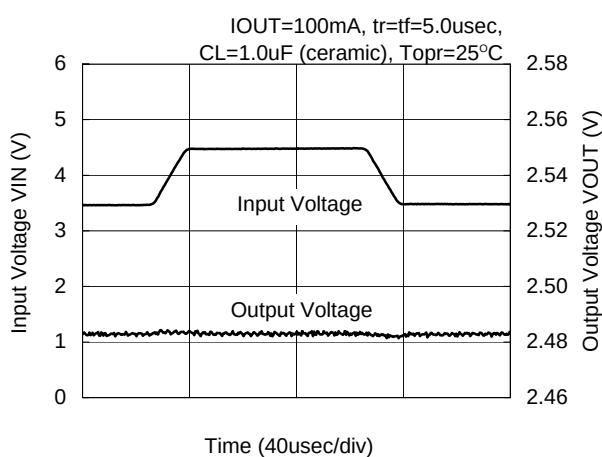
XC6405 Series (VR:2.5V)



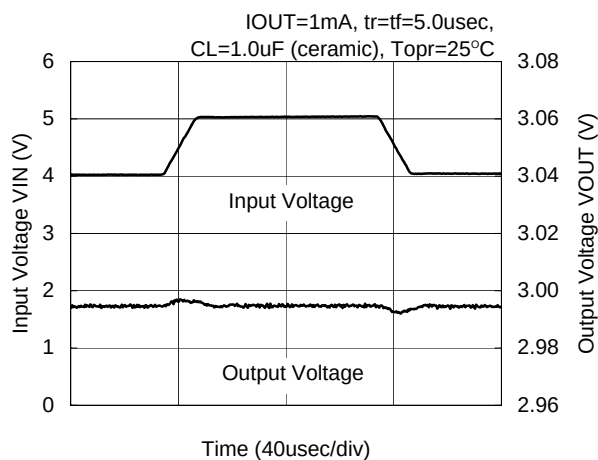
XC6405 Series (VR:2.5V)



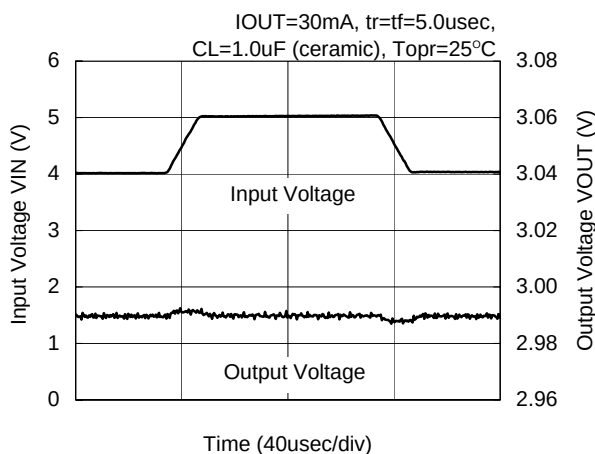
XC6405 Series (VR:2.5V)



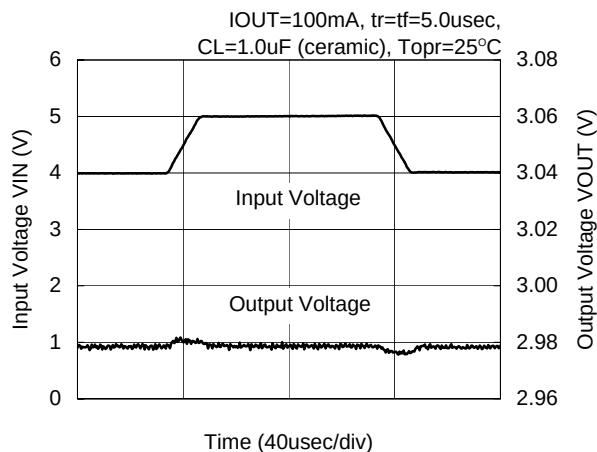
XC6405 Series (VR:3.0V)



XC6405 Series (VR:3.0V)



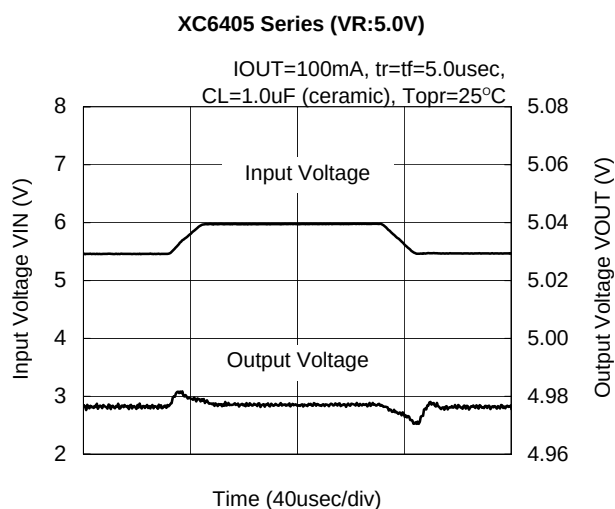
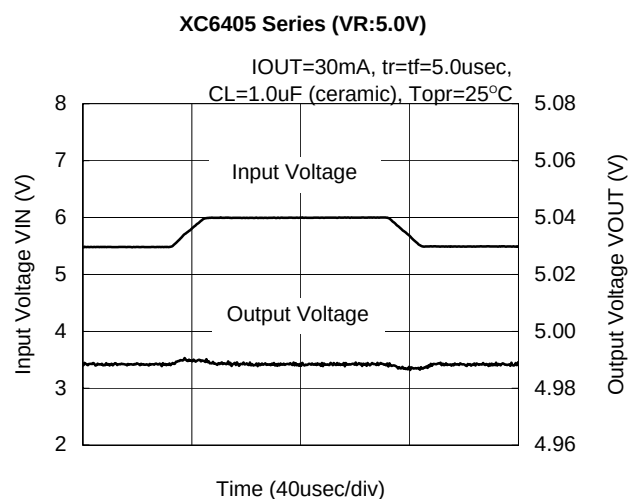
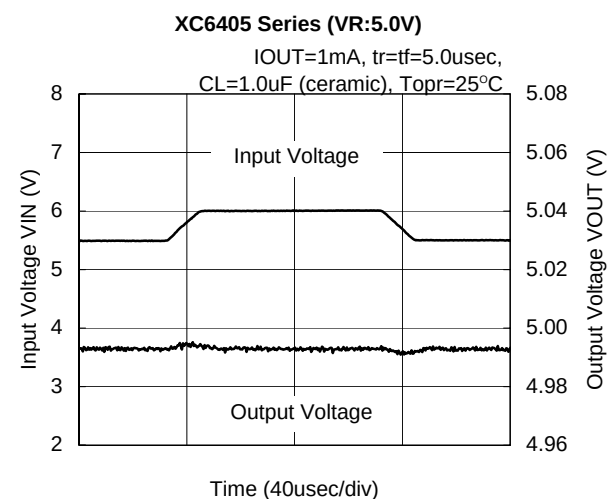
XC6405 Series (VR:3.0V)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

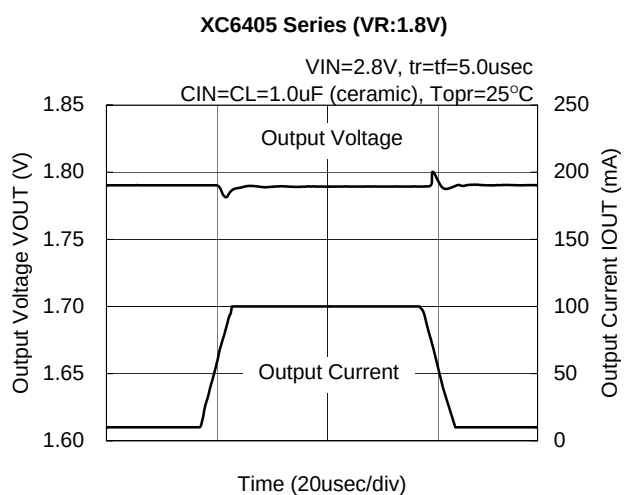
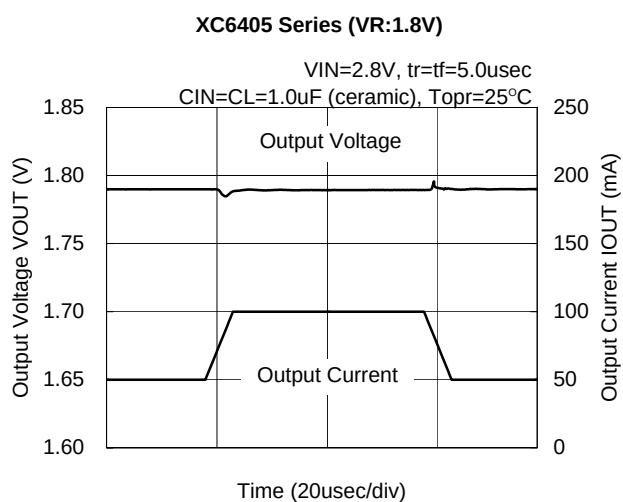
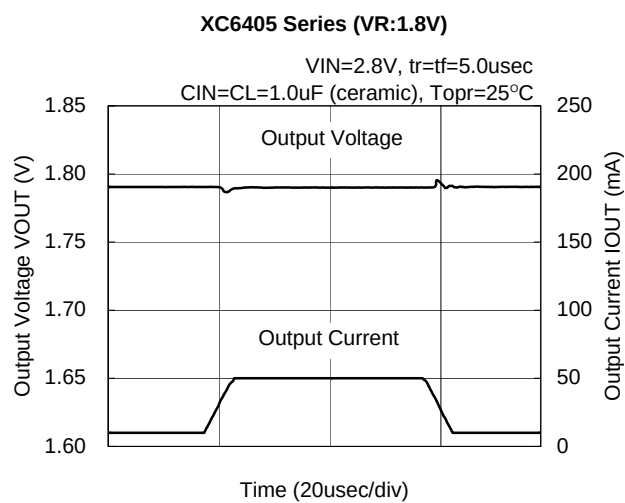
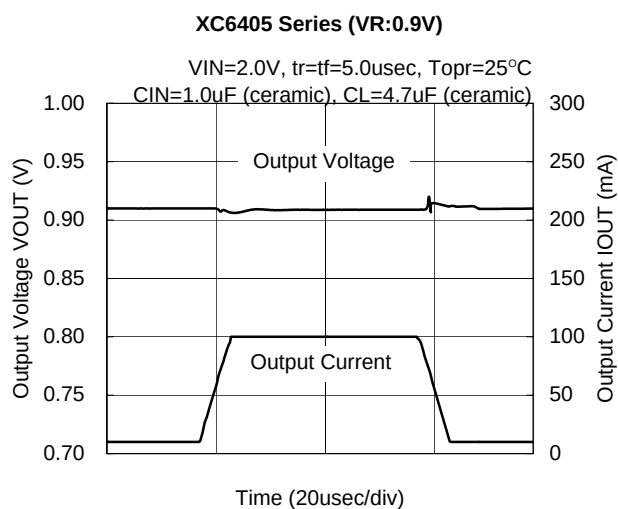
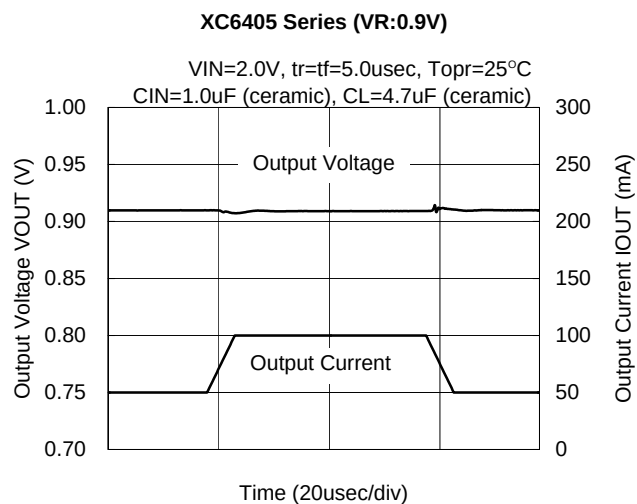
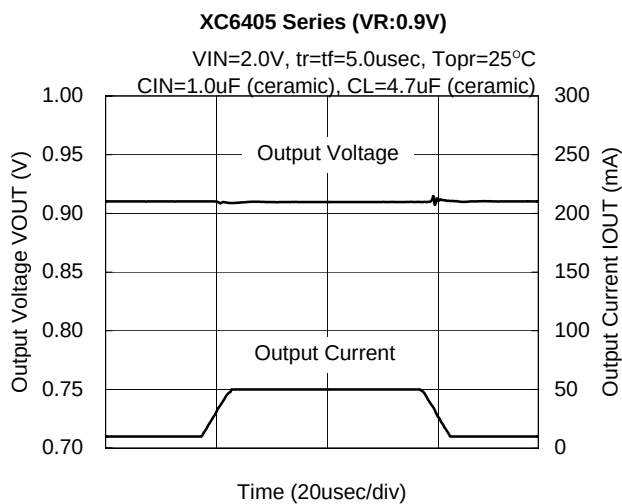
(14) Input Transient Response (Continued)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

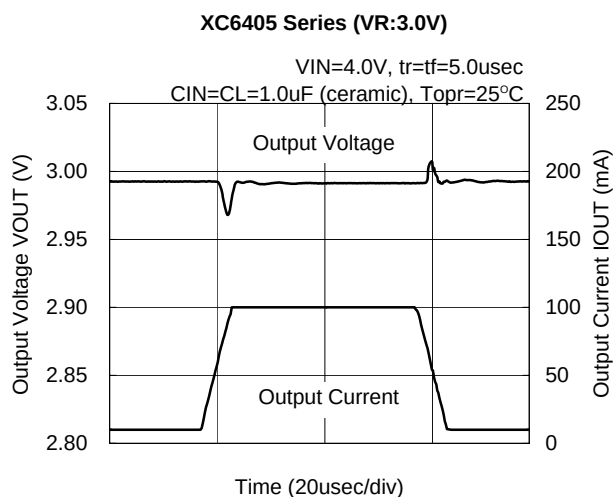
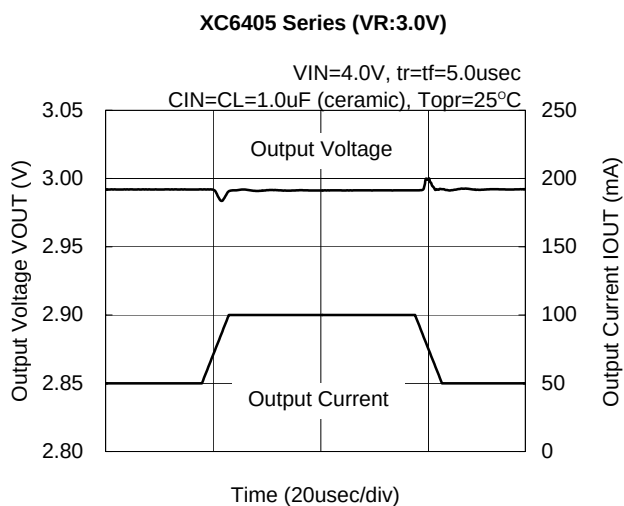
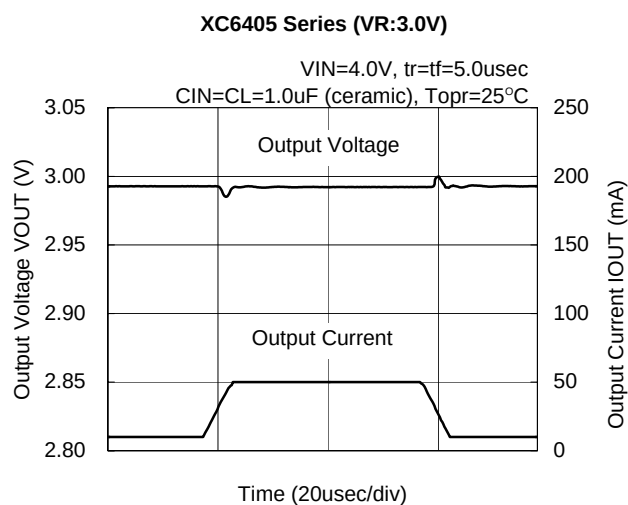
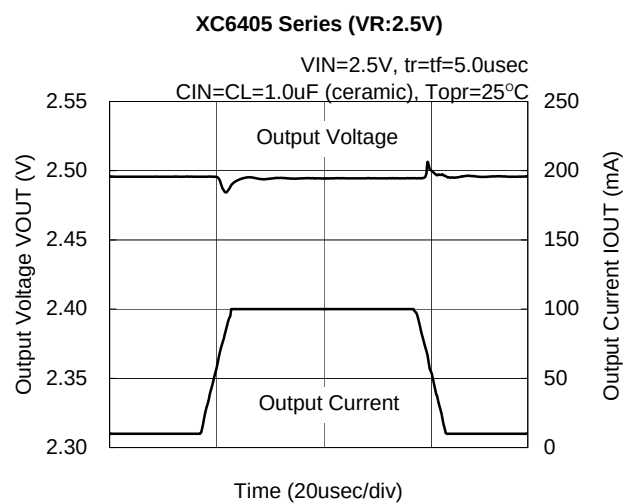
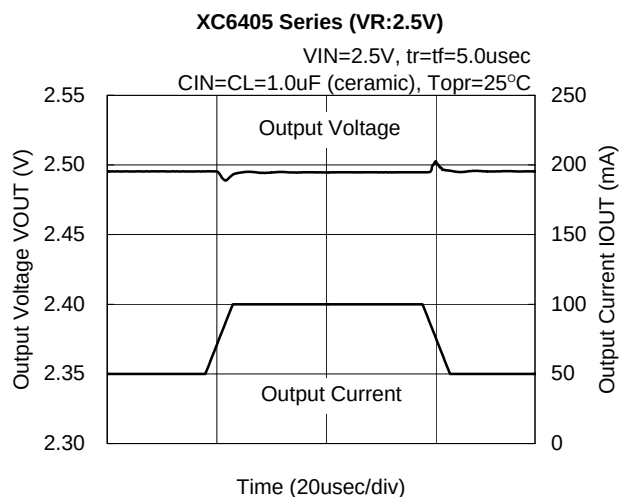
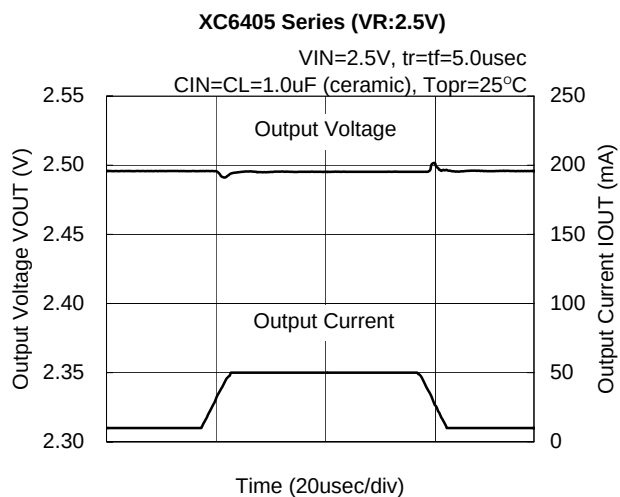
(15) Load Transient Response



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

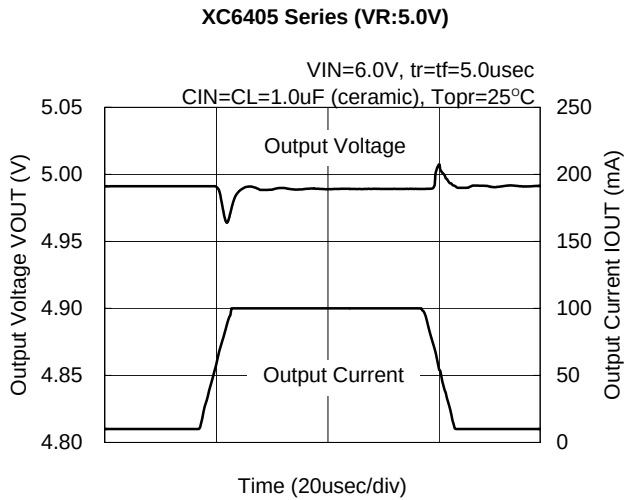
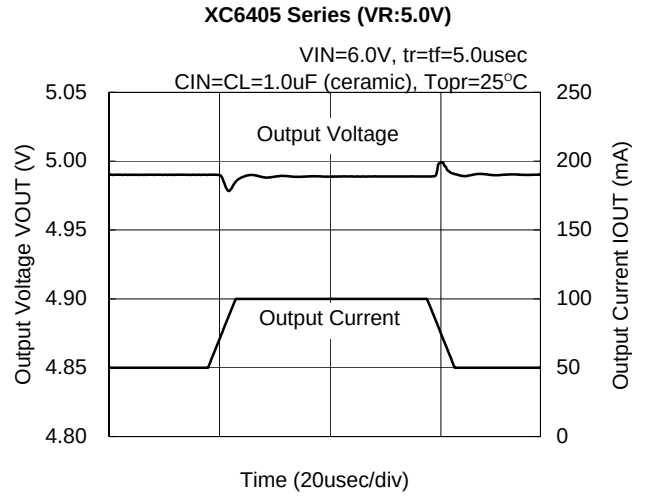
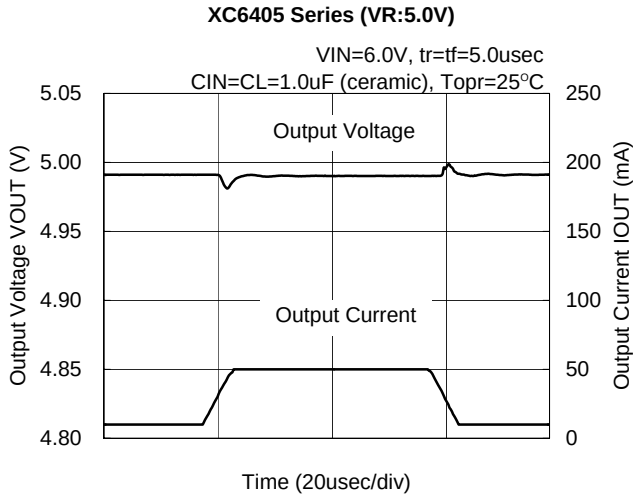
(15) Load Transient Response (Continued)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

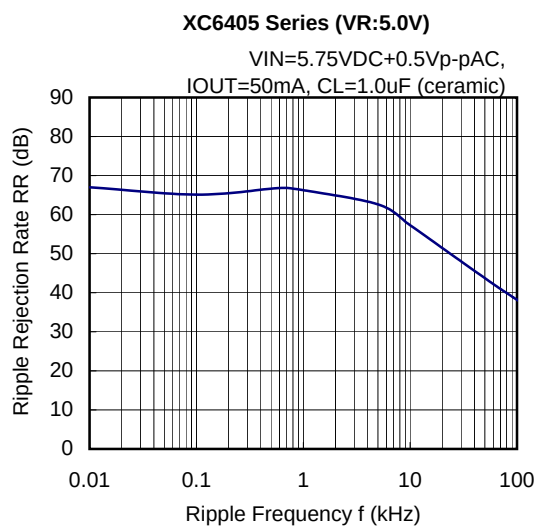
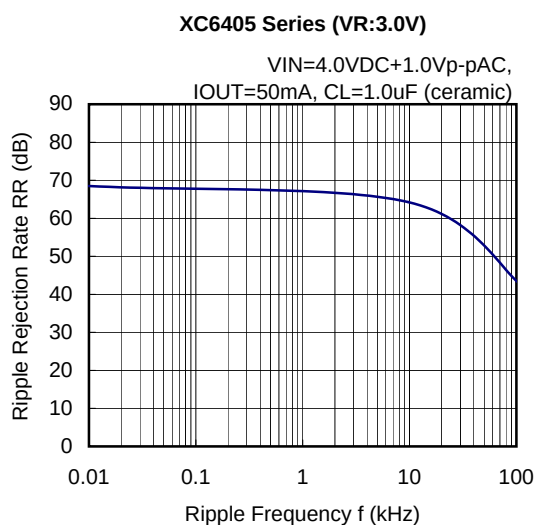
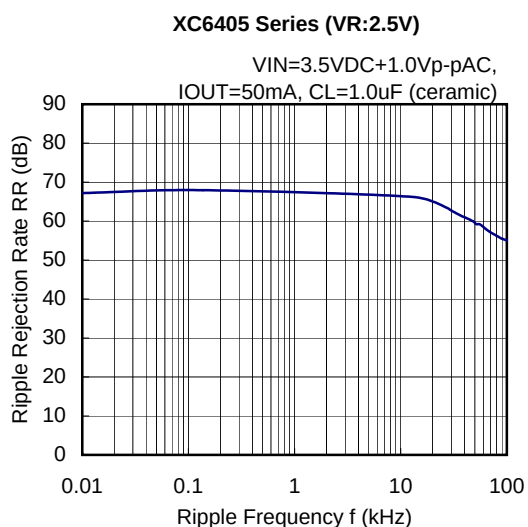
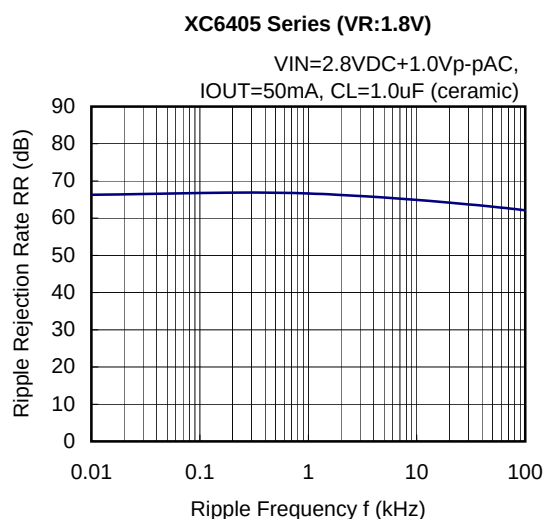
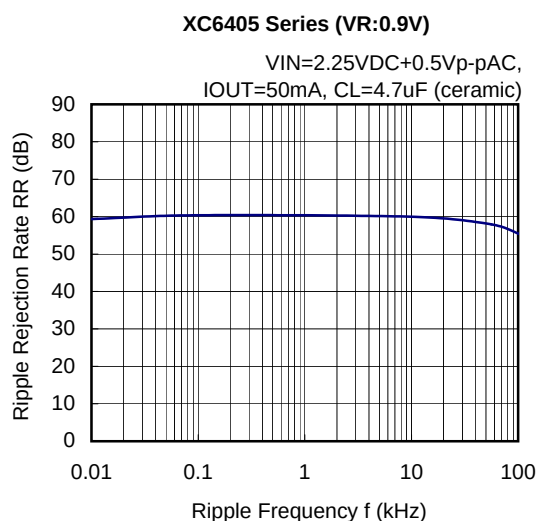
(15) Load Transient Response (Continued)



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(16) Ripple Rejection Rate

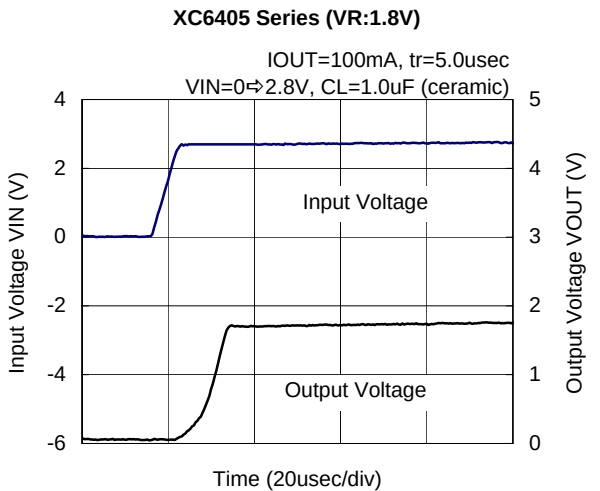
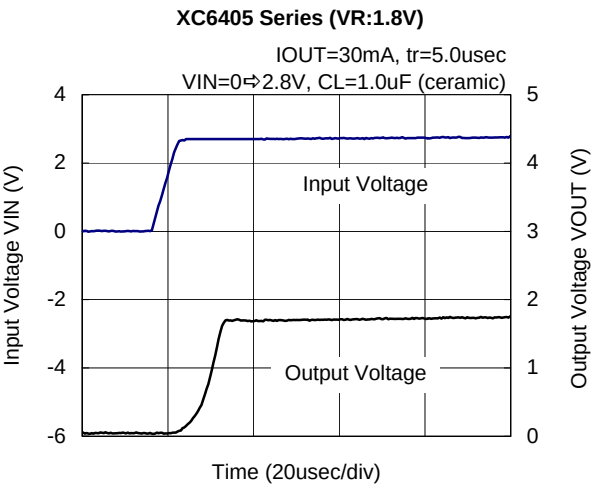
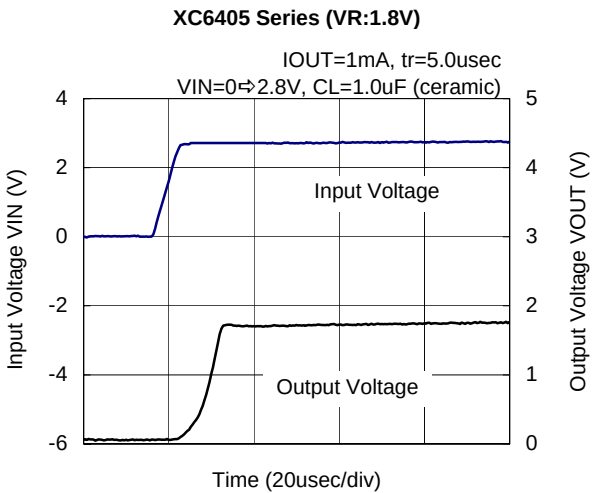
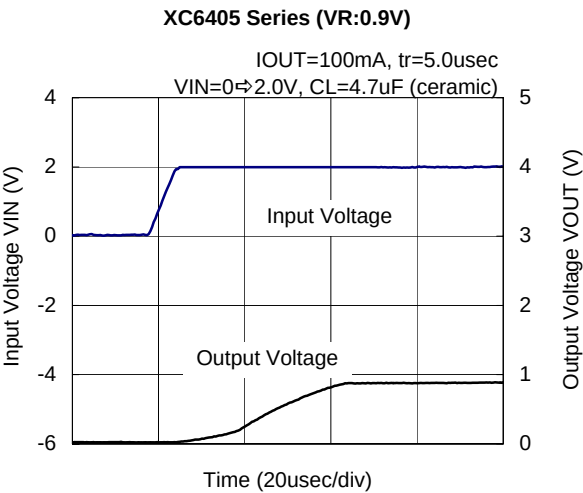
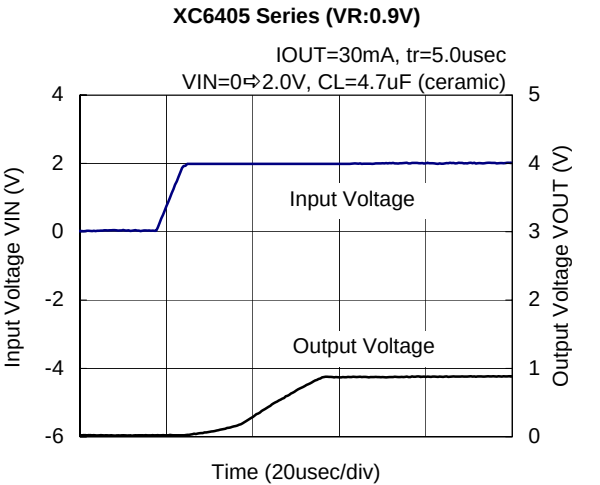
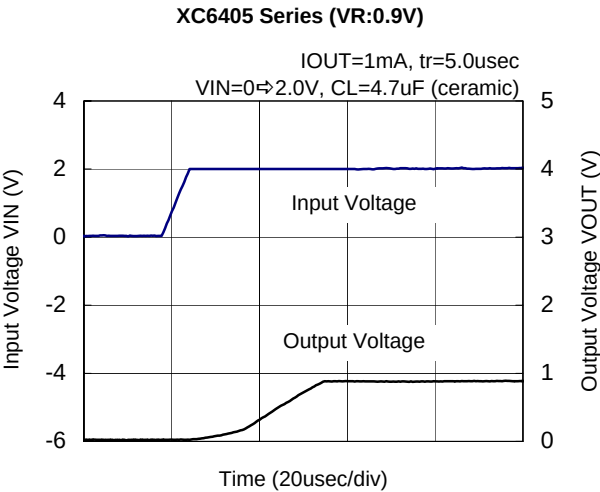




XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(17) Rising Response Time

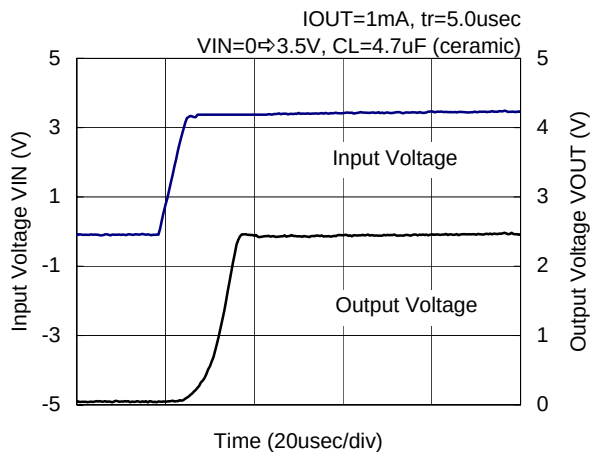


# XC6405 Series

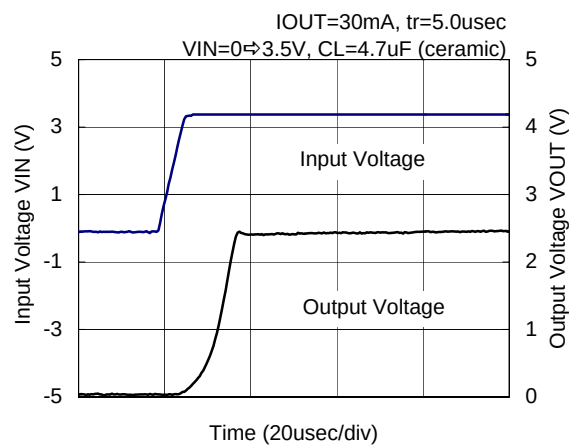
High Current, High Speed LDO Regulators, Voltage Detector Function

(17) Rising Response Time (Continued)

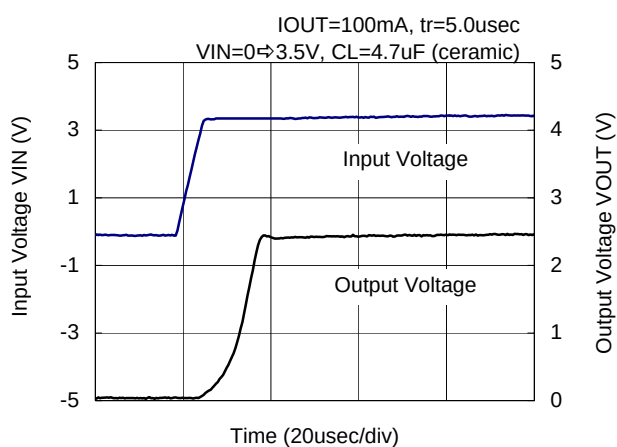
XC6405 Series (VR:2.5V)



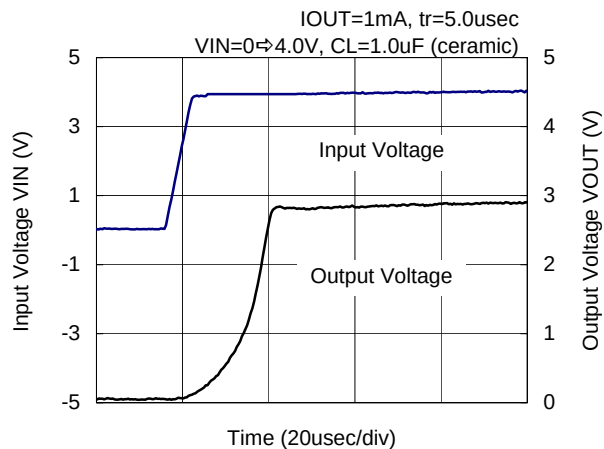
XC6405 Series (VR:2.5V)



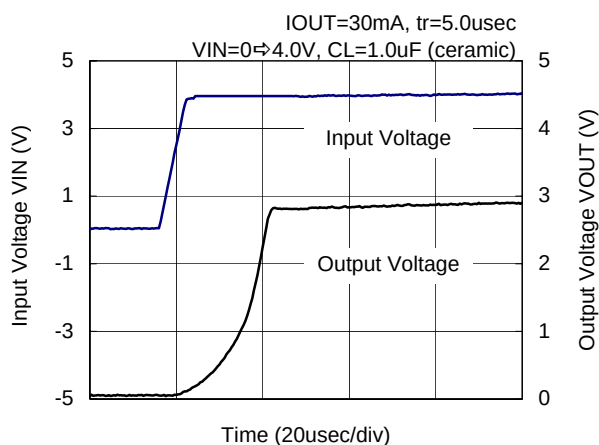
XC6405 Series (VR:2.5V)



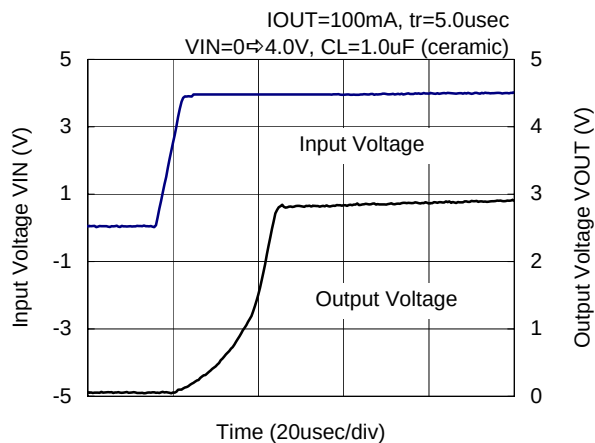
XC6405 Series (VR:3.0V)



XC6405 Series (VR:3.0V)



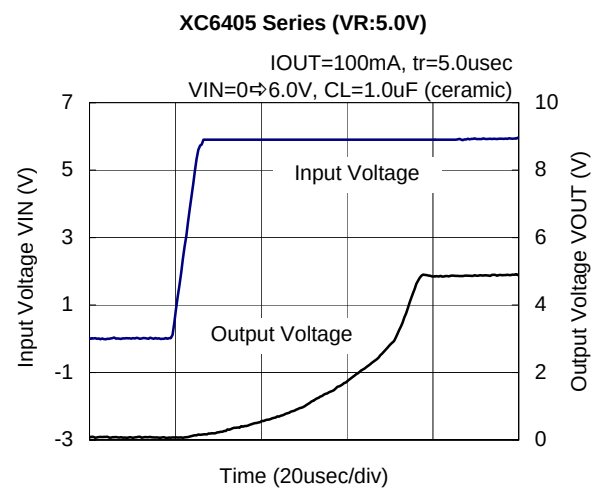
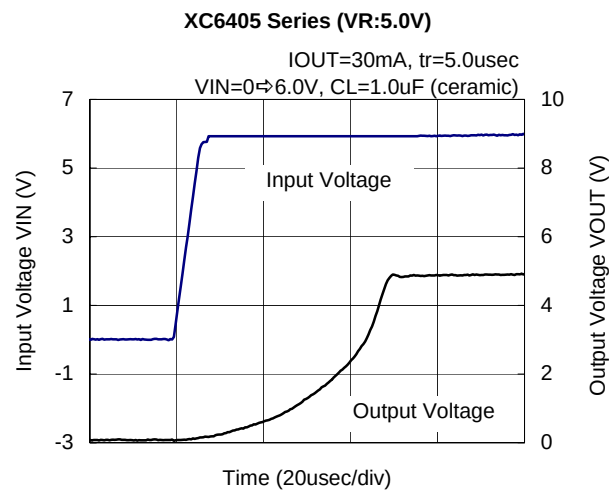
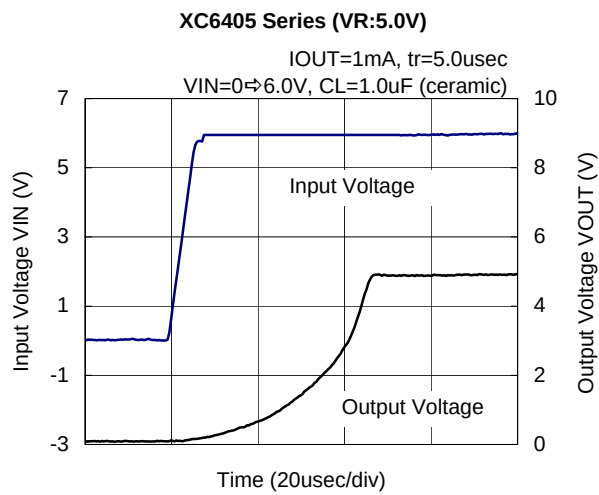
XC6405 Series (VR:3.0V)



XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

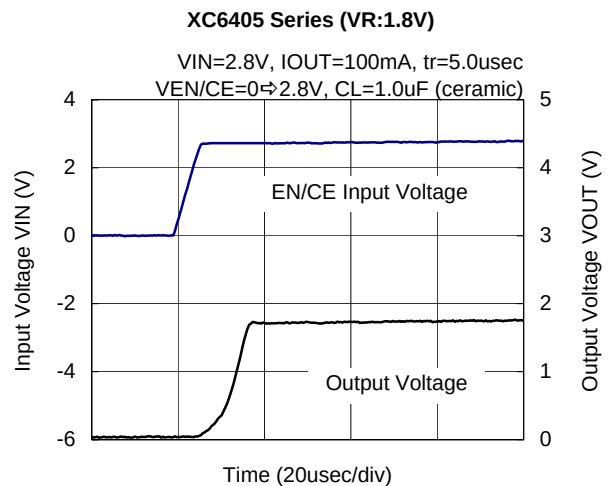
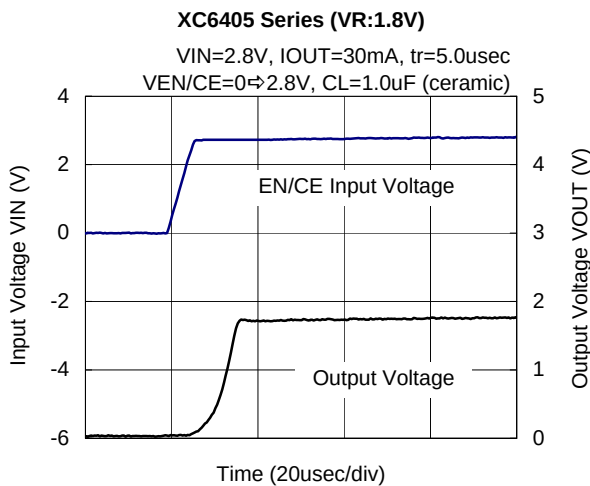
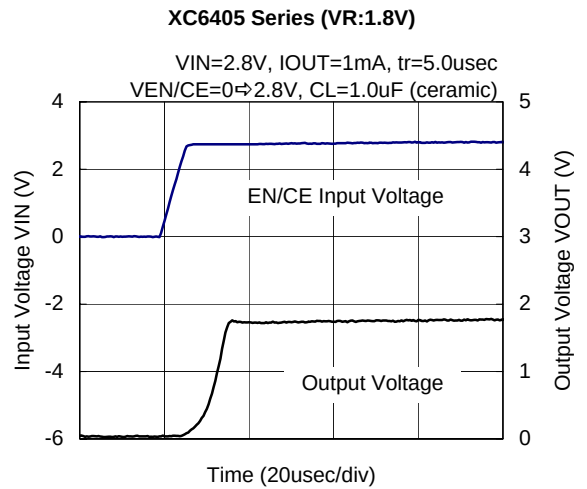
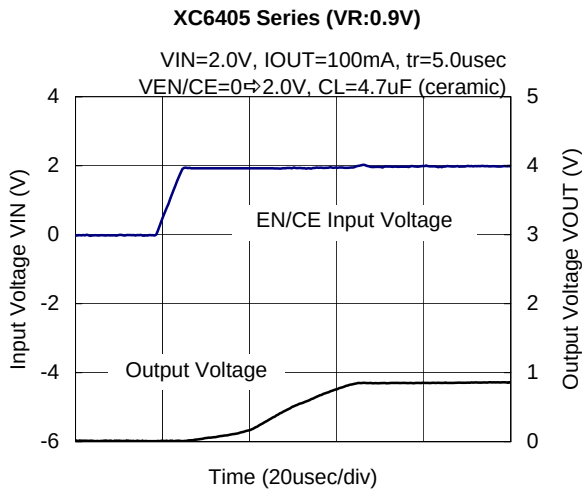
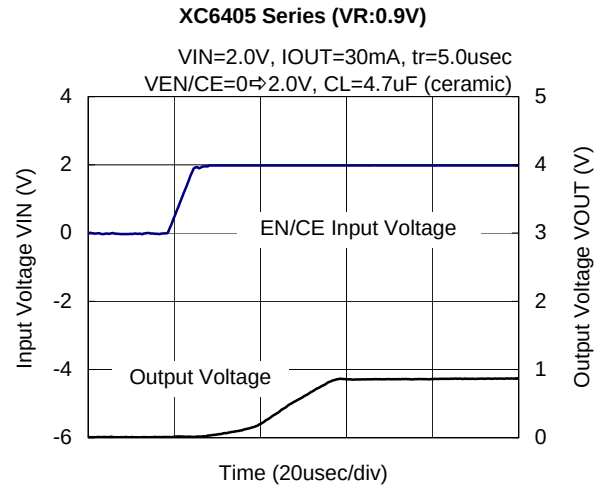
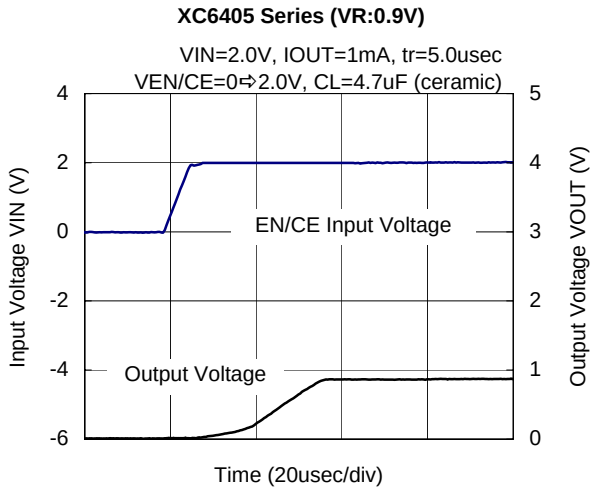
(18) EN/CE Rising Response Time



# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(18) EN/CE Rising Response Time (Continued)



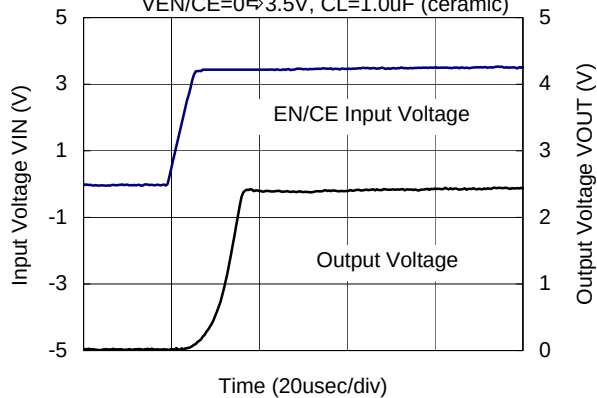
# XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(18) EN/CE Rising Response Time (Continued)

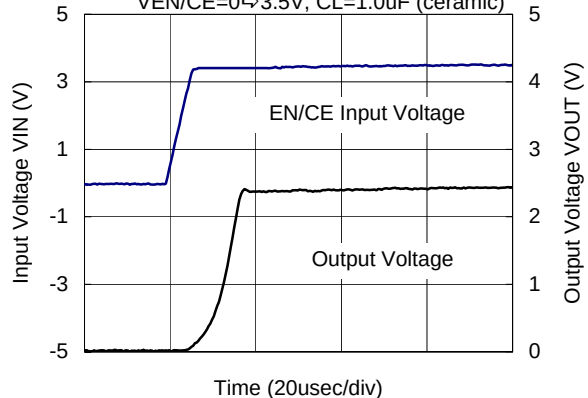
XC6405 Series (VR:2.5V)

VIN=3.5V, IOUT=1mA, tr=5.0usec  
VEN/CE=0⇒3.5V, CL=1.0uF (ceramic)



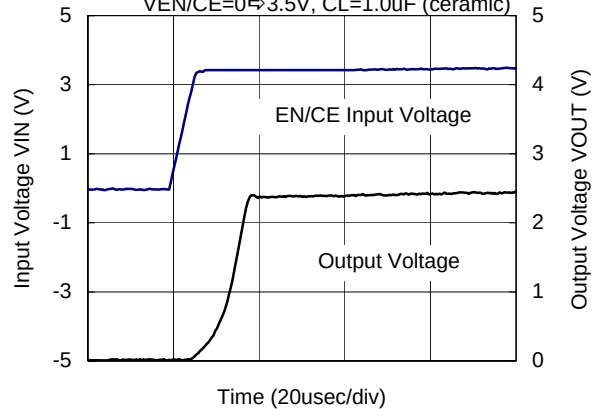
XC6405 Series (VR:2.5V)

VIN=3.5V, IOUT=30mA, tr=5.0usec  
VEN/CE=0⇒3.5V, CL=1.0uF (ceramic)



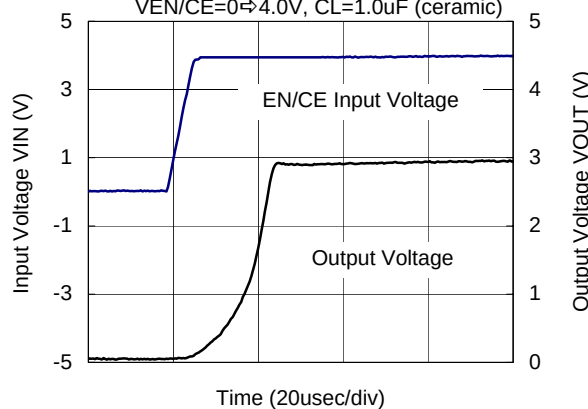
XC6405 Series (VR:2.5V)

VIN=3.5V, IOUT=100mA, tr=5.0usec  
VEN/CE=0⇒3.5V, CL=1.0uF (ceramic)



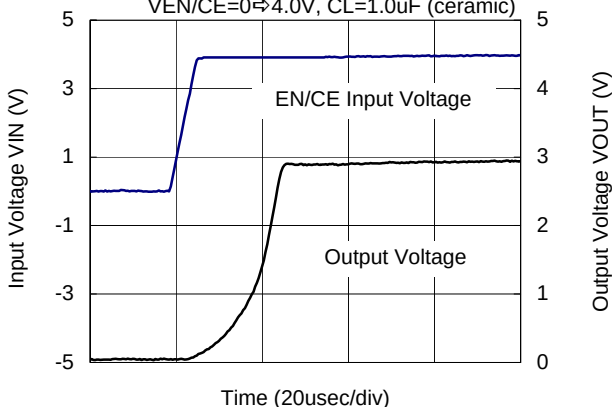
XC6405 Series (VR:3.0V)

VIN=4.0V, IOUT=1mA, tr=5.0usec  
VEN/CE=0⇒4.0V, CL=1.0uF (ceramic)



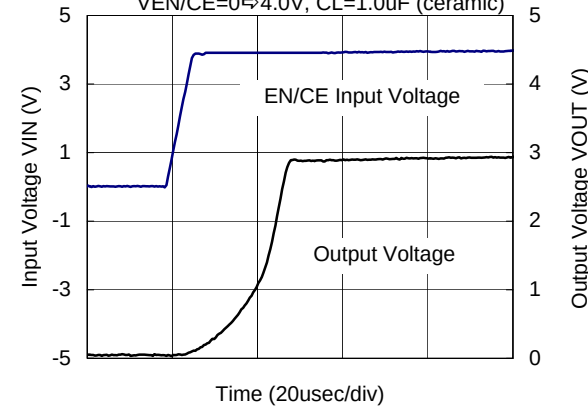
XC6405 Series (VR:3.0V)

VIN=4.0V, IOUT=30mA, tr=5.0usec  
VEN/CE=0⇒4.0V, CL=1.0uF (ceramic)



XC6405 Series (VR:3.0V)

VIN=4.0V, IOUT=100mA, tr=5.0usec  
VEN/CE=0⇒4.0V, CL=1.0uF (ceramic)



XC6405 Series

High Current, High Speed LDO Regulators, Voltage Detector Function

(18) EN/CE Rising Response Time (Continued)

