

# XC6367/XC6368 Series

ETR04001-006a

## PWM Controlled, PWM/PFM Switchable Step-up DC/DC Controllers

☆Green Operation Compatible

### ■GENERAL DESCRIPTION

The XC6367/XC6368 series are multi-functional step-up DC/DC controllers which provide high efficiency outputs by using an externally connected transistor, coil, diode and capacitor.

Output voltage is selectable in 0.1V increments within a range of 1.5V ~ 6.5V ( $\pm 2.5\%$ ). For output voltages outside this range, we recommend FB version, which has a 1.0V internal reference voltage. Using the FB version, the required output voltage can be set-up using 2 external resistors.

With a 300kHz oscillation frequency, the size of the external components can be reduced.

Control switches from PWM to PFM during light loads with the XC6368 (PWM/PFM switchable) and the series is highly efficient from light loads to large output currents.

Soft start time of XC6367/ XC6368A, B, and E series is internally set to 10ms and XC6367/68C, D, and F series regulate soft-start time by connecting resistors and capacitors externally.

During stand-by (CE pin "L"), supply current is reduced to less than  $0.5\mu\text{A}$ .

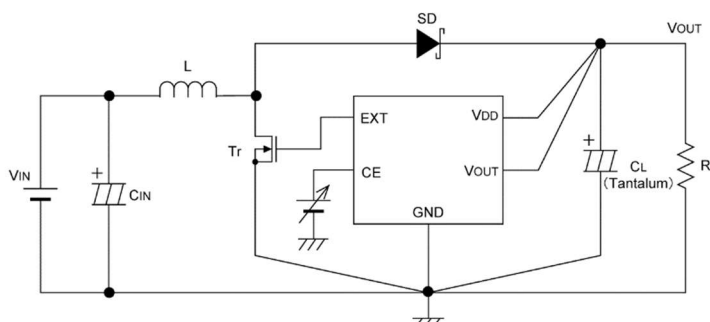
### ■APPLICATIONS

- E-book Readers / Electronic dictionaries
- Smart phones / Mobile phones
- Note PCs / Tablet PCs
- Digital audio equipments
- Multi-function power supplies

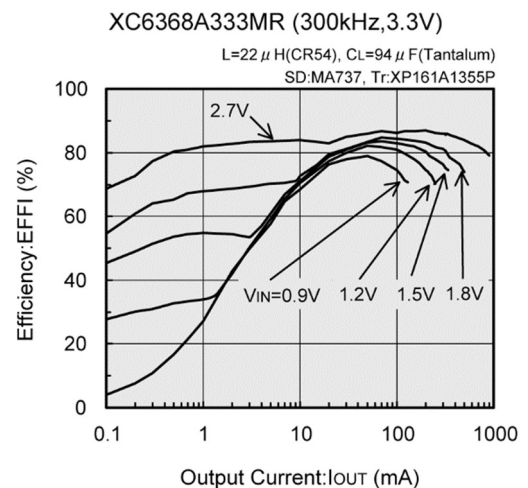
### ■FEATURES

- Input Voltage Range** : 0.9V ~ 10V
- Operating Voltage Range** : 2.0V ~ 10V
- Output Voltage Range** : 1.5V ~ 6.5V (0.1V increments) ( $\pm 2.5\%$ )
- Oscillation Frequency** : 300kHz, 100kHz ( $\pm 15\%$ )  
Custom products for 180kHz, 500kHz
- Output Current** : More than 200mA ( $V_{\text{IN}}=1.8\text{V}$ ,  $V_{\text{OUT}}=3.3\text{V}$ )
- High Efficiency** : 84% (TYP.)
- Stand-by capability** :  $I_{\text{STB}}=0.5\mu\text{A}$  (MAX.)
- Selection** : Soft-start set-up external  
Output voltage set-up internal ( $V_{\text{OUT}}$ )  
Output voltage set-up external (FB)  
PWM/PFM Control (XC6368)
- Package** : SOT-25
- Environmentally Friendly** : EU RoHS Compliant, Pb Free

### ■TYPICAL APPLICATION CIRCUIT



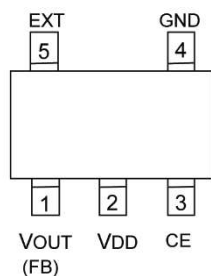
### ■TYPICAL PERFORMANCE CHARACTERISTICS



## PIN CONFIGURATION

XC6367/XC6368 series

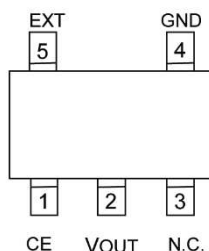
A, B, C, D types



SOT-25  
(TOP VIEW)

XC6367/XC6368 series

E, F types



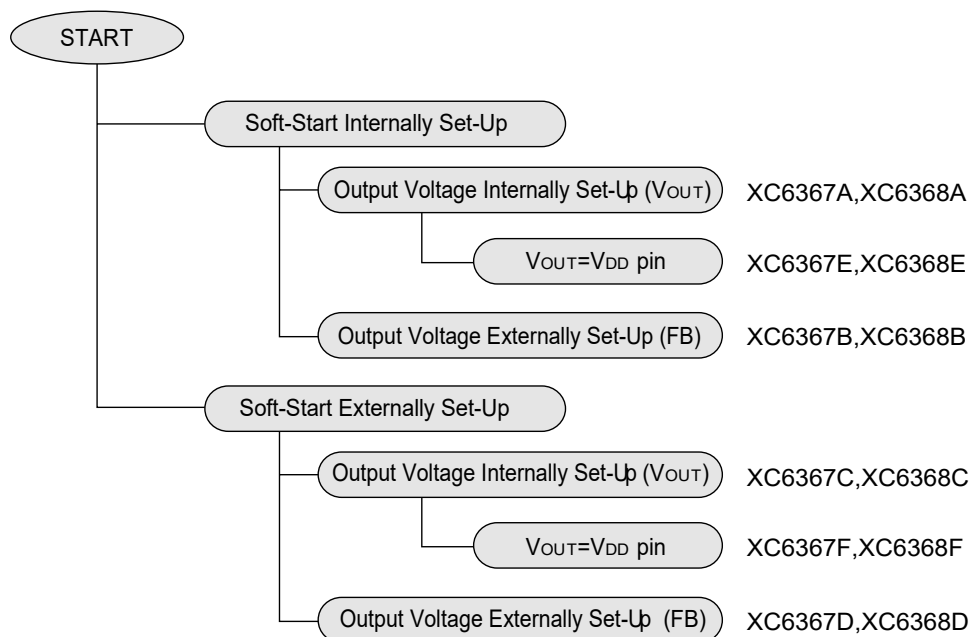
SOT-25  
(TOP VIEW)

## PIN ASSIGNMENT

| PIN NUMBER    |      | PIN NAME     | FUNCTION                                                                                                                     |
|---------------|------|--------------|------------------------------------------------------------------------------------------------------------------------------|
| XC6367/XC6368 |      |              |                                                                                                                              |
| A, B, C, D    | E, F |              |                                                                                                                              |
| 5             | 5    | EXT          | External Transistor Connection                                                                                               |
| 2             | -    | VDD          | Supply Voltage Input                                                                                                         |
| 4             | 4    | GND          | Ground                                                                                                                       |
| 3             | 1    | CE           | Chip Enable<br>(C, D, F Types: Soft Start External Set-Up,<br>Soft Start Capacitor Connected)                                |
| 1             | 2    | VOUT<br>(FB) | Output Voltage Monitor<br>(E, F Types: Output Voltage Monitor, Power Supply)<br>(B, D Types: Output Voltage External Set-up) |

## PRODUCT CLASSIFICATION

### Selection Guide



## ■ PRODUCT CLASSIFICATION (Continued)

### ● Ordering Information

(a) VOUT type: VOUT internally set-up

XC6367①②③④⑤⑥-⑦<sup>(\*)</sup> PWM Control  
XC6368①②③④⑤⑥-⑦<sup>(\*)</sup> PWM/PFM Switching Control

| DESIGNATOR | ITEM                  | SYMBOL  | DESCRIPTION                                                     |
|------------|-----------------------|---------|-----------------------------------------------------------------|
| ①          | Type                  | A       | VOUT type: VOUT internally set-up, Soft-start internally set-up |
|            |                       | C       | VOUT type: VOUT internally set-up, Soft-start externally set-up |
|            |                       | E       | VOUT type: VOUT internally set-up, Soft-start internally set-up |
|            |                       | F       | VOUT type: VOUT internally set-up, Soft-start externally set-up |
| ②③         | Output Voltage        | 15 ~ 65 | VOUT type: 3.0V output → ②=3, ③=0                               |
| ④          | Oscillation Frequency | 3       | 300kHz                                                          |
|            |                       | 1       | 100kHz                                                          |
|            |                       | 2       | 180kHz (Custom)                                                 |
| ⑤⑥-⑦       | Package (Order Unit)  | MR-G    | SOT-25 (3,000/Reel)                                             |

<sup>(\*)</sup> The “-G” suffix indicates that the products are Halogen and Antimony free as well as being fully EU RoHS compliant.

(b) FB type: VOUT externally set-up

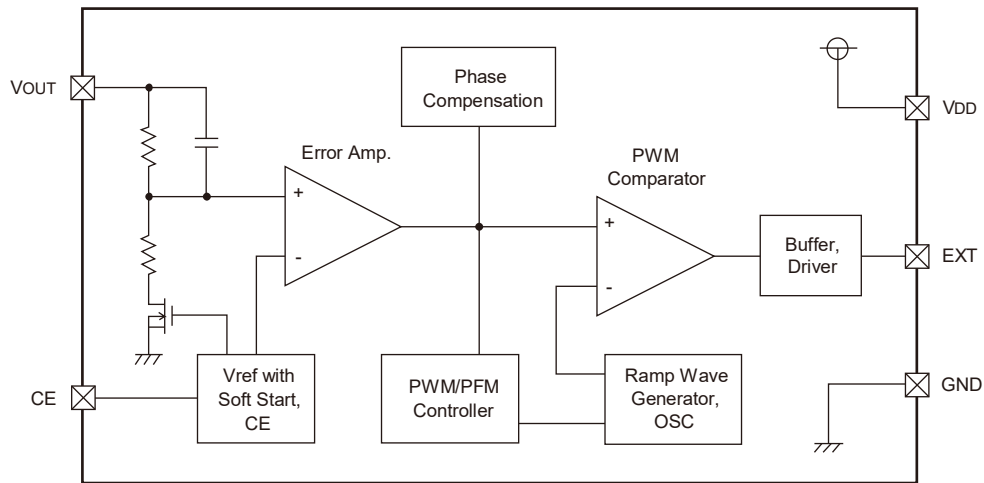
XC6367①②③④⑤⑥-⑦<sup>(\*)</sup> PWM Control  
XC6368①②③④⑤⑥-⑦<sup>(\*)</sup> PWM/PFM Switching Control

| DESIGNATOR | ITEM                  | SYMBOL | DESCRIPTION                                                   |
|------------|-----------------------|--------|---------------------------------------------------------------|
| ①          | Type                  | B      | FB type: VOUT externally set-up, Soft-start internally set-up |
|            |                       | D      | FB type: VOUT externally set-up, Soft-start externally set-up |
| ②③         | FB Voltage            | 10     | FB type                                                       |
| ④          | Oscillation Frequency | 3      | 300kHz                                                        |
|            |                       | 1      | 100kHz                                                        |
|            |                       | 2      | 180kHz (Custom)                                               |
|            |                       | 5      | 500kHz (Custom)                                               |
| ⑤⑥-⑦       | Package (Order Unit)  | MR-G   | SOT-25 (3,000/Reel)                                           |

<sup>(\*)</sup> The “-G” suffix indicates that the products are Halogen and Antimony free as well as being fully EU RoHS compliant.

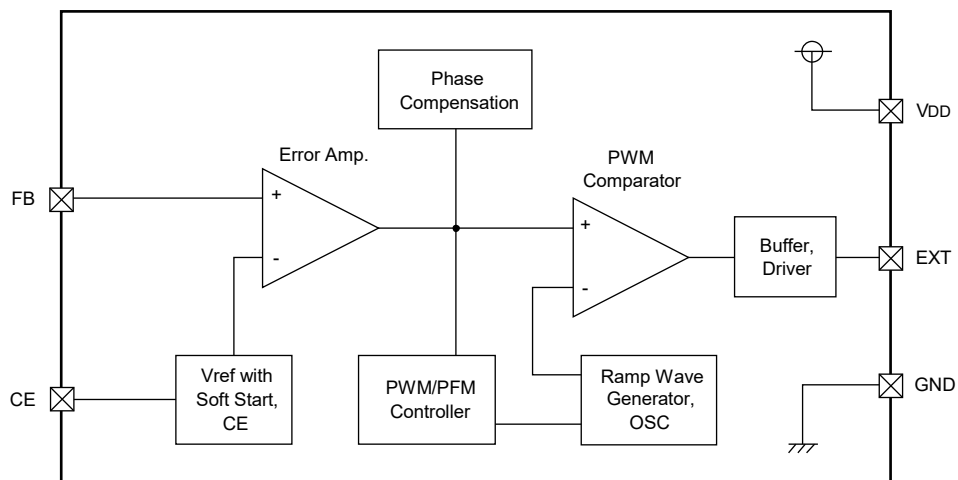
## BLOCK DIAGRAMS

XC6367, XC6368 Series A, C, E, F types (VOUT)



\* VOUT and VDD of the E and F types should be connected internally.

XC6367, XC6368 Series B, D types (FB)



## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER                      | SYMBOL           | RATINGS                      | UNITS                                            |
|--------------------------------|------------------|------------------------------|--------------------------------------------------|
| V <sub>DD</sub> Pin Voltage    | V <sub>DD</sub>  | -0.3 ~ 12.0                  | V                                                |
| V <sub>OUT</sub> Pin Voltage   | V <sub>OUT</sub> | -0.3 ~ 12.0                  | V                                                |
| FB Pin Voltage                 | V <sub>FB</sub>  | -0.3 ~ 12.0                  | V                                                |
| CE Pin Voltage                 | V <sub>CE</sub>  | -0.3 ~ 12.0                  | V                                                |
| EXT Pin Voltage                | V <sub>EXT</sub> | -0.3 ~ V <sub>DD</sub> + 0.3 | V                                                |
| EXT Pin Current                | I <sub>EXT</sub> | ±100                         | mA                                               |
| Power Dissipation<br>(Ta=25°C) | SOT-25           | Pd                           | 150                                              |
|                                |                  |                              | 600 (40mm x 40mm standard board) <sup>(*)1</sup> |
|                                |                  |                              | 760 (JESD51-7 board) <sup>(*)1</sup>             |
| Operating Temperature Range    | T <sub>opr</sub> | -30 ~ 80                     | °C                                               |
| Storage Temperature Range      | T <sub>stg</sub> | -40 ~ 125                    | °C                                               |

\* Voltage is all ground standardized.

<sup>(\*)1</sup> Please refer to PACKAGING INFORMATION for the mounting conditions.

## ■ ELECTRICAL CHARACTERISTICS

XC6367A333MR, XC6368A333MR

V<sub>OUT</sub>=3.3V, F<sub>OSC</sub>=300kHz, Ta=25°C

| PARAMETER                      | SYMBOL            | CONDITIONS                                                          | MIN.  | TYP.  | MAX.  | UNITS |
|--------------------------------|-------------------|---------------------------------------------------------------------|-------|-------|-------|-------|
| Output Voltage                 | V <sub>OUT</sub>  |                                                                     | 3.218 | 3.300 | 3.383 | V     |
| Supply Voltage <sup>(*)1</sup> | V <sub>DD</sub>   |                                                                     | 2.0   | -     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | -     | -     | V     |
| Oscillation Start Voltage 1    | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                | -     | -     | 0.9   | V     |
| Oscillation Start Voltage 2    | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE: Apply voltage                                 | -     | -     | 0.8   | V     |
| Oscillation Hold Voltage       | V <sub>HLD</sub>  | Tr: Use of a 2SX1628, I <sub>OUT</sub> =1.0mA                       | -     | -     | 0.7   | V     |
| Supply Current 1               | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=setting output voltage x 0.95                  | -     | 130   | 200   | μA    |
| Supply Current 2               | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=setting output voltage + 0.5V                  | -     | 20    | 35    | μA    |
| Stand-by Current               | I <sub>STB</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95, CE=0V              | -     | -     | 0.5   | μA    |
| Oscillator Frequency           | F <sub>OSC</sub>  | Same as I <sub>DD1</sub>                                            | 255   | 300   | 345   | kHz   |
| Maximum Duty Ratio             | MAXDTY            | Same as I <sub>DD1</sub>                                            | 78    | 85    | 92    | %     |
| PFM Duty Ratio <sup>(*)3</sup> | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "H" Voltage                 | V <sub>CEH</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95                     | 0.65  | -     | -     | V     |
| CE "L" Voltage                 | V <sub>CEL</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95                     | -     | -     | 0.20  | V     |
| EXT "H" ON Resistance          | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V | -     | 29    | 43    | Ω     |
| EXT "L" ON Resistance          | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | -     | 19    | 27    | Ω     |
| Efficiency <sup>(*)2</sup>     | EFFI              |                                                                     | -     | 84    | -     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | ms    |

Conditions: Unless otherwise stated, connect V<sub>DD</sub> to V<sub>OUT</sub>; V<sub>IN</sub>=setting output voltage x 0.6, I<sub>OUT</sub>=130mA

NOTE:

\* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.

Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.

\* 2: EFFI = [(output voltage) x (output current)] ÷ [(input voltage) x (input current)] x 100

\* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ELECTRICAL CHARACTERISTICS (Continued)

XC6367A503MR, XC6368A503MR

V<sub>OUT</sub>=5.0V, F<sub>OSC</sub>=300kHz, T<sub>a</sub>=25°C

| PARAMETER                   | SYMBOL            | CONDITIONS                                                                                      | MIN. | TYP.  | MAX.  | UNITS |
|-----------------------------|-------------------|-------------------------------------------------------------------------------------------------|------|-------|-------|-------|
| Output Voltage              | V <sub>OUT</sub>  |                                                                                                 | 4875 | 5.000 | 5.125 | V     |
| Supply Voltage (*1)         | V <sub>DD</sub>   |                                                                                                 | 2.0  | -     | 10.0  | V     |
| Maximum Input Voltage       | V <sub>IN</sub>   |                                                                                                 | 10.0 | -     | -     | V     |
| Oscillation Start Voltage 1 | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                                            | -    | -     | 0.9   | V     |
| Oscillation Start Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE : Apply voltage                                                            | -    | -     | 0.8   | V     |
| Oscillation Hold Voltage    | V <sub>HLD</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                                            | -    | -     | 0.7   | V     |
| Supply Current 1            | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=setting output voltage x 0.95                                              | -    | 180   | 280   | μA    |
| Supply Current 2            | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=setting output voltage + 0.5V                                              | -    | 22    | 38    | μA    |
| Stand-by Current            | I <sub>STB</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95, CE=0V                                          | -    | -     | 0.5   | μA    |
| Oscillation Frequency       | F <sub>OSC</sub>  | Same as I <sub>DD1</sub>                                                                        | 255  | 300   | 345   | kHz   |
| Maximum Duty Ratio          | MAXDTY            | Same as I <sub>DD1</sub>                                                                        | 78   | 85    | 92    | %     |
| PFM Duty Ratio (*3)         | PFMDTY            | I <sub>OUT</sub> =0mA                                                                           | 15   | 25    | 35    | %     |
| CE "H" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =setting output voltage x0.95                                                  | 0.65 | -     | -     | V     |
| CE "L" Voltage              | V <sub>CEL</sub>  | V <sub>OUT</sub> =setting output voltage x0.95                                                  | -    | -     | 0.20  | V     |
| EXT "H" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V                             | -    | 20    | 29    | Ω     |
| EXT "L" ON Resistance       | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                                               | -    | 13    | 19    | Ω     |
| Efficiency (*2)             | EFFI              |                                                                                                 | -    | 87    | -     | %     |
| Soft-Start Time             | T <sub>SS</sub>   | Connect R <sub>SS</sub> and C <sub>SS</sub> ,<br>CE:0V→3.0V<br>(XC6367C/F and XC6368C/F series) | 5    | 10    | 20    | ms    |

Conditions: Unless otherwise specified, connect V<sub>DD</sub> to V<sub>OUT</sub>; V<sub>IN</sub>=setting output voltage x 0.6, I<sub>OUT</sub>=200mA

### NOTE:

- \* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.
- \* 2:  $EFFI = \{[(\text{output voltage}) \times (\text{output current})] \div [(\text{input voltage}) \times (\text{input current})]\} \times 100$
- \* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).
- \* 4: The values of supply voltage and NOTE \*1 do not apply to XC6367E/F and XC6368E/F series. For XC6367E/F and XC6368E/F series, output voltage less than 2.0V cannot be set-up.

## ■ ELECTRICAL CHARACTERISTICS (Continued)

XC6367B103MR, XC6368B103MR

V<sub>OUT</sub>=3.0V, F<sub>OSC</sub>=300kHz, T<sub>a</sub>=25°C

| PARAMETER                   | SYMBOL            | CONDITIONS                                                                       | MIN.  | TYP.  | MAX.  | UNITS |
|-----------------------------|-------------------|----------------------------------------------------------------------------------|-------|-------|-------|-------|
| Output Voltage              | V <sub>OUT</sub>  |                                                                                  | 2.925 | 3.000 | 3.075 | V     |
| Supply Voltage (*1)         | V <sub>DD</sub>   |                                                                                  | 2.0   | -     | 10.0  | V     |
| Maximum Input Voltage       | V <sub>IN</sub>   |                                                                                  | 10.0  | -     | -     | V     |
| Oscillation Start Voltage 1 | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                             | -     | -     | 0.9   | V     |
| Oscillation Start Voltage 2 | V <sub>ST2</sub>  | V <sub>DD</sub> =CE: Apply voltage, FB=0V                                        | -     | -     | 0.8   | V     |
| Oscillation Hold Voltage    | V <sub>HLD</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                             | -     | -     | 0.7   | V     |
| Supply Current 1            | I <sub>DD1</sub>  | V <sub>DD</sub> =CE=2.85V, FB=0V                                                 | -     | 120   | 190   | μA    |
| Supply Current 2            | I <sub>DD2</sub>  | V <sub>DD</sub> =CE=3.5V, FB=1.2V                                                | -     | 20    | 34    | μA    |
| Stand-by Current            | I <sub>STB</sub>  | V <sub>DD</sub> =2.85V, CE=0V, FB=0V                                             | -     | -     | 0.5   | μA    |
| Oscillation Frequency       | F <sub>OSC</sub>  | Same as I <sub>DD1</sub>                                                         | 255   | 300   | 345   | kHz   |
| Maximum Duty Ratio          | MAXDTY            | Same as I <sub>DD1</sub>                                                         | 78    | 85    | 92    | %     |
| PFM Duty Ratio (*3)         | PFMDTY            | I <sub>OUT</sub> =0mA                                                            | 15    | 25    | 35    | %     |
| CE "H" Voltage              | V <sub>CEH</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                                    | 0.65  | -     | -     | V     |
| CE "L" Voltage              | V <sub>CEL</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                                    | -     | -     | 0.20  | V     |
| EXT "H" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>DD</sub> -0.4V               | -     | 32    | 47    | Ω     |
| EXT "L" ON Resistance       | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                                | -     | 20    | 30    | Ω     |
| Efficiency (*2)             | EFFI              |                                                                                  | -     | 84    | -     | %     |
| Soft-Start Time             | T <sub>SS</sub>   | Connect R <sub>SS</sub> and C <sub>SS</sub> ,<br>CE:0V→3.0V (XC6367D/68D series) | 5     | 10    | 20    | ms    |

Conditions: Unless otherwise stated, V<sub>IN</sub>=1.8V, I<sub>OUT</sub>=120mA  
External components : R<sub>FB1</sub> = 400kΩ, R<sub>FB2</sub> = 200kΩ, C<sub>FB</sub> = 47pF

### NOTE:

- \* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.
- \* 2:  $EFFI = \frac{[(\text{output voltage}) \times (\text{output current})]}{[(\text{input voltage}) \times (\text{input current})]} \times 100$
- \* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ELECTRICAL CHARACTERISTICS (Continued)

XC6367A331MR, XC6368A331MR

V<sub>OUT</sub>=3.3V, F<sub>OSC</sub>=100kHz, T<sub>a</sub>=25°C

| PARAMETER                   | SYMBOL            | CONDITIONS                                                          | MIN.  | TYP.  | MAX.  | UNITS |
|-----------------------------|-------------------|---------------------------------------------------------------------|-------|-------|-------|-------|
| Output Voltage              | V <sub>OUT</sub>  |                                                                     | 3.218 | 3.300 | 3.383 | V     |
| Supply Voltage (*1)         | V <sub>DD</sub>   |                                                                     | 2.0   | -     | 10.0  | V     |
| Maximum Input Voltage       | V <sub>IN</sub>   |                                                                     | 10.0  | -     | -     | V     |
| Oscillation Start Voltage 1 | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                | -     | -     | 0.9   | V     |
| Oscillation Start Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE: Apply voltage                                 | -     | -     | 0.8   | V     |
| Oscillation Hold Voltage    | V <sub>HLD</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                | -     | -     | 0.7   | V     |
| Supply Current 1            | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=setting output voltage x 0.95                  | -     | 50    | 100   | μA    |
| Supply Current 2            | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=setting output voltage + 0.5V                  | -     | 11    | 20    | μA    |
| Stand-by Current            | I <sub>STB</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95, CE=0V              | -     | -     | 0.5   | μA    |
| Oscillation Frequency       | F <sub>OSC</sub>  | Same as I <sub>DD1</sub>                                            | 85    | 100   | 115   | kHz   |
| Maximum Duty Ratio          | MAXDTY            | Same as I <sub>DD1</sub>                                            | 78    | 85    | 92    | %     |
| PFM Duty Ratio (*3)         | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "H" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95                     | 0.65  | -     | -     | V     |
| CE "L" Voltage              | V <sub>CEL</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95                     | -     | -     | 0.20  | V     |
| EXT "H" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V | -     | 29    | 43    | Ω     |
| EXT "L" ON Resistance       | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | -     | 19    | 27    | Ω     |
| Efficiency (*2)             | EFFI              |                                                                     | -     | 84    | -     | %     |
| Soft-Start Time             | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | ms    |

Conditions: Unless otherwise stated, connect V<sub>DD</sub> to V<sub>OUT</sub>; V<sub>IN</sub>=setting output voltage x 0.6, I<sub>OUT</sub>=130mA

### NOTE:

- \* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.
- \* 2: EFFI = {[ (output voltage) x (output current) ] ÷ [ (input voltage) x (input current) ]} x 100
- \* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ■ ELECTRICAL CHARACTERISTICS (Continued)

XC6367A501MR, XC6368A501MR

V<sub>OUT</sub>=5.0V, F<sub>OSC</sub>=100kHz, T<sub>a</sub>=25°C

| PARAMETER                   | SYMBOL            | CONDITIONS                                                          | MIN. | TYP.  | MAX.  | UNITS |
|-----------------------------|-------------------|---------------------------------------------------------------------|------|-------|-------|-------|
| Output Voltage              | V <sub>OUT</sub>  |                                                                     | 4875 | 5.000 | 5.125 | V     |
| Supply Voltage (*1)         | V <sub>DD</sub>   |                                                                     | 2.0  | -     | 10.0  | V     |
| Maximum Input Voltage       | V <sub>IN</sub>   |                                                                     | 10.0 | -     | -     | V     |
| Oscillation Start Voltage 1 | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                                | -    | -     | 0.9   | V     |
| Oscillation Start Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE: Apply voltage                                 | -    | -     | 0.8   | V     |
| Oscillation Hold Voltage    | V <sub>HLD</sub>  | Tr: 2SX1628, I <sub>OUT</sub> =1.0mA                                | -    | -     | 0.7   | V     |
| Supply Current 1            | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=setting output voltage x 0.95                  | -    | 70    | 120   | μA    |
| Supply Current 2            | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=setting output voltage + 0.5V                  | -    | 11    | 22    | μA    |
| Stand-by Current            | I <sub>STB</sub>  | V <sub>OUT</sub> =setting output voltage x 0.95, CE=0V              | -    | -     | 0.5   | μA    |
| Oscillation Frequency       | F <sub>OSC</sub>  | Same as I <sub>DD1</sub>                                            | 85   | 100   | 115   | kHz   |
| Maximum Duty Ratio          | MAXDTY            | Same as I <sub>DD1</sub>                                            | 78   | 85    | 92    | %     |
| PFM Duty Ratio (*3)         | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15   | 25    | 35    | %     |
| CE "H" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =setting output voltage x0.95                      | 0.65 | -     | -     | V     |
| CE "L" Voltage              | V <sub>CEL</sub>  | V <sub>OUT</sub> =setting output voltage x0.95                      | -    | -     | 0.20  | V     |
| EXT "H" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V | -    | 20    | 29    | Ω     |
| EXT "L" ON Resistance       | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | -    | 13    | 19    | Ω     |
| Efficiency (*2)             | EFFI              |                                                                     | -    | 87    | -     | %     |
| Soft-Start Time             | T <sub>SS</sub>   |                                                                     | 5    | 10    | 20    | ms    |

Conditions: Unless otherwise stated, connect V<sub>DD</sub> to V<sub>OUT</sub>; V<sub>IN</sub>=setting output voltage x 0.6, I<sub>OUT</sub>=200mA

### NOTE:

- \* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.
- \* 2:  $EFFI = \{[(\text{output voltage}) \times (\text{output current})] \div [(\text{input voltage}) \times (\text{input current})] \times 100$
- \* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ELECTRICAL CHARACTERISTICS (Continued)

XC6367B101MR, XC6368B101MR

V<sub>OUT</sub>=3.0V, FOSC=100kHz, T<sub>a</sub>=25°C

| PARAMETER                   | SYMBOL            | CONDITIONS                                                         | MIN.  | TYP.  | MAX.  | UNITS |
|-----------------------------|-------------------|--------------------------------------------------------------------|-------|-------|-------|-------|
| Output Voltage              | V <sub>OUT</sub>  |                                                                    | 2.925 | 3.000 | 3.075 | V     |
| Supply Voltage (*1)         | V <sub>DD</sub>   |                                                                    | 2.0   | -     | 10.0  | V     |
| Maximum Input Voltage       | V <sub>IN</sub>   |                                                                    | 10.0  | -     | -     | V     |
| Oscillation Start Voltage 1 | V <sub>ST1</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                               | -     | -     | 0.9   | V     |
| Oscillation Start Voltage 2 | V <sub>ST2</sub>  | V <sub>DD</sub> =CE: Apply voltage, FB=0V                          | -     | -     | 0.8   | V     |
| Oscillation Hold Voltage    | V <sub>HLD</sub>  | Tr: 2SD1628, I <sub>OUT</sub> =1.0mA                               | -     | -     | 0.7   | V     |
| Supply Current 1            | I <sub>DD1</sub>  | V <sub>DD</sub> =CE=2.85V, FB=0V                                   | -     | 50    | 90    | μA    |
| Supply Current 2            | I <sub>DD2</sub>  | V <sub>DD</sub> =CE=3.5V, FB=1.2V                                  | -     | 11    | 20    | μA    |
| Stand-by Current            | I <sub>STB</sub>  | V <sub>DD</sub> =2.85V, CE=0V, FB=0V                               | -     | -     | 0.5   | μA    |
| Oscillation Frequency       | FOSC              | Same as I <sub>DD1</sub>                                           | 85    | 100   | 115   | kHz   |
| Maximum Duty Ratio          | MAXDTY            | Same as I <sub>DD1</sub>                                           | 78    | 85    | 92    | %     |
| PFM Duty Ratio (*3)         | PFMDTY            | I <sub>OUT</sub> =0mA                                              | 15    | 25    | 35    | %     |
| CE "H" Voltage              | V <sub>CEH</sub>  | V <sub>DD</sub> =2.85V,FB=0V                                       | 0.65  | -     | -     | V     |
| CE "L" Voltage              | V <sub>CEL</sub>  | V <sub>DD</sub> =2.85V,FB=0V                                       | -     | -     | 0.20  | V     |
| EXT "H" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>DD</sub> -0.4V | -     | 32    | 47    | Ω     |
| EXT "L" ON Resistance       | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                  | -     | 20    | 30    | Ω     |
| Efficiency (*2)             | EFFI              |                                                                    | -     | 84    | -     | %     |
| Soft-Start Time             | T <sub>SS</sub>   |                                                                    | 5     | 10    | 20    | ms    |

Conditions: Unless otherwise stated, V<sub>IN</sub>=1.8V, I<sub>OUT</sub>=120mA

External components : R<sub>FB1</sub> = 400kΩ, R<sub>FB2</sub> = 200kΩ, C<sub>FB</sub> = 47pF

### NOTE:

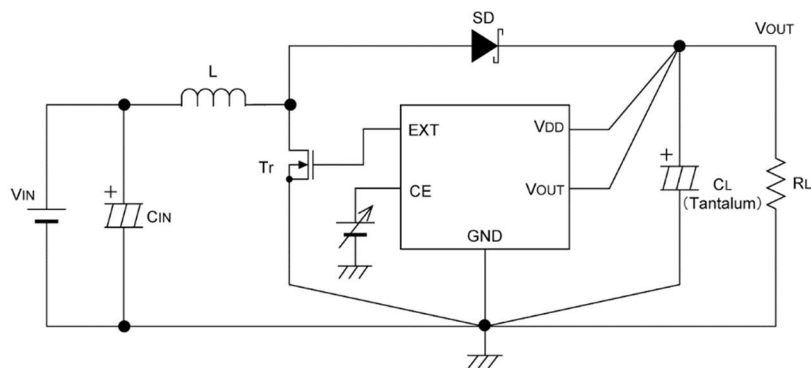
\* 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.

\* 2: EFFI = {[(output voltage) x (output current)]÷[(input voltage) x (input current)] x 100

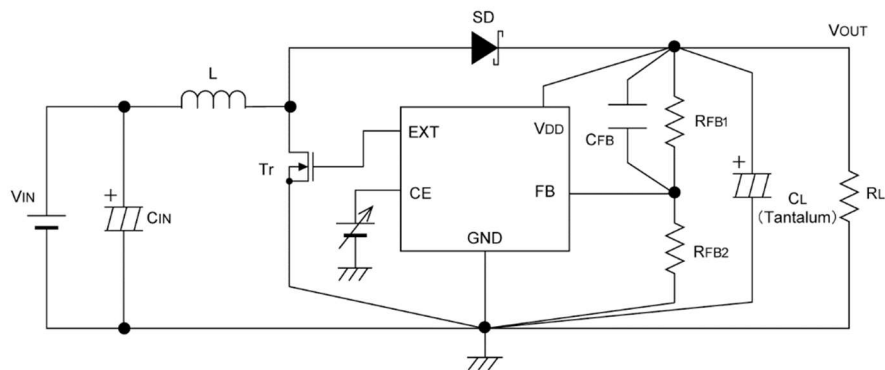
\* 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ■ TEST CIRCUITS

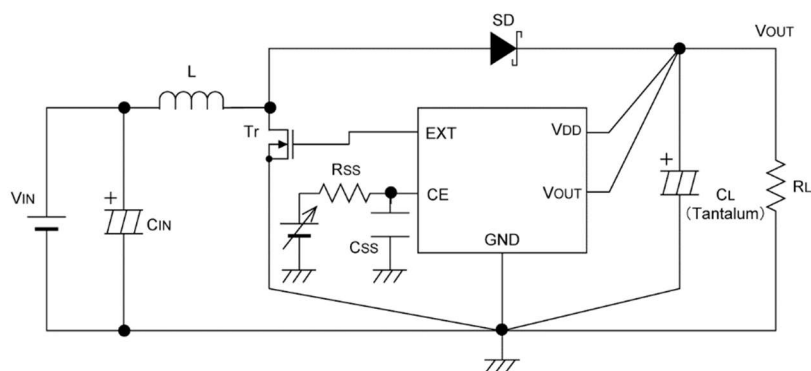
Circuit 1. XC6367A, XC6368A



Circuit 2. XC6367B, XC6368B

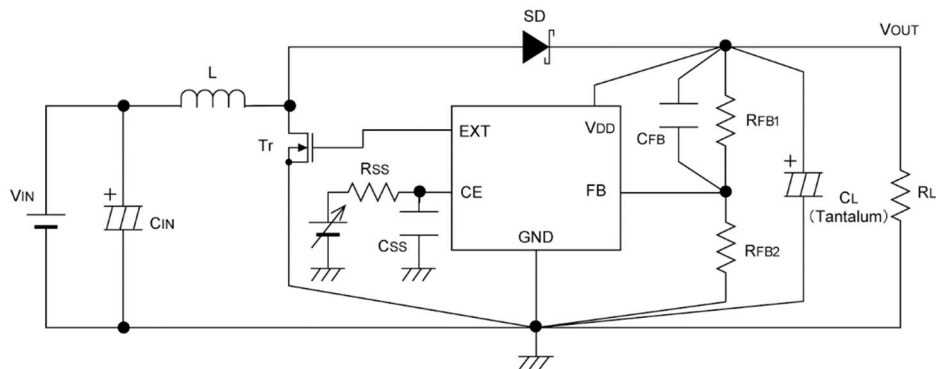


Circuit 3. XC6367C, XC6368C

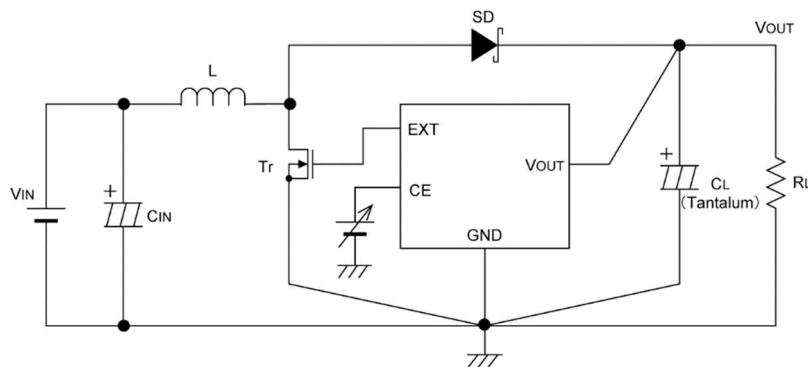


## TEST CIRCUITS (Continued)

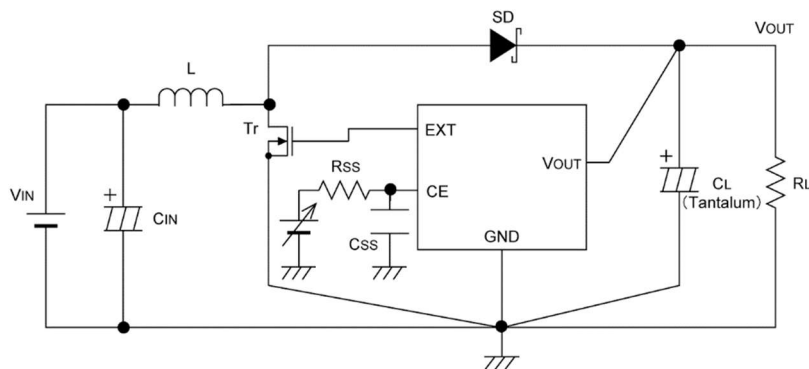
Circuit 4. XC6367D, XC6368D



Circuit 5. XC6367E, XC6368E

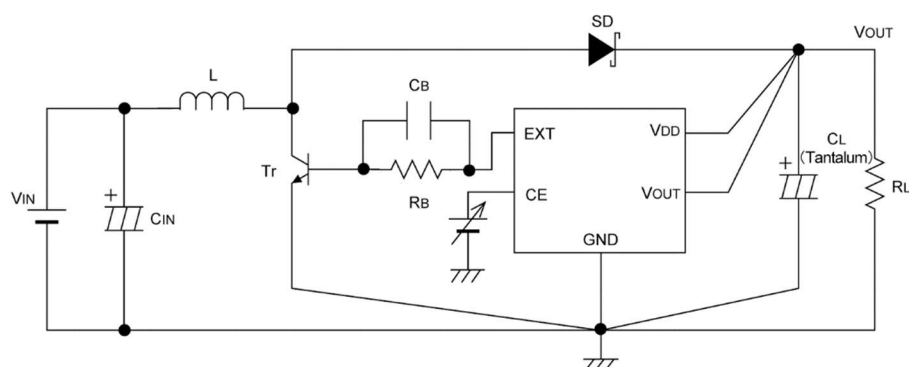


Circuit 6. XC6367F, XC6368F

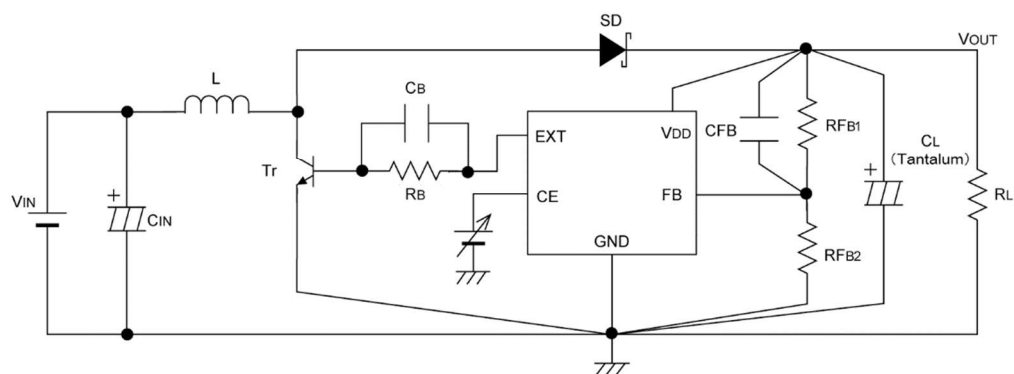


## ■ TEST CIRCUITS (Continued)

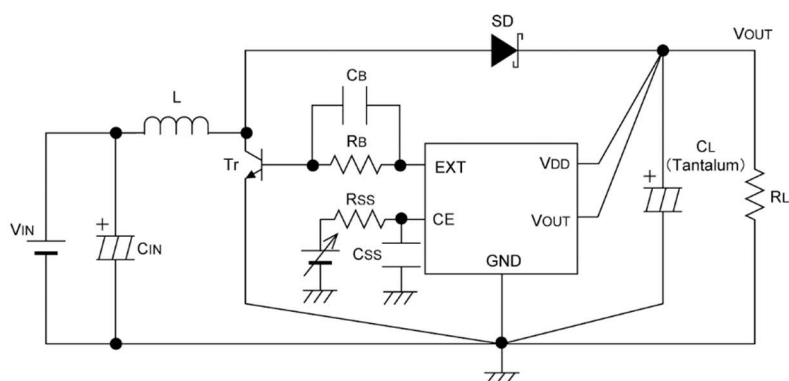
Circuit 7. XC6367A, XC6368A (NPN Transistor)



Circuit 8. XC6367B, XC6368B (NPN Transistor)

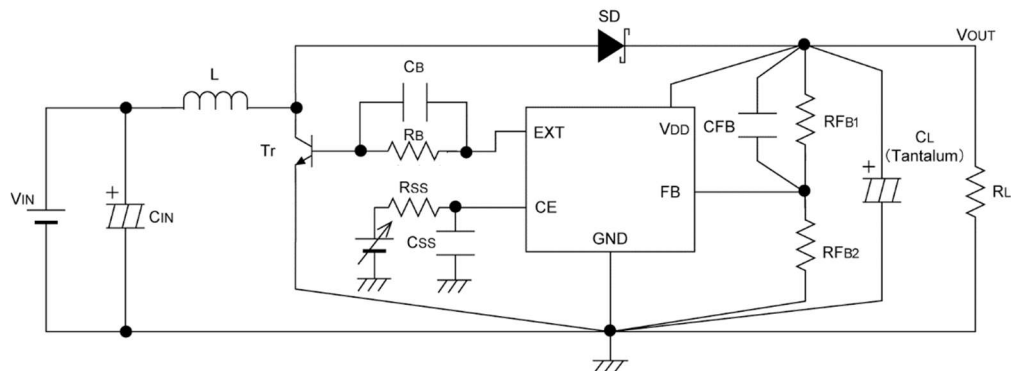


Circuit 9. XC6367C, XC6368C (NPN Transistor)

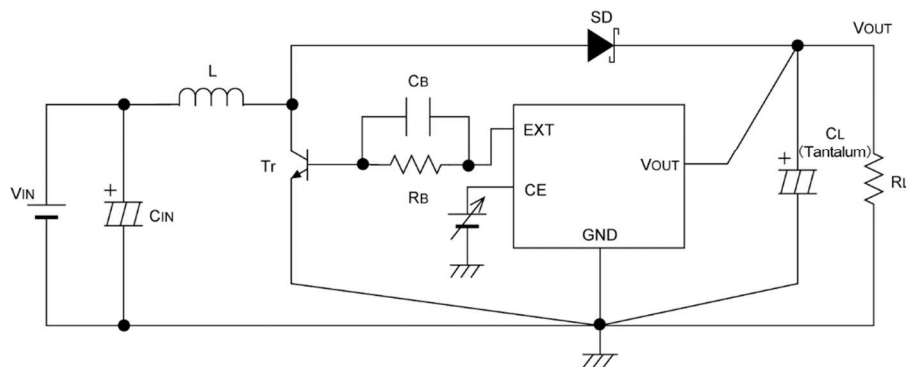


## TEST CIRCUITS (Continued)

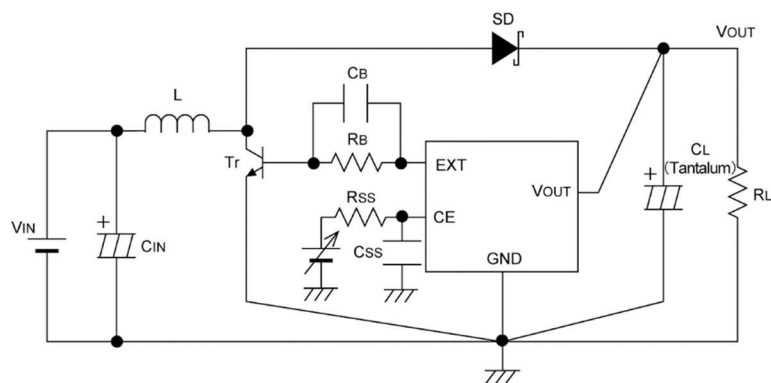
Circuit 10. XC6367D, XC6368D (NPN Transistor)



Circuit 11. XC6367E, XC6368E (NPN Transistor)



Circuit 12. XC6367F, XC6368F (NPN Transistor)



## ■ TEST CIRCUITS (Continued)

### ● External Components

Tr : XP161A1355PR (N-ch Power MOSFET, TOREX)  
As the breakdown voltage of XP161A1355PR is 8V, take care with the power supply voltage. With output voltages over 6V, use the XP161A1265PR with a breakdown voltage of 12V.  
V<sub>ST1</sub> : XP161A1355PR = 1.2V (MAX.)  
XP161A1265PR = 1.5V (MAX.)  
L : 22  $\mu$  H (CR54, SUMIDA FOSC=300kHz)  
47  $\mu$  H (CR75, SUMIDA FOSC=100, 180kHz)  
10  $\mu$  H (CR54, SUMIDA FOSC=500kHz)  
SD : MA2Q735 (Schottky Diode, MATSUSHITA)  
C<sub>IN</sub> : 16V, 220  $\mu$  F (Aluminum Electrolytic Capacitor)  
CL : 16V, 47  $\mu$  F + 47  $\mu$  F (Tantalum capacitor, NICHICON MCE)

NPN Tr type:

Tr : 2SD1628 (SANYO)  
R<sub>b</sub> : 500 $\Omega$ (Adjust according to load and Tr. hFE levels)  
C<sub>b</sub> : 2200pF (Ceramic Type)

Set up so that  $CB \leq 1 \div (2 \pi \times RB \times FOSC \times 0.7)$

C, D, F type (soft-start externally set-up):

C<sub>SS</sub> : 0.1  $\mu$  F (Ceramic Capacitor)  
R<sub>SS</sub> : 470k $\Omega$ (C, F Type), 220k $\Omega$ (D Type)

B, D type (FB versions)

R<sub>FB</sub> : Set up so that  $R_{FB1} \div R_{FB2} = V_{OUT} - 1$  ( $V_{OUT}$  = setting output voltage),  
Please use with  $R_{FB1} + R_{FB2} \leq 2M\Omega$   
C<sub>FB</sub> : Set up so that  $f_{zfb} = 1 \div (2 \times \pi \times C_{FB} \times R_{FB1})$  is within the  
0.1 to 20kHz range (10kHz conventional)  
Adjustments necessary in respect of L, CL.  
e.g  $V_{OUT} = 3.0V$   
 $R_{FB1} = 400k\Omega$ ,  $R_{FB2} = 200k\Omega$ ,  $C_{FB} = 47pF$

When using MOSFETs, we recommend using TOREX MOSFETs which have a built-in gate protection diode.

| GATE PROTECTION DIODE BUILT-IN MOSFET | R <sub>ds</sub> (ON)                   |
|---------------------------------------|----------------------------------------|
| XP161A1355PR                          | 0.15 $\Omega$ @ V <sub>gs</sub> =1.5V  |
| XP161A1265PR                          | 0.095 $\Omega$ @ V <sub>gs</sub> =2.5V |

## NOTES ON USE

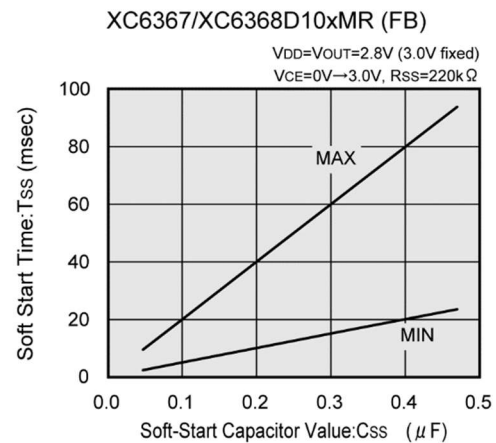
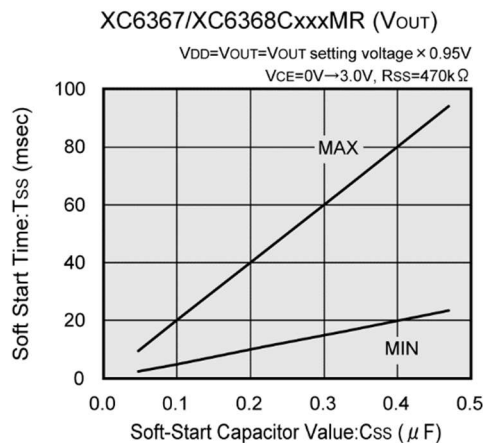
1. Take ample care to ensure that none of the IC's, nor the external component's, absolute maximum ratings are exceeded.
2. Be extremely careful when selecting parts and do not limit your reference to the specifications and characteristics for the DC/DC converter alone. The IC also depends, to a great extent, upon the external components.
3. Arrange the peripherals in the environs of the IC. In order to reduce wiring impedance, use short, thick wires. In particular, wire the load capacitor as close as possible and strengthen the ground wiring sufficiently.
4. Ground current during switching may cause the IC's operations to become unstable due to changes in ground voltage, so please strengthen the IC's GND pin surroundings.

## External Components

### 1. Setting soft-start time

In order to lengthen soft-start time we recommend that you use the C or D types of the series which have soft start time externally set-up.

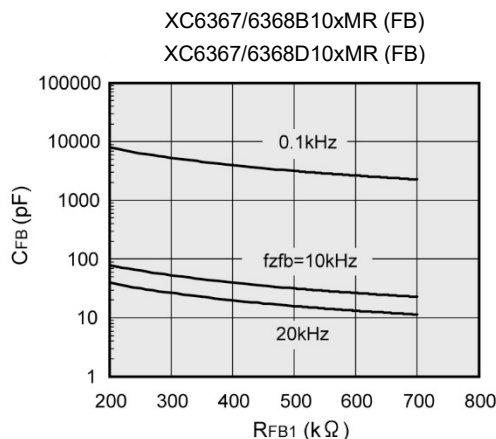
Soft-start time (Tss) is between MIN & MAX, as indicated in the graphs below, so please select soft-start capacitor value (C<sub>SS</sub>) to suit your application.



### 2. R<sub>FB1</sub>, C<sub>FB</sub> set up

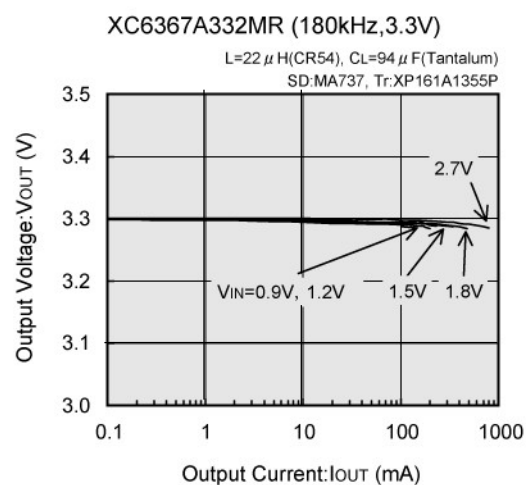
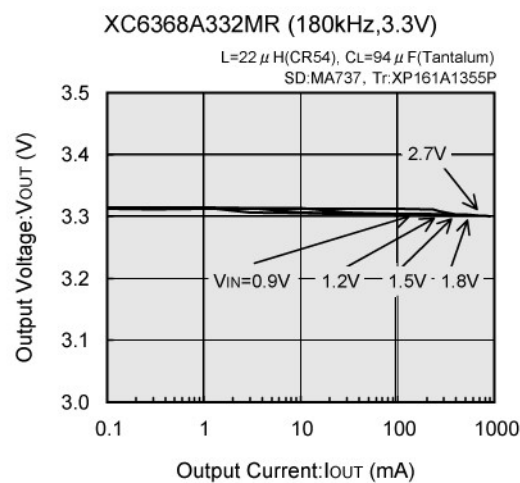
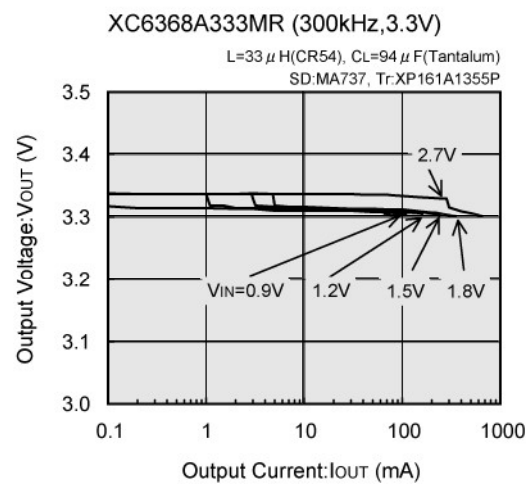
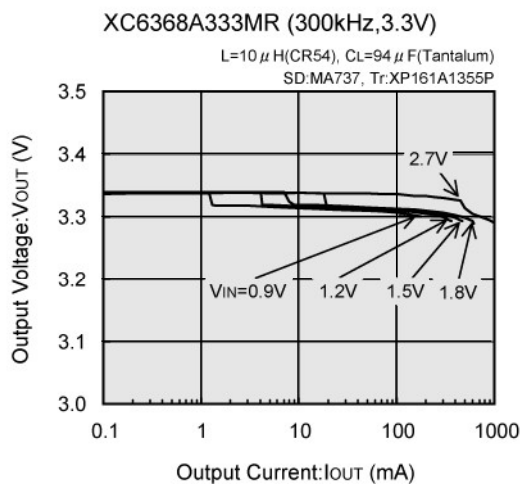
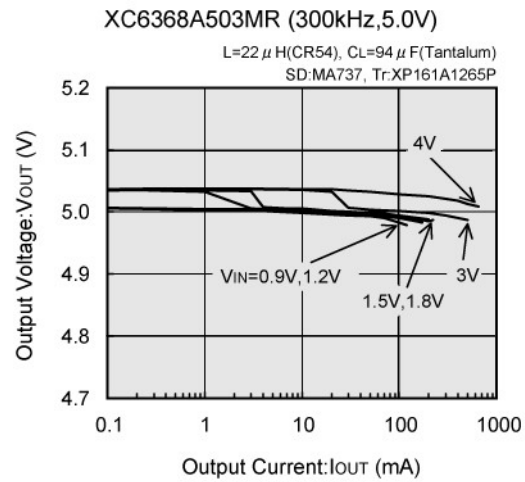
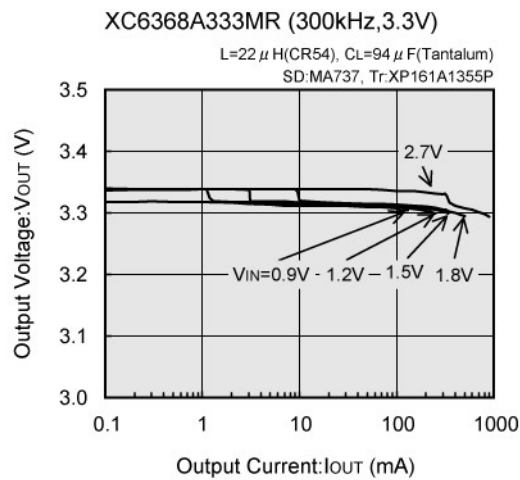
$$f_{zfb} = 1 \div (2 \pi \times C_{FB} \times R_{FB1})$$

In order to achieve a value for f<sub>zfb</sub> within the range of 0.1kHz to 20kHz, we recommend that values for R<sub>FB1</sub> & C<sub>FB</sub> are selected from the area indicated within the lines of f<sub>zfb</sub> = 0.1kHz and f<sub>zfb</sub> = 20 kHz as shown on the graph below. Please select combinations of values as close to the f<sub>zfb</sub> = 10kHz line as possible.



## TYPICAL PERFORMANCE CHARACTERISTICS

### (1) Output Voltage vs. Output Current

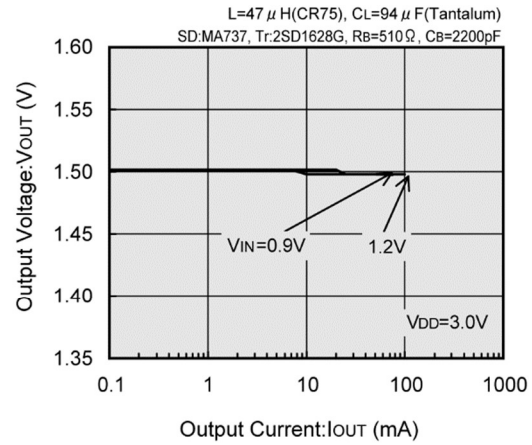


〈External component〉 CIN=220  $\mu$  F (Electrolytic capacitor)

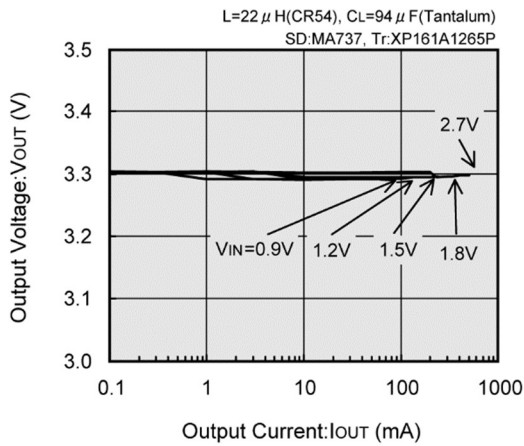
## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

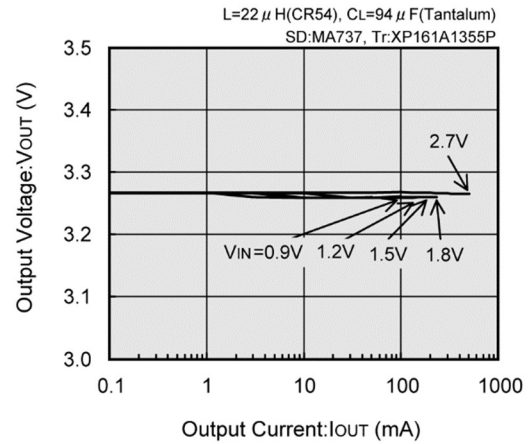
XC6368A151MR (100kHz, 1.5V)



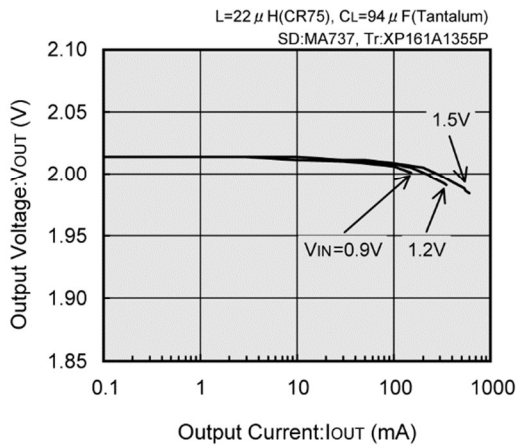
XC6368B103MR (300kHz, 3.3V)



XC6368B102MR (180kHz, 3.3V)



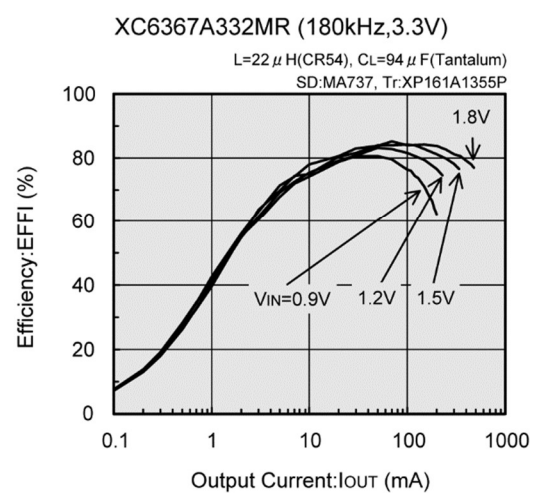
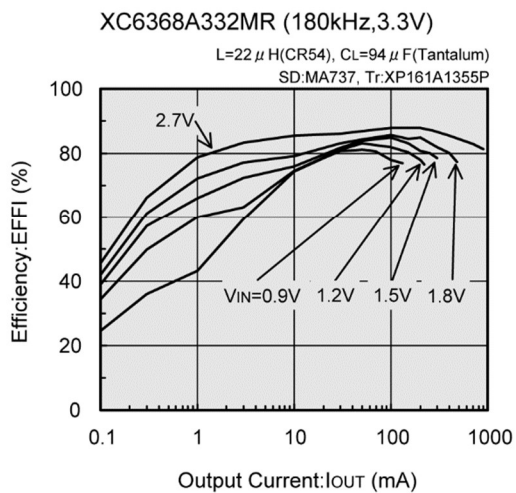
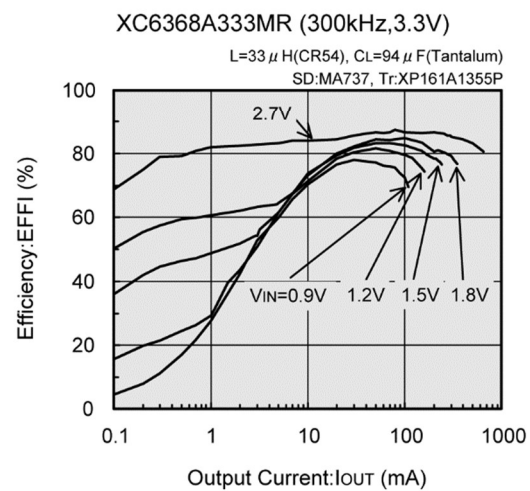
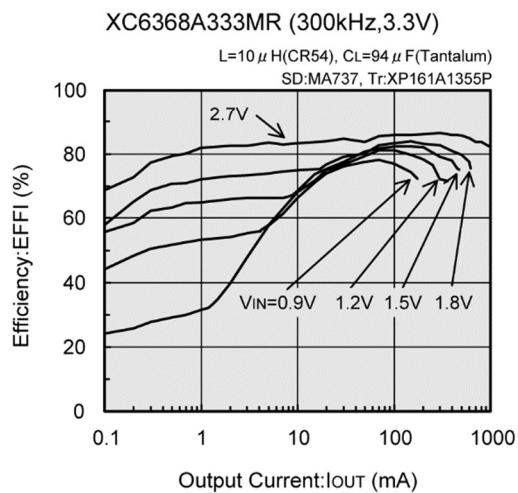
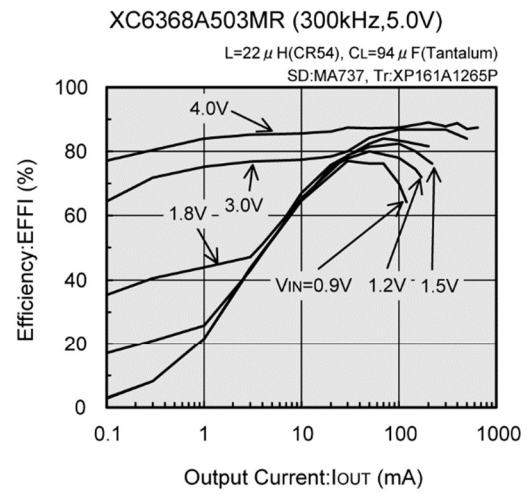
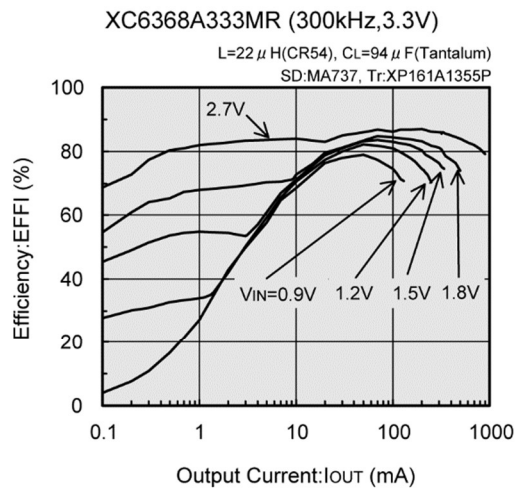
XC6368B101MR (100kHz, 2.0V)



〈External component〉 CIN=220  $\mu$  F (Electrolytic capacitor)

## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

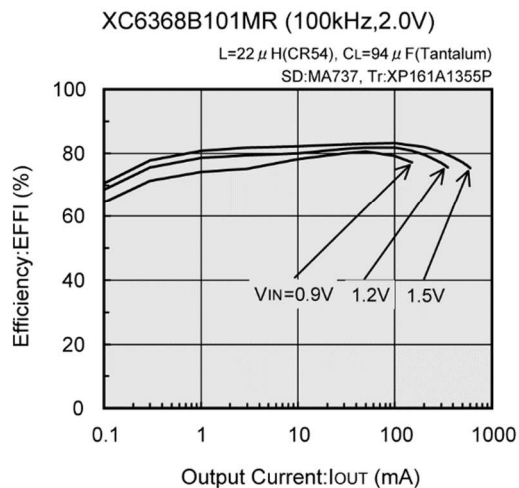
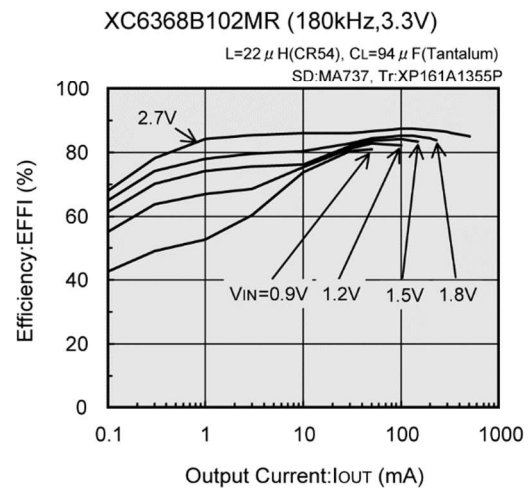
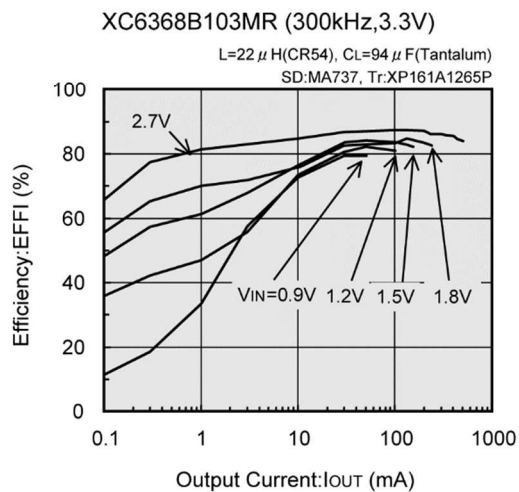
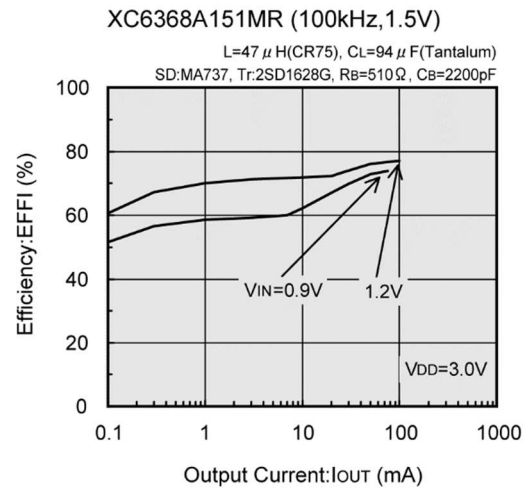
### (2) Efficiency vs. Output Current



〈External component〉 CIN=220  $\mu$  F (Electrolytic capacitor)

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

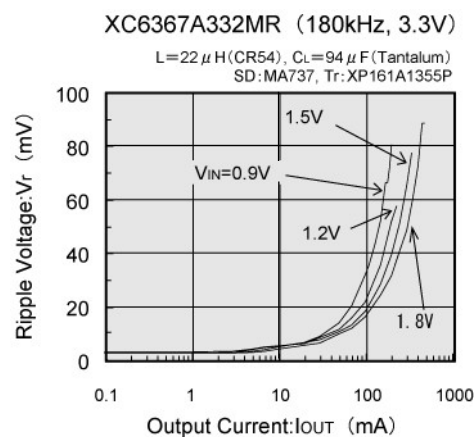
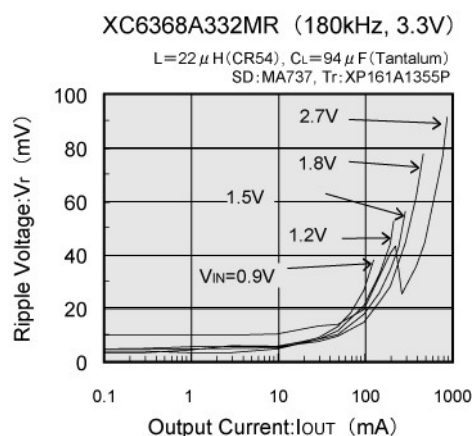
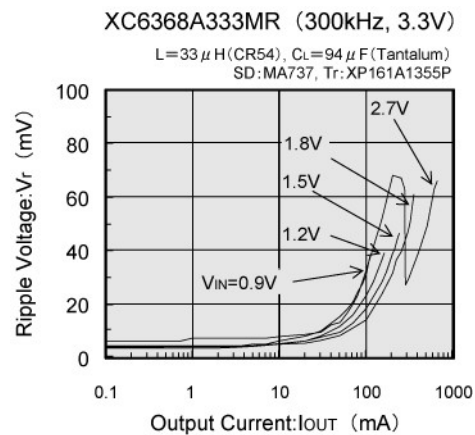
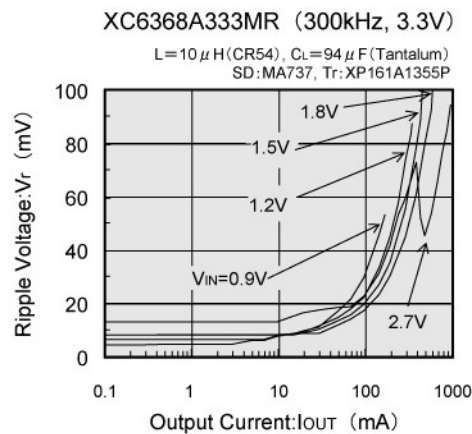
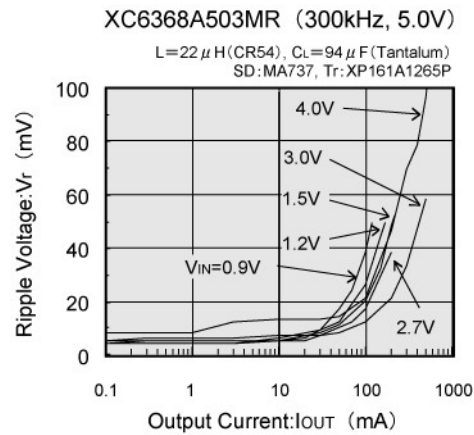
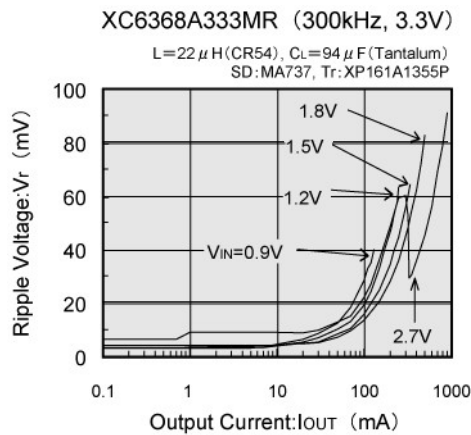
### (2) Efficiency vs. Output Current (Continued)



〈External component〉 CIN=220  $\mu$ F (Electrolytic capacitor)

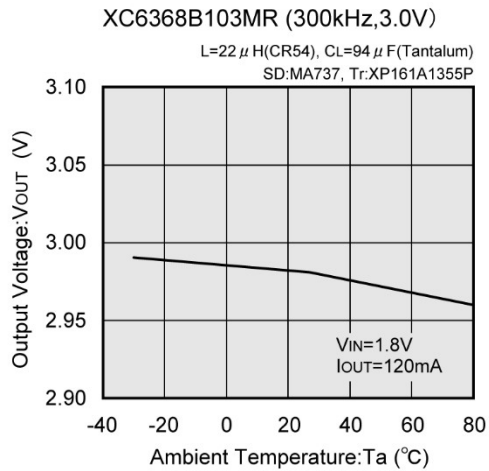
## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (3) Ripple Voltage vs. Output Current

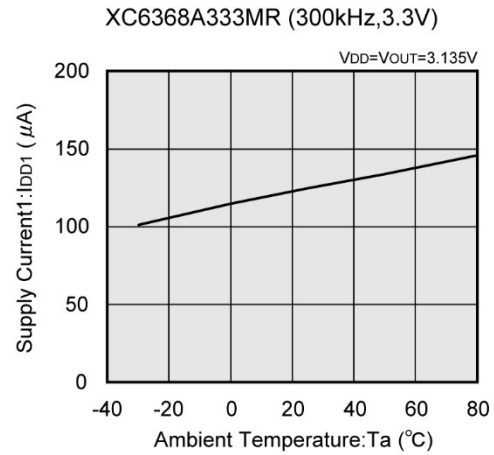


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

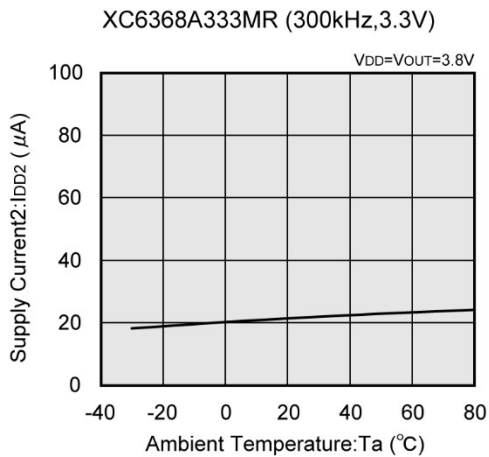
(4) Output Voltage vs. Ambient Temperature



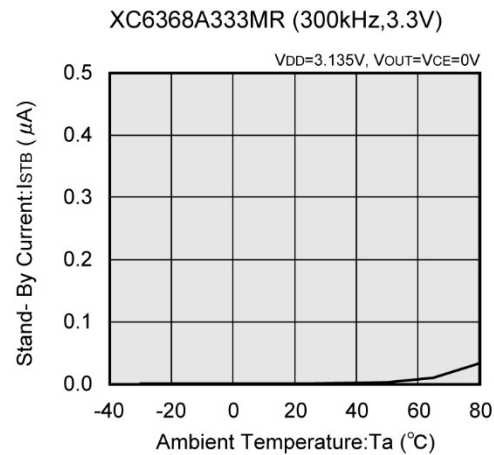
(5) Supply Current 1 vs. Ambient Temperature



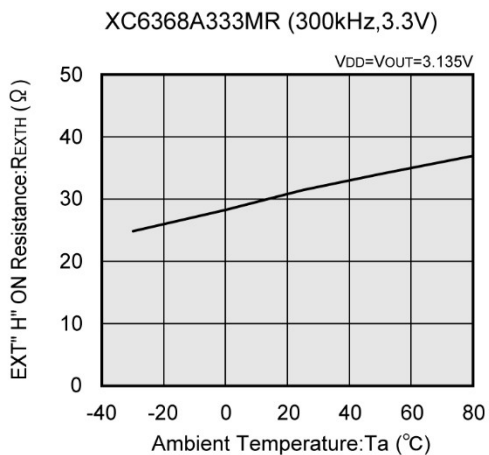
(6) Supply Current 2 vs. Ambient Temperature



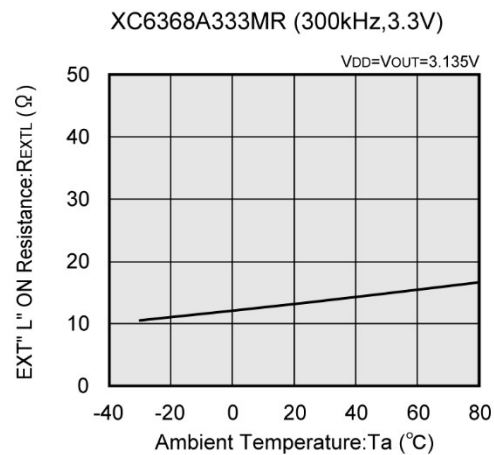
(7) Stand-by Current vs. Ambient Temperature



(8) EXT "H" ON Resistance vs. Ambient Temperature

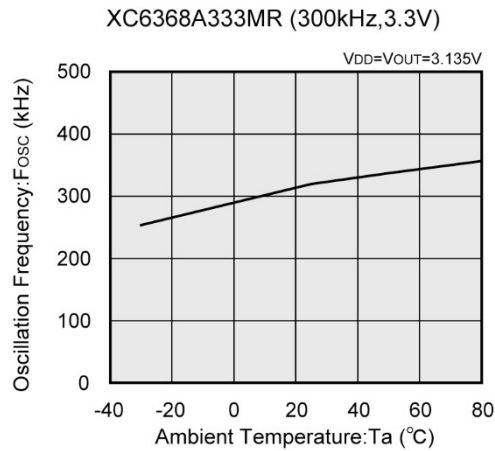


(9) EXT "L" ON Resistance vs. Ambient Temperature

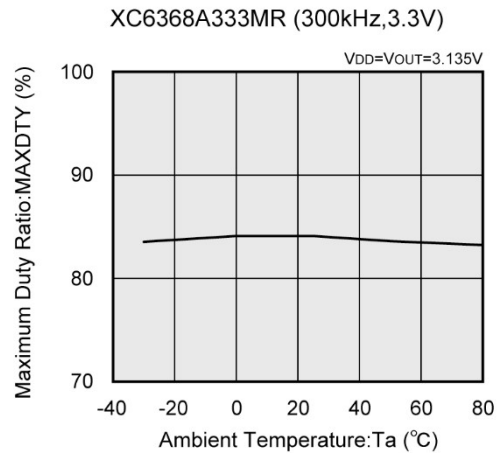


## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

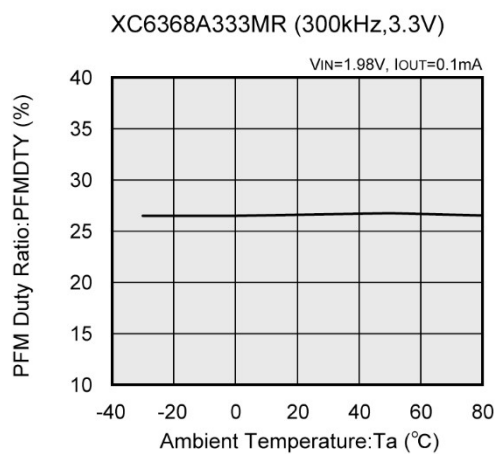
(10) Oscillation Frequency vs. Ambient Temperature



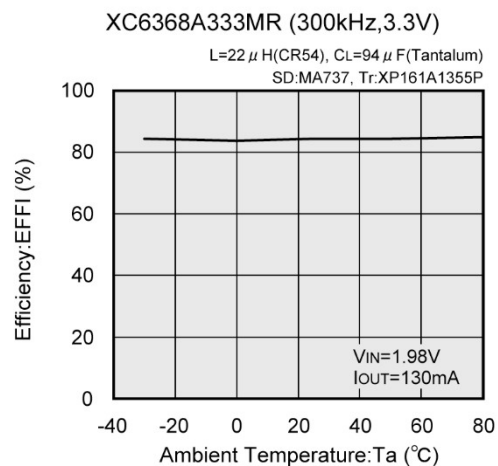
(11) Maximum Duty Ratio vs. Ambient Temperature



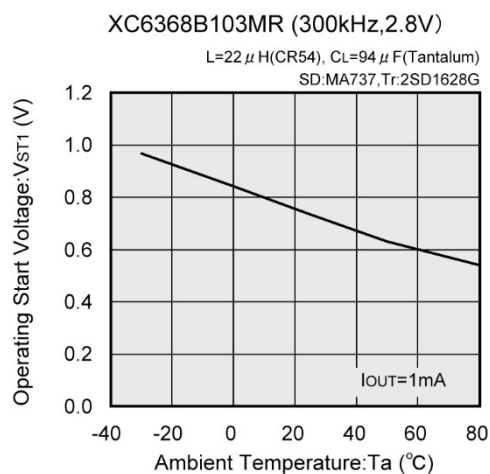
(12) PFM Duty Ratio vs. Ambient Temperature



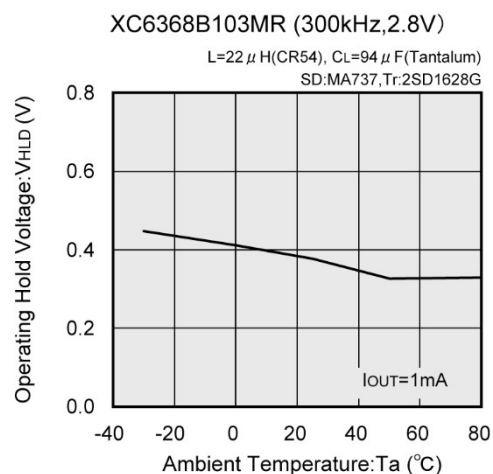
(13) Efficiency vs. Ambient Temperature



(14) Operation Start Voltage vs. Ambient Temperature

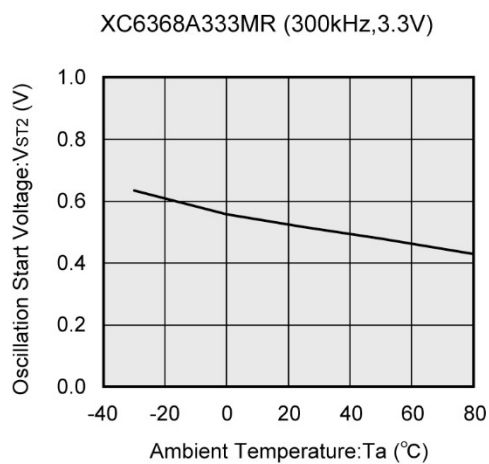


(15) Operation Hold Voltage vs. Ambient Temperature

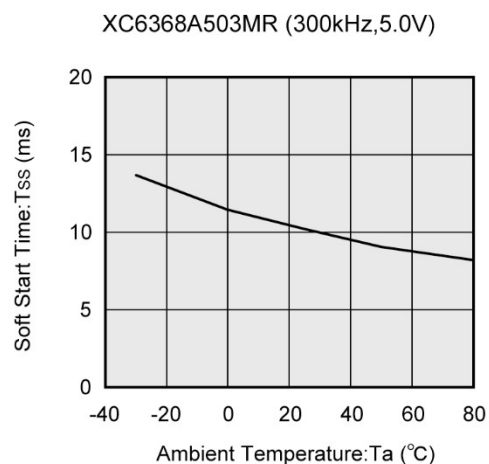


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

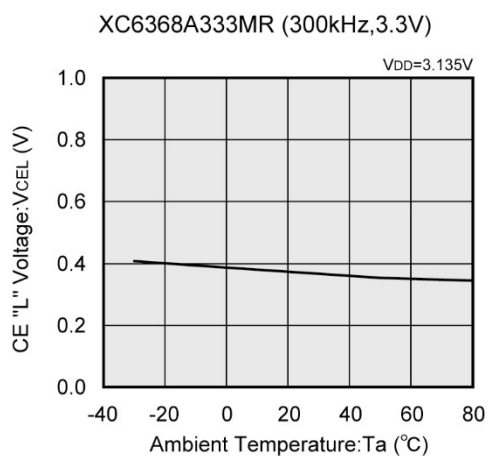
(16) Oscillation Start Voltage vs. Ambient Temperature



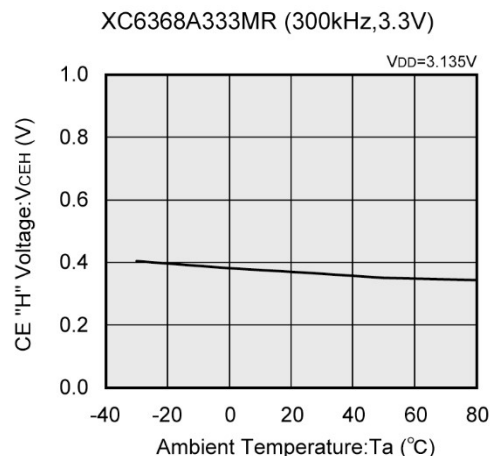
(17) Soft-Start Time vs. Ambient Temperature



(18) CE "L" Voltage vs. Ambient Temperature

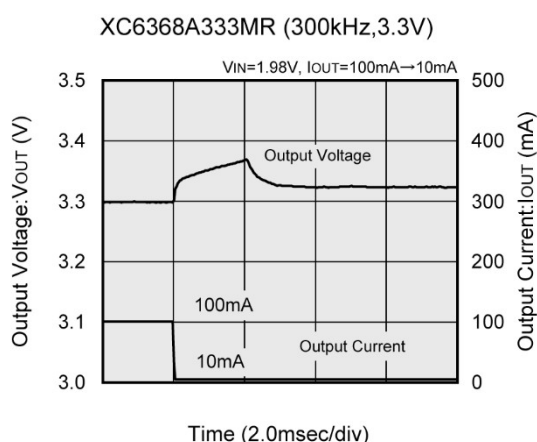
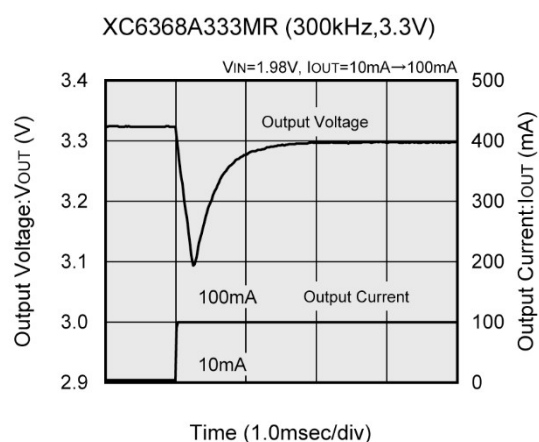
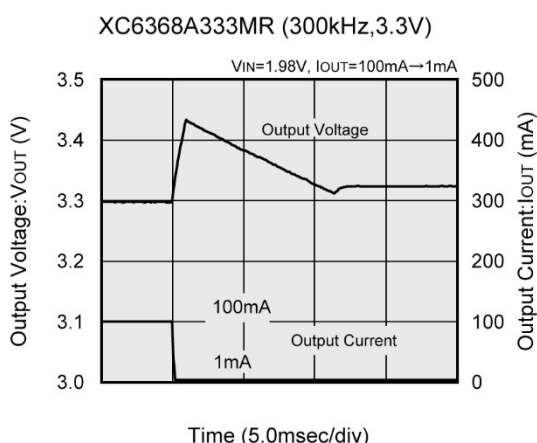
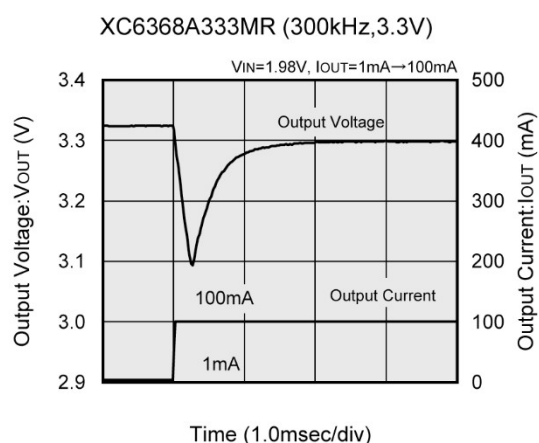
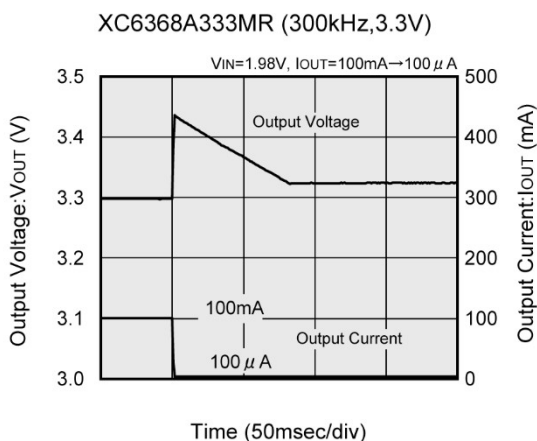
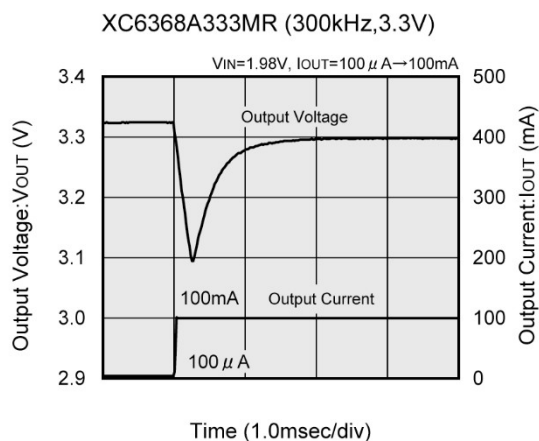


(19) CE "H" Voltage vs. Ambient Temperature



## ■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

### (20) Load Transient Response



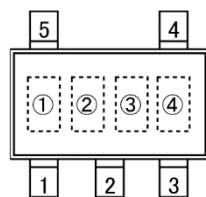
## ■ PACKAGING INFORMATION

For the latest package information go to, [www.torexsemi.com/technical-support/packages](http://www.torexsemi.com/technical-support/packages)

| PACKAGE | OUTLINE / LAND PATTERN     | THERMAL CHARACTERISTICS                  |
|---------|----------------------------|------------------------------------------|
| SOT-25  | <a href="#">SOT-25 PKG</a> | <a href="#">SOT-25 Power Dissipation</a> |

## MARKING RULE

### ●XC6367/6368 Series



SOT-25  
(TOP VIEW)

① represents product series

| MARK     | PRODUCT SERIES | MARK     | PRODUCT SERIES |
|----------|----------------|----------|----------------|
| <u>A</u> | XC6367A        | <u>K</u> | XC6368A        |
| <u>B</u> | XC6367B        | <u>L</u> | XC6368B        |
| <u>C</u> | XC6367C        | <u>M</u> | XC6368C        |
| <u>D</u> | XC6367D        | <u>N</u> | XC6368D        |
| <u>E</u> | XC6367E        | <u>P</u> | XC6368E        |
| <u>F</u> | XC6367F        | <u>R</u> | XC6368F        |

② represents integer of output voltage and oscillation frequency

| OUTPUT VOLTAGE (V) | OSCILLATION FREQUENCY (kHz) |     |     |     |
|--------------------|-----------------------------|-----|-----|-----|
|                    | 100                         | 180 | 300 | 500 |
| 1                  | B                           | 1   | 1   | B   |
| 2                  | C                           | 2   | 2   |     |
| 3                  | D                           | 3   | 3   |     |
| 4                  | E                           | 4   | 4   |     |
| 5                  | F                           | 5   | 5   |     |
| 6                  | H                           | 6   | 6   |     |

③ represents decimal number of output voltage and oscillation frequency

| OUTPUT VOLTAGE (V) | OSCILLATION FREQUENCY (kHz) |     |     |     |
|--------------------|-----------------------------|-----|-----|-----|
|                    | 100                         | 180 | 300 | 500 |
| 0                  | 0                           | 0   | A   | A   |
| 1                  | 1                           | 1   | B   |     |
| 2                  | 2                           | 2   | C   |     |
| 3                  | 3                           | 3   | D   |     |
| 4                  | 4                           | 4   | E   |     |
| 5                  | 5                           | 5   | F   |     |
| 6                  | 6                           | 6   | H   |     |
| 7                  | 7                           | 7   | K   |     |
| 8                  | 8                           | 8   | L   |     |
| 9                  | 9                           | 9   | M   |     |

④ represents production lot number

0 to 9, A to Z repeated (G, I, J, O, Q, W excluded)

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