

# XC6367/6368

## Series



PWM Controlled, PWM/PFM Switchable Step - Up DC/DC Controllers

- ◆ **Input Voltage Range** : 0.9~10.0V
- ◆ **Output Voltage Range** : 1.5~6.5V(±2.5%)
- ◆ **Oscillator Frequency** : 300kHz(±15%)
- ◆ **PWM/PFM Switching Control (XC6368)**
- ◆ **High Efficiency** : 84% (typ.)
- ◆ **SOT-25 Package**

### Applications

- Electronic Information Organizers
- Palmtops
- Cellular and portable phones
- Portable Audio Systems
- Various Multi-function Power Supplies

### General Description

The XC6367/68 series are multi-functional step-up DC/DC converter controllers with built-in high speed, low ON resistance drivers. Large output currents are possible using an externally connected transistor, coil, diode and condenser.

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

With a 300kHz switching 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.

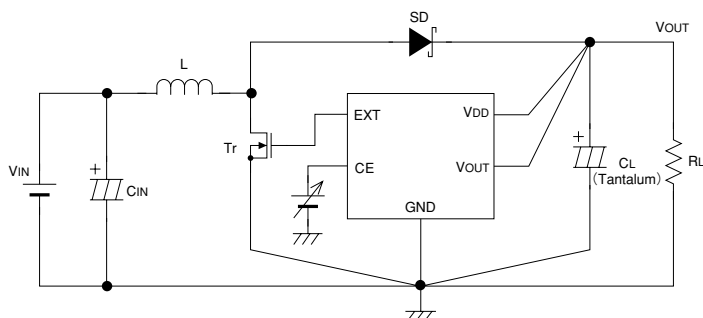
Soft start time of XC6367/68A, B, and C series is internally set to 10msec and XC6367/68C, D, and F series regulate soft start time by connecting resistors and capacitors externally.

During stand-by time (CE pin "Low"), current consumption is reduced to less than 0.5μA.

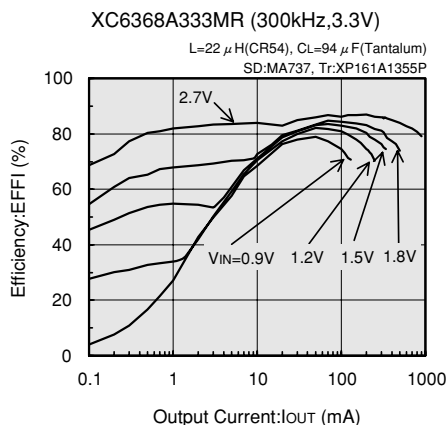
### Features

- Input voltage range** : 0.9V~10V
- Operating voltage range** : 2.0V~10V
- Output voltage range** : 1.5V~6.5V programmable in 0.1V steps (±2.5%)
- Oscillator frequency** : 300, 100kHz (±15%)  
Custom products for 180, 500kHz
- Output Current** : 200mA + (VIN=1.8V, VOUT=3.3V)
- High Efficiency** : 84% (typ.)
- Stand-by capability Selection** : ISTB=0.5A (max.)  
Soft start set-up external  
Output Voltage set-up internal (VOUT)  
Output Voltage set-up external (FB)
- Package** : SOT-25

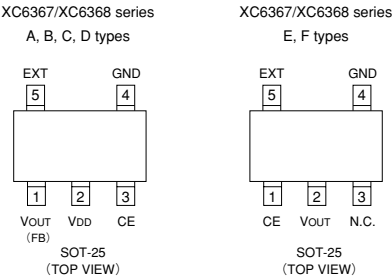
### Typical Application Circuit



### Typical Performance Characteristic



■ Pin Configuration



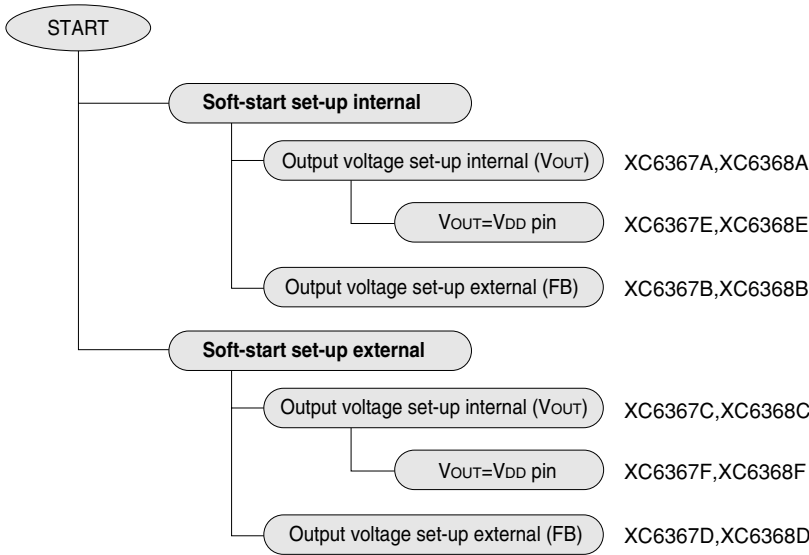
■ Pin Assignment

| PIN<br>NUMBER   |      | PIN<br>NAME              | FUNCTION                                                                                                                       |
|-----------------|------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| XC6367 / XC6368 |      |                          |                                                                                                                                |
| A, B, C, D      | E, F |                          |                                                                                                                                |
| 5               | 5    | EXT                      | External transistor connection                                                                                                 |
| 2               | –    | V <sub>DD</sub>          | Supply voltage input                                                                                                           |
| 4               | 4    | GND                      | Ground                                                                                                                         |
| 3               | 1    | CE                       | Chip Enable<br>(C, D, F types : soft start set-up external,<br>soft start capacitor connected)                                 |
| 1               | 2    | V <sub>OUT</sub><br>(FB) | Output voltage monitor<br>(E, F types : output voltage monitor, power supply)<br>(B, D types : output voltage set-up external) |

4

■ Product Classification

● Selection Guide



●Ordering Information

**XC6367**①②③④⑤⑥

**XC6367 Series**      PWM Control

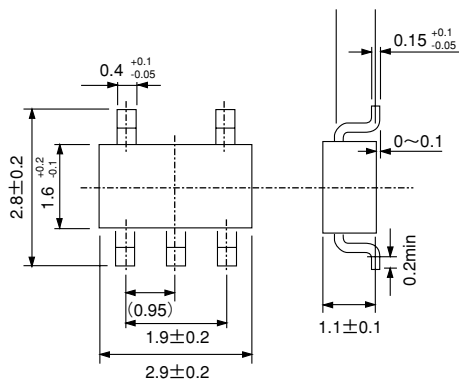
| SYMBOL |                                                                                                 | V <sub>OUT</sub> /FB                 | SOFT-START      |
|--------|-------------------------------------------------------------------------------------------------|--------------------------------------|-----------------|
| ①      | A                                                                                               | V <sub>OUT</sub>                     | Set-up Internal |
|        | B                                                                                               | FB                                   | Set-up Internal |
|        | C                                                                                               | V <sub>OUT</sub>                     | Set-up External |
|        | D                                                                                               | FB                                   | Set-up External |
|        | E                                                                                               | V <sub>OUT</sub>                     | Set-up Internal |
|        | F                                                                                               | V <sub>OUT</sub>                     | Set-up External |
| ②<br>③ | Output voltage value : e.g. 3.0V output : (②=3, ③=0),<br>F.B. products (B,D types) : (②=1, ③=0) |                                      |                 |
| ④      | 3                                                                                               | Oscillator Frequency 300kHz          |                 |
|        | 1                                                                                               | Oscillator Frequency 100kHz          |                 |
|        | 2                                                                                               | Oscillator Frequency 180kHz (Custom) |                 |
|        | 5                                                                                               | Oscillator Frequency 500kHz (Custom) |                 |
| ⑤      | M                                                                                               | Package SOT-25                       |                 |
| ⑥      | R                                                                                               | Embossed Tape : Standard Feed        |                 |
|        | L                                                                                               | : Reverse Feed                       |                 |

**XC6368**①②③④⑤⑥

**XC6368 Series**      PWM/PFM switching control (same as XC6367 series)

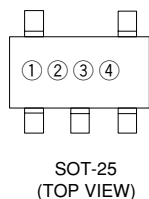
■Packaging Information

●SOT-25



### ■ Marking

#### ● XC6367 Series



① Represents the Product Classification

| PRODUCT NAME | DESIGNATOR |
|--------------|------------|
| XC6367A      | <u>A</u>   |
| XC6367B      | <u>B</u>   |
| XC6367C      | <u>C</u>   |
| XC6367D      | <u>D</u>   |
| XC6367E      | <u>E</u>   |
| XC6367F      | <u>F</u>   |

② Represents the integer of the Output Voltage and Oscillator Frequency

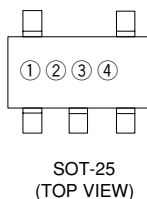
| INTEGER OF THE<br>OUTPUT VOLTAGE | OSCILLATOR FREQUENCY (kHz) |     |     |     |
|----------------------------------|----------------------------|-----|-----|-----|
|                                  | 100                        | 180 | 300 | 500 |
| 1                                | B                          | 1   | 1   | B   |
| 2                                | C                          | 2   | 2   | C   |
| 3                                | D                          | 3   | 3   | D   |
| 4                                | E                          | 4   | 4   | E   |
| 5                                | F                          | 5   | 5   | F   |
| 6                                | H                          | 6   | 6   | H   |

③ Represents the decimal number of the Output Voltage and Oscillator Frequency

| THE DECIMAL NUMBER<br>OF OUTPUT VOLTAGE | OSCILLATOR FREQUENCY (kHz) |     |     |     |
|-----------------------------------------|----------------------------|-----|-----|-----|
|                                         | 100                        | 180 | 300 | 500 |
| 0                                       | 0                          | 0   | A   | A   |
| 1                                       | 1                          | 1   | B   | B   |
| 2                                       | 2                          | 2   | C   | C   |
| 3                                       | 3                          | 3   | D   | D   |
| 4                                       | 4                          | 4   | E   | E   |
| 5                                       | 5                          | 5   | F   | F   |
| 6                                       | 6                          | 6   | H   | H   |
| 7                                       | 7                          | 7   | K   | K   |
| 8                                       | 8                          | 8   | L   | L   |
| 9                                       | 9                          | 9   | M   | M   |

④ Denotes the production lot number  
0 to 9, A to Z repeated(G.I.J.O.Q.W excepted)

●XC6368 Series



① Represents the Product Classification

| PRODUCT NAME | DESIGNATOR |
|--------------|------------|
| XC6368A      | <u>K</u>   |
| XC6368B      | <u>L</u>   |
| XC6368C      | <u>M</u>   |
| XC6368D      | <u>N</u>   |
| XC6368E      | <u>P</u>   |
| XC6368F      | <u>R</u>   |

② Represents the integer of the Output Voltage and Oscillator Frequency

| INTEGER OF THE<br>OUTPUT VOLTAGE | OSCILLATOR FREQUENCY (kHz) |     |     |     |
|----------------------------------|----------------------------|-----|-----|-----|
|                                  | 100                        | 180 | 300 | 500 |
| 1                                | B                          | 1   | 1   | B   |
| 2                                | C                          | 2   | 2   | C   |
| 3                                | D                          | 3   | 3   | D   |
| 4                                | E                          | 4   | 4   | E   |
| 5                                | F                          | 5   | 5   | F   |
| 6                                | H                          | 6   | 6   | H   |
| CUSTOM                           | S                          |     |     |     |

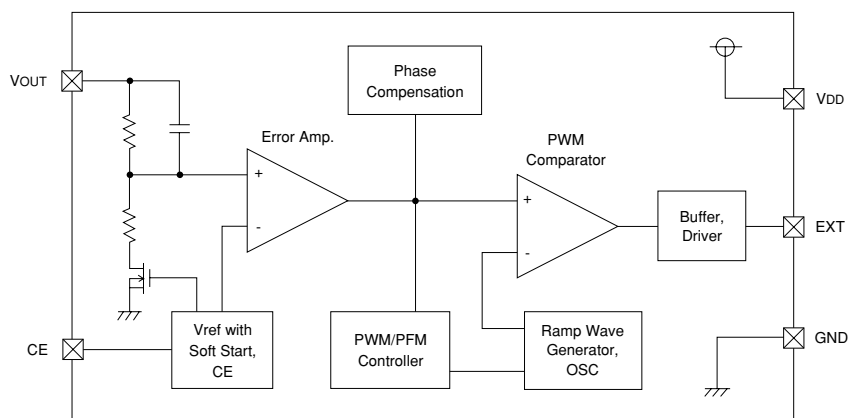
③ Represents the decimal number of the Output Voltage and Oscillator Frequency

| THE DECIMAL NUMBER<br>OF OUTPUT VOLTAGE | OSCILLATOR FREQUENCY (kHz) |     |     |     |
|-----------------------------------------|----------------------------|-----|-----|-----|
|                                         | 100                        | 180 | 300 | 500 |
| 0                                       | 0                          | 0   | A   | A   |
| 1                                       | 1                          | 1   | B   | B   |
| 2                                       | 2                          | 2   | C   | C   |
| 3                                       | 3                          | 3   | D   | D   |
| 4                                       | 4                          | 4   | E   | E   |
| 5                                       | 5                          | 5   | F   | F   |
| 6                                       | 6                          | 6   | H   | H   |
| 7                                       | 7                          | 7   | K   | K   |
| 8                                       | 8                          | 8   | L   | L   |
| 9                                       | 9                          | 9   | M   | M   |

④ Denotes the production lot number  
0 to 9, A to Z repeated(G.I.J.O.Q.W excepted)

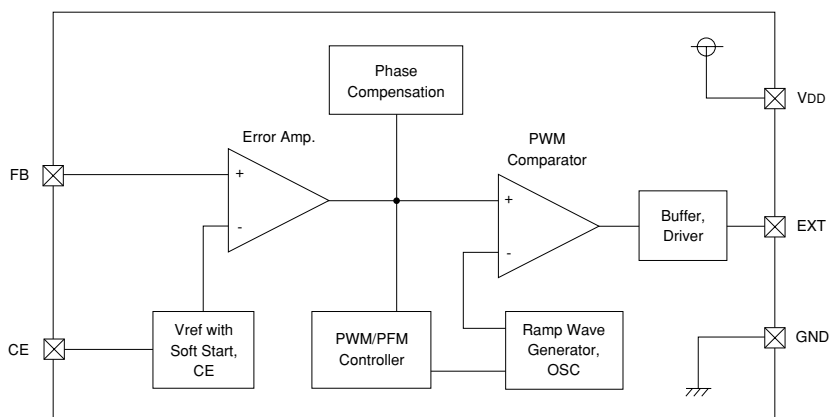
## Block Diagram

XC6367, XC6368 Series A, C, E, F types (V<sub>OUT</sub>)



Note : Connecting V<sub>OUT</sub> and V<sub>DD</sub> internally with E, F types.

XC6367, XC6368 Series B,D types (FB)



## Absolute Maximum Ratings

Ta=25°C

| PARAMETER                          | SYMBOL           | RATINGS                     | UNITS |
|------------------------------------|------------------|-----------------------------|-------|
| V <sub>DD</sub> Pin Voltage        | V <sub>DD</sub>  | -0.3 ~ 12                   | V     |
| V <sub>OUT</sub> Pin Voltage       | V <sub>OUT</sub> | -0.3 ~ 12                   | V     |
| FB Pin Voltage                     | V <sub>FB</sub>  | -0.3 ~ 12                   | V     |
| CE Pin Voltage                     | V <sub>CE</sub>  | -0.3 ~ 12                   | 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    |
| Continuous Total Power Dissipation | P <sub>d</sub>   | 150                         | mW    |
| Operating Ambient Temperature      | T <sub>opr</sub> | -30 ~ +80                   | °C    |
| Storage Temperature                | T <sub>stg</sub> | -40 ~ +125                  | °C    |

4

## 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 (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE : Apply voltage                                | –     | –     | 0.8   | V     |
| Oscillation Hold Voltage       | V <sub>HLD</sub>  | Use of a 2SX1628 transistor recommended, I <sub>OUT</sub> =1.0mA    | –     | –     | 0.7   | V     |
| Supply Current 1               | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=set-up output voltage x 0.95                   | –     | 130   | 200   | μA    |
| Supply Current 2               | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=set-up output voltage + 0.5V                   | –     | 20    | 35    | μA    |
| Stand-by Current               | I <sub>STB</sub>  | V <sub>OUT</sub> =set-up 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | –     | –     | 0.20  | V     |
| EXT "High" 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 "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 19    | 27    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 84    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, connect V<sub>DD</sub> to V<sub>OUT</sub> ; V<sub>IN</sub>=set-up 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.

Note 2:  $EFFI = \frac{[(\text{output voltage}) \times (\text{output current})]}{[(\text{input voltage}) \times (\text{input current})]} \times 100$

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

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>  |                                                                     | 4.875 | 5.000 | 5.125 | V     |
| Supply Voltage (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE : Apply voltage                                | –     | –     | 0.8   | V     |
| Oscillation Hold Voltage       | V <sub>HLD</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.7   | V     |
| Supply Current 1               | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=set-up output voltage x 0.95                   | –     | 180   | 280   | μA    |
| Supply Current 2               | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=set-up output voltage + 0.5V                   | –     | 22    | 38    | μA    |
| Stand-by Current               | I <sub>STB</sub>  | V <sub>OUT</sub> =set-up 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | –     | –     | 0.20  | V     |
| EXT "High" 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 "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 13    | 19    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 87    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, connect V<sub>DD</sub> to V<sub>OUT</sub> ; V<sub>IN</sub>=set-up 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.

Note 2:  $EFFI = \{[(\text{output voltage}) \times (\text{output current})] \div [(\text{input voltage}) \times (\text{input current})]\} \times 100$

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

## Series Amendments:

### XC6367C, XC6368C series

Please note that the following condition applies :

Soft Start Time (T<sub>SS</sub>) : Connect R<sub>SS</sub>, C<sub>SS</sub>. CE 0V → 3.0V

### XC6367E, XC6368E series

Please delete 'Supply Voltage (V<sub>DD</sub>)' and '(Note 1)'

Please add the following note :

Note 4: There are no products within the XC6367E, XC6368E series range which have a set-up voltage of less than 2.0V.

### XC6367F, XC6368F series

Please note that the following condition applies :

Soft Start Time (T<sub>SS</sub>) : Connect R<sub>SS</sub>, C<sub>SS</sub>. CE 0V → 3.0V

Please delete 'Supply Voltage (V<sub>DD</sub>)' and '(Note 1)'

Please add the following note :

Note 4: There are no products within the XC6367F, XC6368F series range which have a set-up voltage of less than 2.0V.

XC6367B103MR, XC6368B103MR

V<sub>OUT</sub>=3.0V (when set-up), 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 (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up 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>  | Use of a 2SD1628 transistor, 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    |
| 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                       | –     | –     | 0.20  | V     |
| EXT "High" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V | –     | 32    | 47    | Ω     |
| EXT "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 20    | 30    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 84    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, 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.

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

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

#### Series Amendments:

XC6367D, XC6368D series

Please note that the following condition applies :

Soft Start Time (T<sub>SS</sub>) : Connect R<sub>SS</sub>, C<sub>SS</sub>. CE 0V → 3.0V

4

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 (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE : Apply voltage                                | –     | –     | 0.8   | V     |
| Oscillation Hold Voltage       | V <sub>HLD</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.7   | V     |
| Supply Current 1               | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=set-up output voltage x 0.95                   | –     | 50    | 100   | μA    |
| Supply Current 2               | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=set-up output voltage + 0.5V                   | –     | 11    | 20    | μA    |
| Stand-by Current               | I <sub>STB</sub>  | V <sub>OUT</sub> =set-up output voltage x 0.95, CE=0V               | –     | –     | 0.5   | μA    |
| Oscillator 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | –     | –     | 0.20  | V     |
| EXT "High" 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 "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 19    | 27    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 84    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, connect V<sub>DD</sub> to V<sub>OUT</sub> ; V<sub>IN</sub>=set-up 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.

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

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

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>  |                                                                     | 4.875 | 5.000 | 5.125 | V     |
| Supply Voltage (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up Voltage 2 | V <sub>ST2</sub>  | V <sub>OUT</sub> =CE : Apply voltage                                | –     | –     | 0.8   | V     |
| Oscillation Hold Voltage       | V <sub>HLD</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.7   | V     |
| Supply Current 1               | I <sub>DD1</sub>  | V <sub>OUT</sub> =CE=set-up output voltage x 0.95                   | –     | 70    | 120   | μA    |
| Supply Current 2               | I <sub>DD2</sub>  | V <sub>OUT</sub> =CE=set-up output voltage + 0.5V                   | –     | 11    | 22    | μA    |
| Stand-by Current               | I <sub>STB</sub>  | V <sub>OUT</sub> =set-up output voltage x 0.95, CE=0V               | –     | –     | 0.5   | μA    |
| Oscillator 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>OUT</sub> =set-up output voltage x0.95                       | –     | –     | 0.20  | V     |
| EXT "High" 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 "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 13    | 19    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 87    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, connect V<sub>DD</sub> to V<sub>OUT</sub> ; V<sub>IN</sub>=set-up 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.

Note 2:  $EFFI = \{[(\text{output voltage}) \times (\text{output current})] \div [(\text{input voltage}) \times (\text{input current})]\} \times 100$

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

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XC6367B101MR, XC6368B101MR

V<sub>OUT</sub>=3.0V (when set-up), F<sub>OSC</sub>=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 (Note 1)        | V <sub>DD</sub>   |                                                                     | 2.0   | –     | 10.0  | V     |
| Maximum Input Voltage          | V <sub>IN</sub>   |                                                                     | 10.0  | –     | –     | V     |
| Oscillation Start-up Voltage 1 | V <sub>ST1</sub>  | Use of a 2SD1628 transistor, I <sub>OUT</sub> =1.0mA                | –     | –     | 0.9   | V     |
| Oscillation Start-up 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>  | Use of a 2SD1628 transistor, 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    |
| Oscillator 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 (Note 3)        | PFMDTY            | I <sub>OUT</sub> =0mA                                               | 15    | 25    | 35    | %     |
| CE "High" Voltage              | V <sub>CEH</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                       | 0.65  | –     | –     | V     |
| CE "Low" Voltage               | V <sub>CEL</sub>  | V <sub>DD</sub> =2.85V, FB=0V                                       | –     | –     | 0.20  | V     |
| EXT "High" ON Resistance       | R <sub>EXTH</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V | –     | 32    | 47    | Ω     |
| EXT "Low" ON Resistance        | R <sub>EXTL</sub> | Same as I <sub>DD1</sub> , V <sub>EXT</sub> =0.4V                   | –     | 20    | 30    | Ω     |
| Efficiency (Note 2)            | EFFI              |                                                                     | –     | 84    | –     | %     |
| Soft-Start Time                | T <sub>SS</sub>   |                                                                     | 5     | 10    | 20    | msec  |

Measuring conditions: Unless otherwise specified, 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

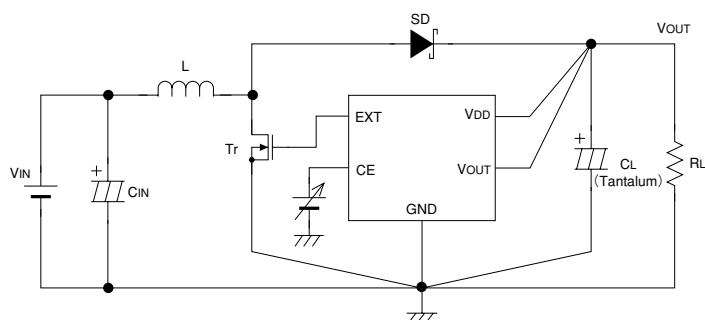
Note 1: When taking V<sub>DD</sub> from another power source please ensure that V<sub>DD</sub> = 2.0V or more.  
Oscillation will occur with a value of V<sub>DD</sub> = 0.8V or more, but with a value of V<sub>DD</sub> = 2.0V or more, output voltage and oscillation frequency will be stable.

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

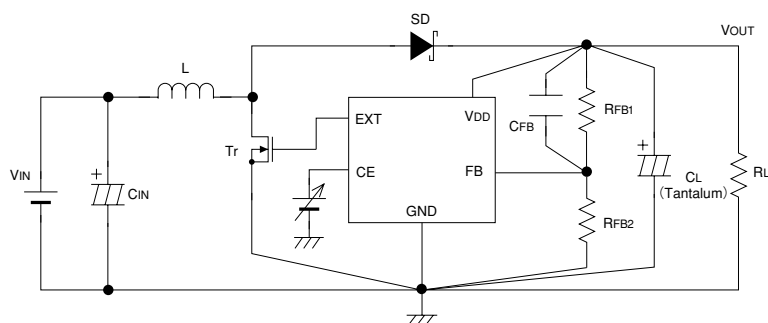
Note 3: Applies to the XC6368 series only (duty ratio when control changes to PFM).

## ■ Typical Application Circuits

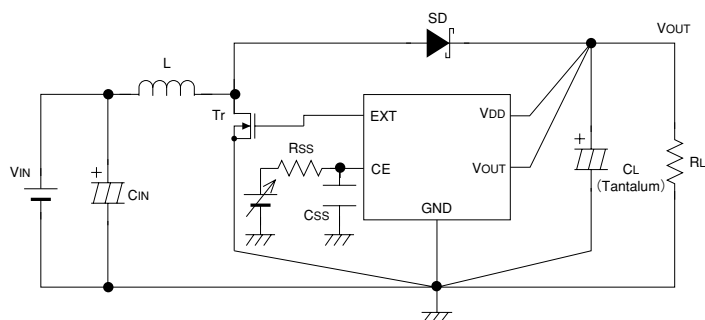
Circuit 1. XC6367A, XC6368A



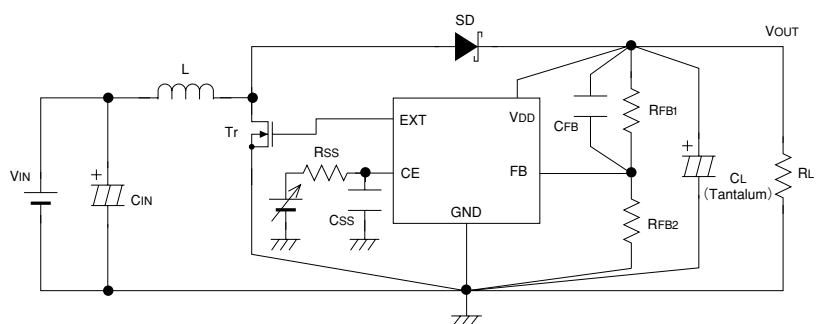
Circuit 2. XC6367B, XC6368B



Circuit 3. XC6367C, XC6368C

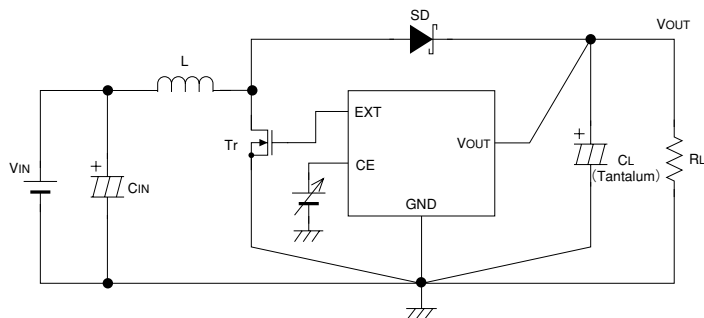


Circuit 4. XC6367D, XC6368D

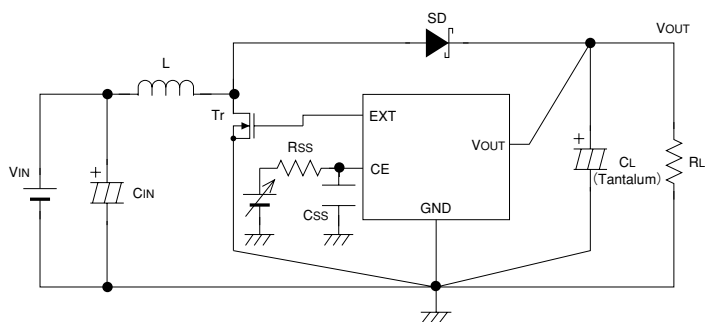


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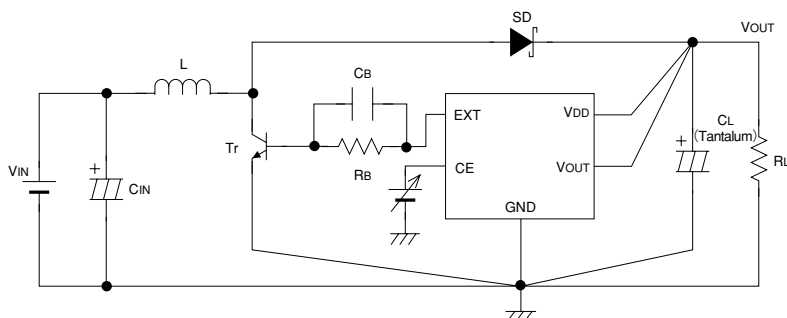
Circuit 5. XC6367E, XC6368E



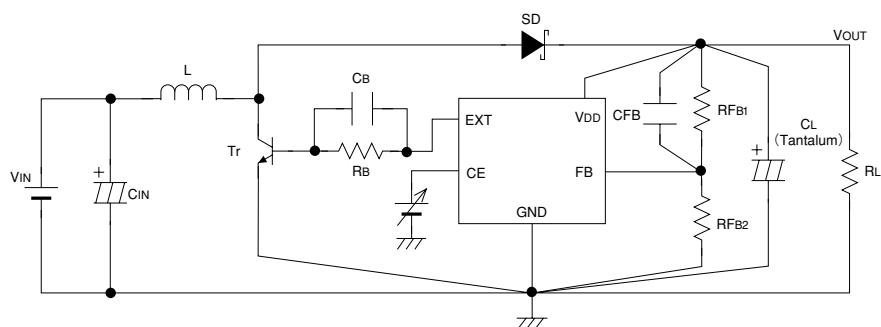
Circuit 6. XC6367F, XC6368F



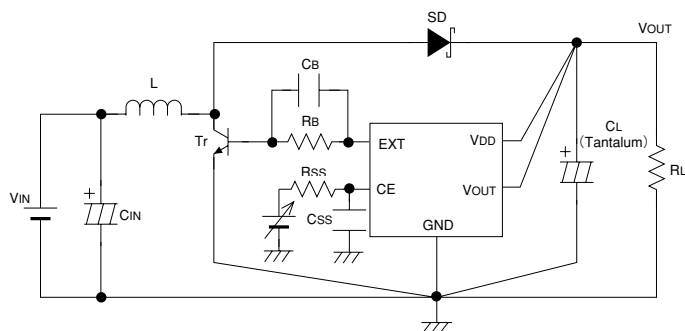
Circuit 7. XC6367A, XC6368A (NPN Transistor)



Circuit 8. XC6367B, XC6368B (NPN Transistor)

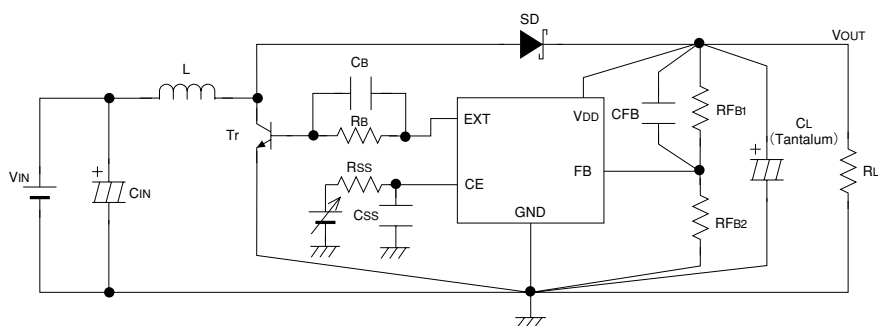


Circuit 9. XC6367C, XC6368C (NPN Transistor)



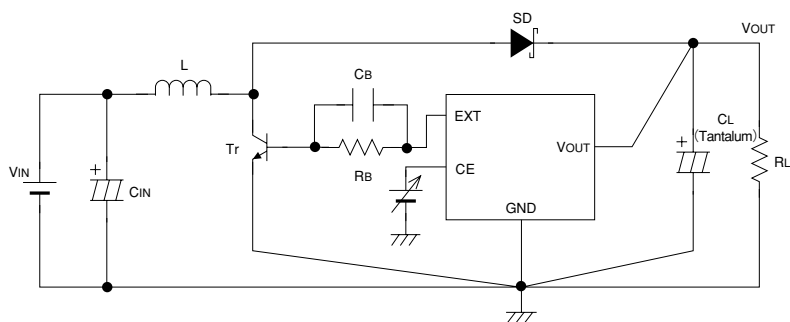
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Circuit 10. XC6367D, XC6368D (NPN Transistor)

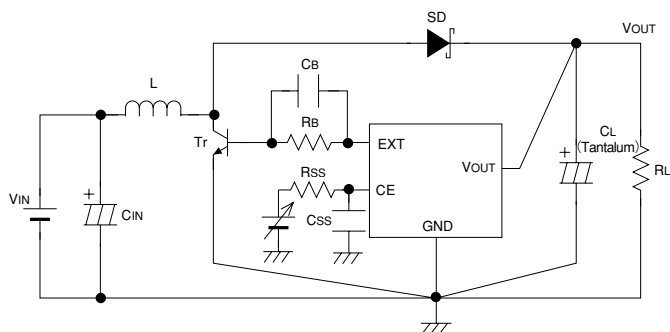


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Circuit 11. XC6367E, XC6368E (NPN Transistor)



Circuit 12. XC6367F, XC6368F (NPN Transistor)



## Recommended Components

- Tr : XP161A1355PR (Torex N-channel Power MOSFET)  
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 : 22μH (Sumida CR54, F<sub>OSC</sub>=300kHz)  
47μH (Sumida CR75, F<sub>OSC</sub>=100, 180kHz)  
10μH (Sumida CR54, F<sub>OSC</sub>=500kHz)
- SD : MA2Q735 (Schottky Diode, Matsushita)
- C<sub>IN</sub> : 16V 220μF (Aluminium Electrolytic Capacitor)
- CL : 16V 47μF + 47μF (Tantalum capacitor, Nichicon MCE)

## NPN Tr type :

- Tr : 2SD1628 (Sanyo)
- R<sub>b</sub> : 500Ω (Adjust according to load and Tr. hFE levels)
- C<sub>b</sub> : 2200pF (Ceramic type)

Set up so that  $C_b \leq 1 \div (2\pi \times R_b \times F_{osc} \times 0.7)$

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

- C<sub>SS</sub> : 0.1μF (Ceramic capacitor)
- R<sub>SS</sub> : 470kΩ (C, F type), 220kΩ (D type)

## B, D type (FB versions)

- R<sub>FB</sub> : Set up so that  $R_{FB1} \div R_{FB2} = V_{OUT} - 1$  ( $V_{OUT}$  = set-up 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.  $V_{OUT} = 3.0V$   
 $R_{FB1} = 400k\Omega$ ,  $R_{FB2} = 200k\Omega$ ,  $C_{FB} = 47pF$

If using a Torex MOSFET, We recommend using one which has a gate protection diode built-in.

|                     | Gate Protection Diode Built-in  |
|---------------------|---------------------------------|
|                     | XP161A1355PR                    |
| R <sub>ds(ON)</sub> | 0.15 Ω @ V <sub>gs</sub> =1.5V  |
|                     | XP161A1265PR                    |
| R <sub>ds(ON)</sub> | 0.095 Ω @ V <sub>gs</sub> =2.5V |

## ■Directions for use

### ●Notes on Use

Take ample care to ensure that none of the IC's, nor the external component's, absolute maximum ratings are exceeded.

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.

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.

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.

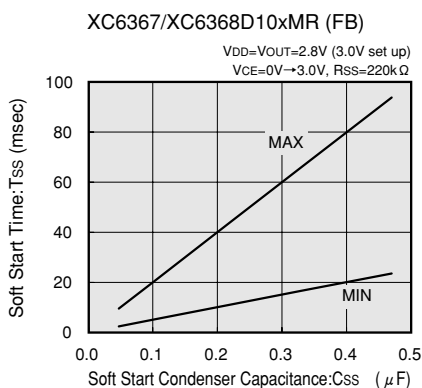
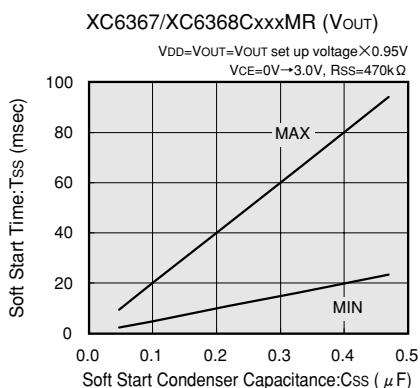
### ●External Components

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#### 1. Soft start time set up

If you wish to lengthen soft start time we recommend that you use the C or D versions of the series which have soft start time externally set up.

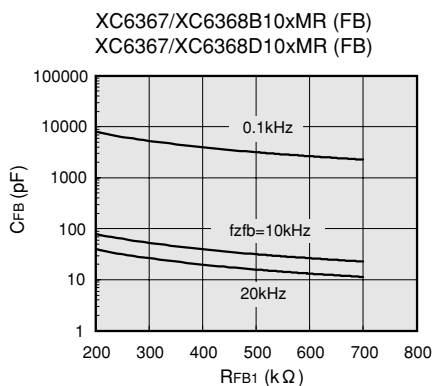
Soft start time (Tss) is between MIN & MAX, as indicated in the graphs below, so please select soft start condenser capacitance (C<sub>SS</sub>) to suit your application.



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

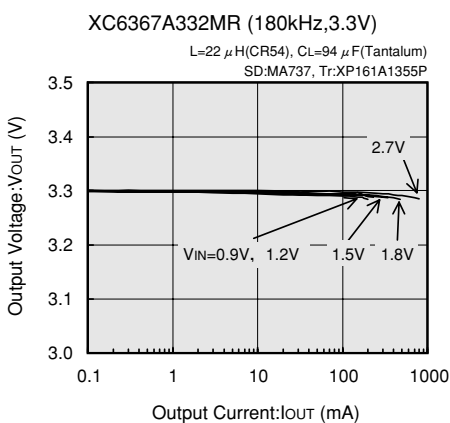
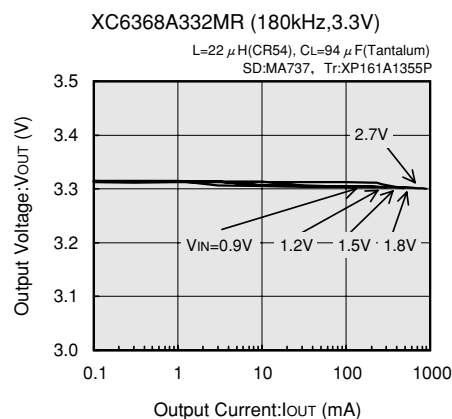
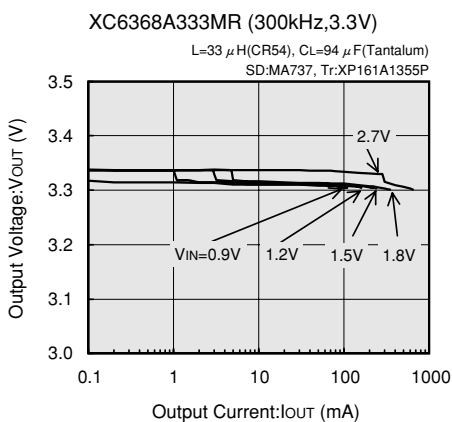
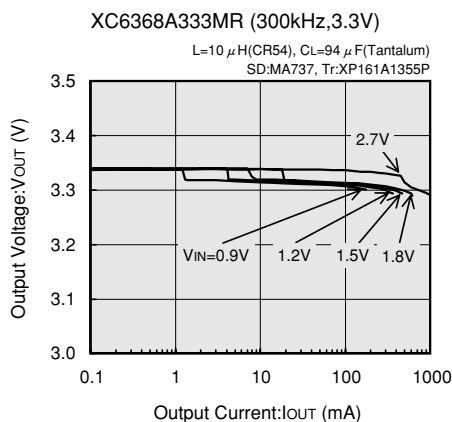
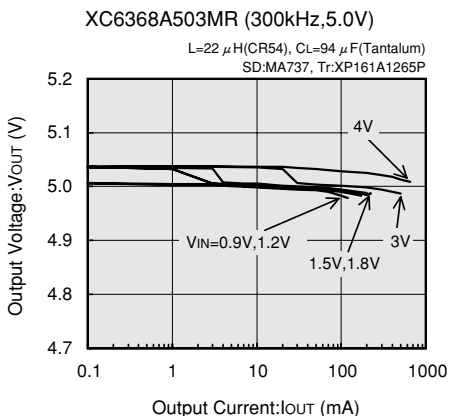
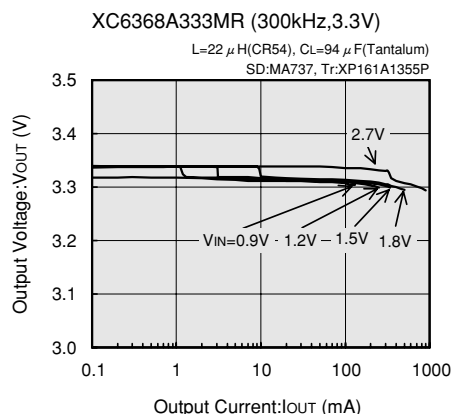
$$f_{zfb} = 1 \div (2\pi \times C_{FB} \times R_{FB1})$$

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

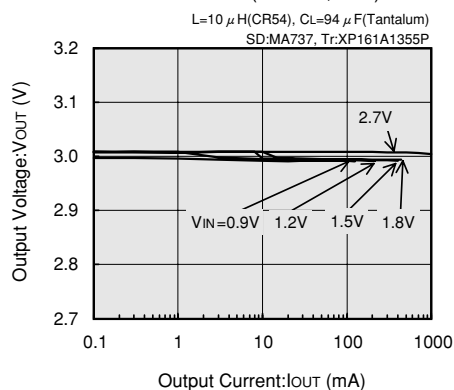
### (1) OUTPUT VOLTAGE vs. OUTPUT CURRENT



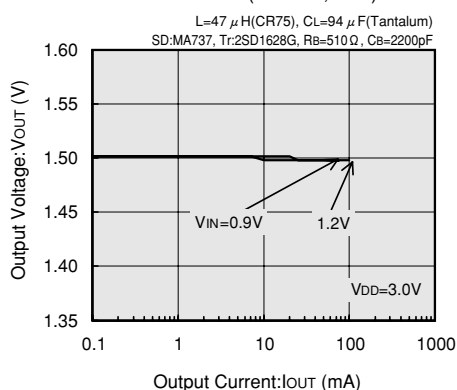
Note: 〈External component〉 CIN=220  $\mu$ F (Electrolytic capacitor)

## (1) OUTPUT VOLTAGE vs. OUTPUT CURRENT

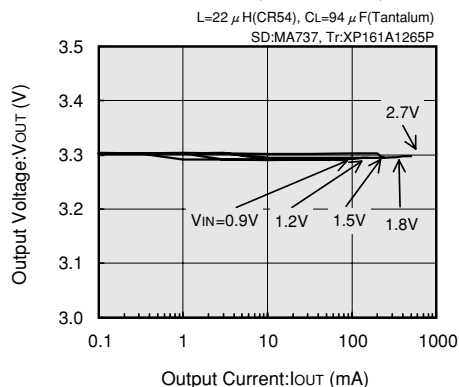
XC6368A305MR (500kHz, 3.0V)



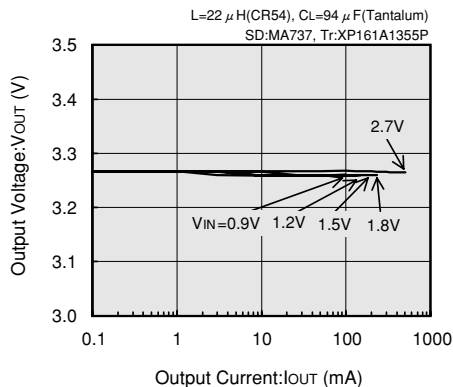
XC6368A151MR (100kHz, 1.5V)



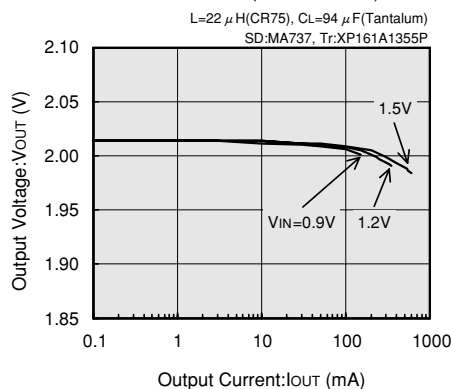
XC6368B103MR (300kHz, 3.3V)



XC6368B102MR (180kHz, 3.3V)

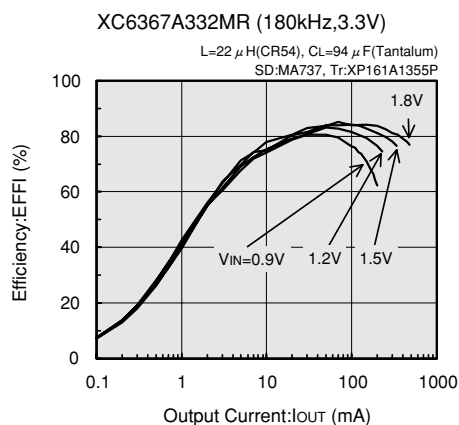
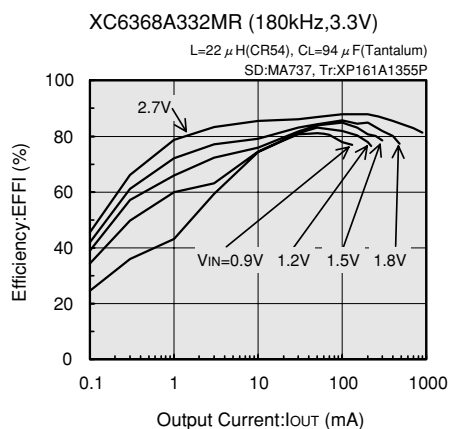
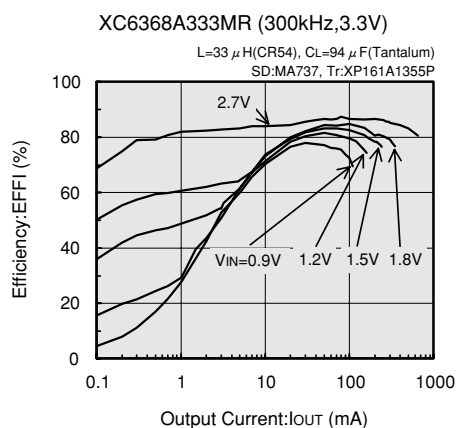
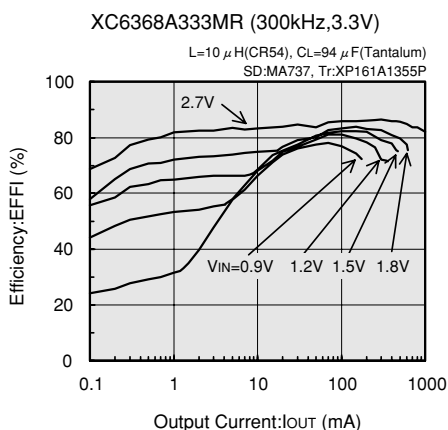
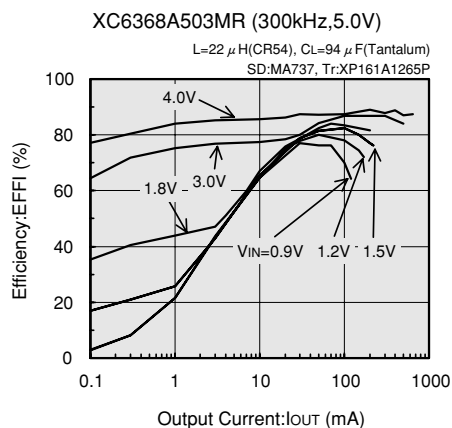
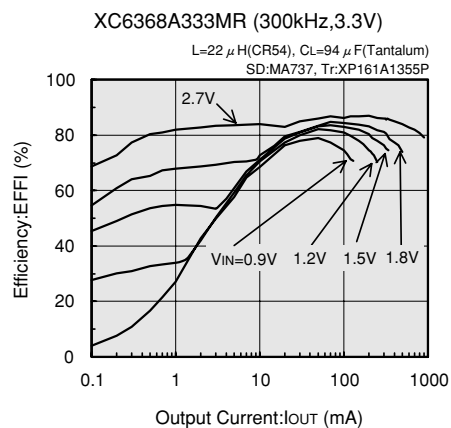


XC6368B101MR (100kHz, 2.0V)



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

(2) EFFICIENCY vs. OUTPUT CURRENT

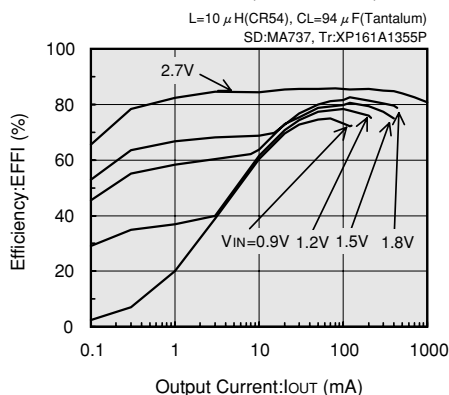


Note: 〈External component〉 CIN=220  $\mu$ F(Electrolytic capacitor)

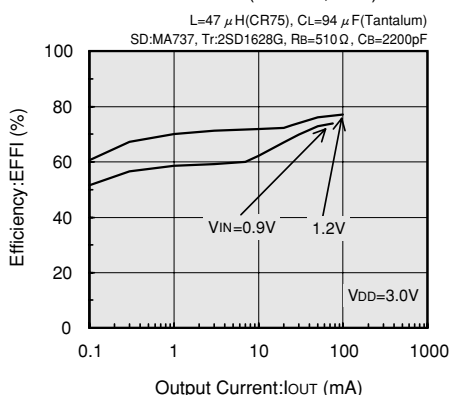
4

## (2) EFFICIENCY vs. OUTPUT CURRENT

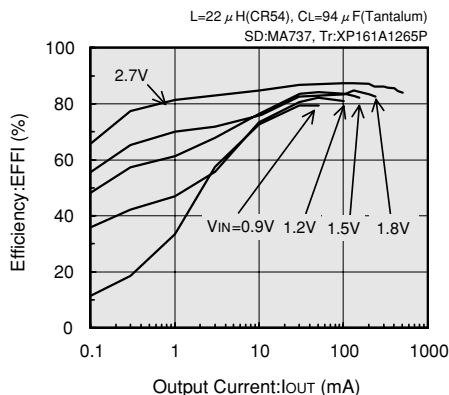
XC6368A305MR (500kHz, 3.0V)



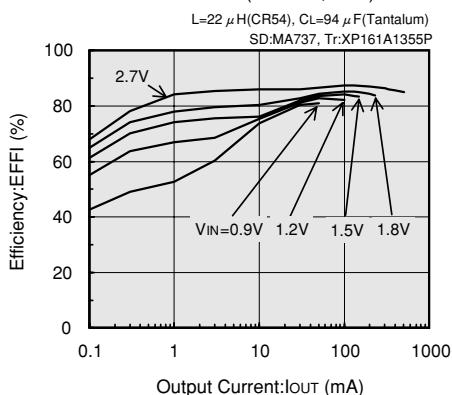
XC6368A151MR (100kHz, 1.5V)



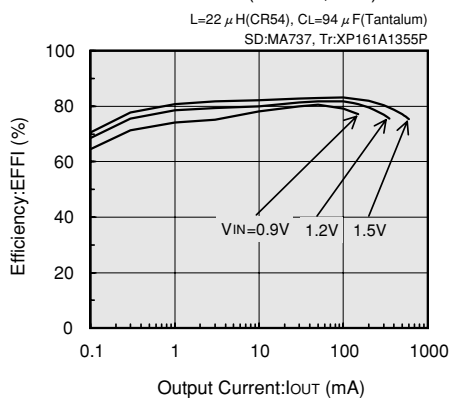
XC6368B103MR (300kHz, 3.3V)



XC6368B102MR (180kHz, 3.3V)

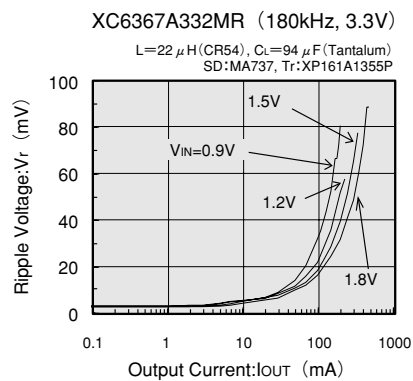
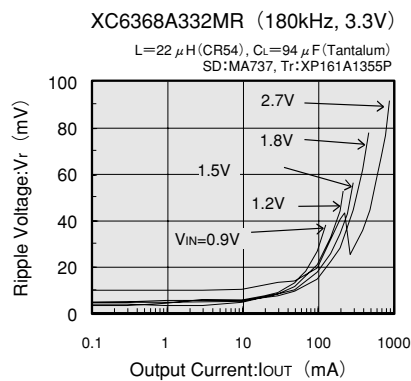
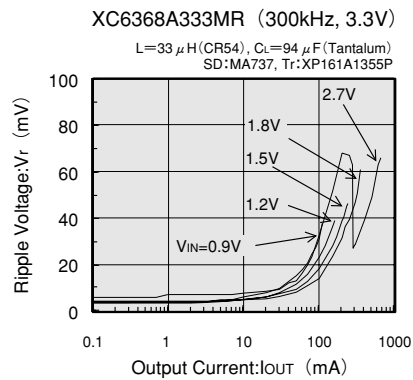
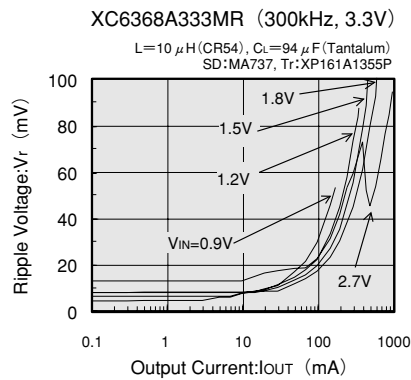
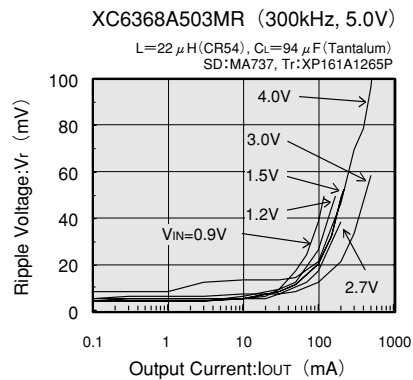
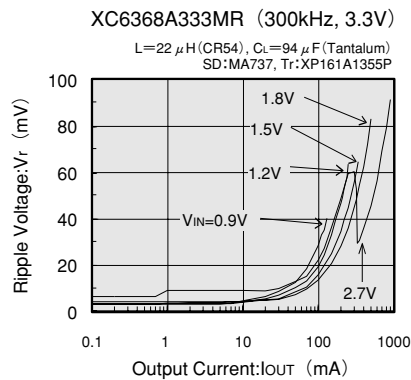


XC6368B101MR (100kHz, 2.0V)

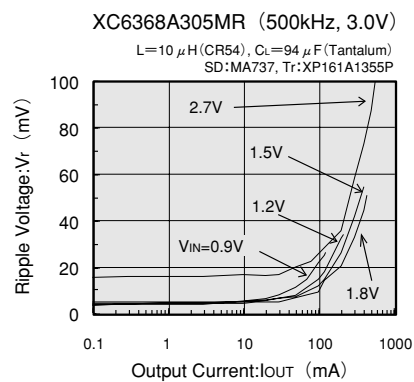


Note: 〈External component〉 CIN=220  $\mu\text{F}$ (Electrolytic capacitor)

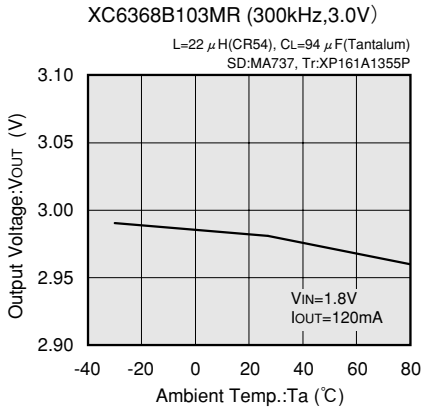
(3) RIPPLE VOLTAGE vs. OUTPUT CURRENT



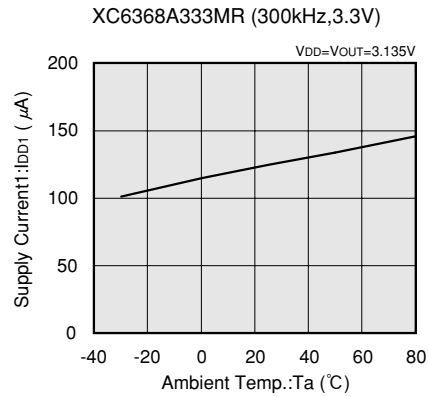
## (3) RIPPLE VOLTAGE vs. OUTPUT CURRENT



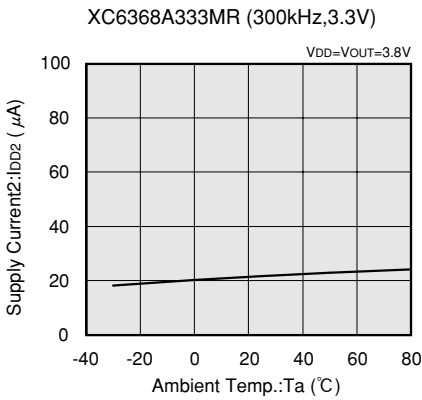
(4) OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



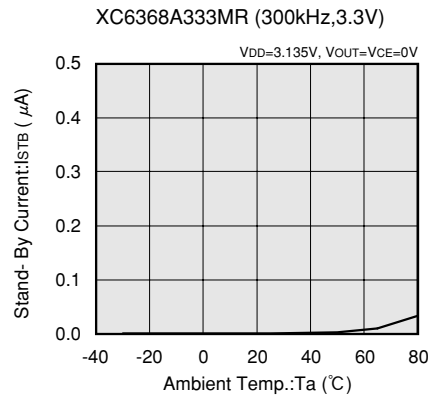
(5) SUPPLY CURRENT 1 vs. AMBIENT TEMPERATURE



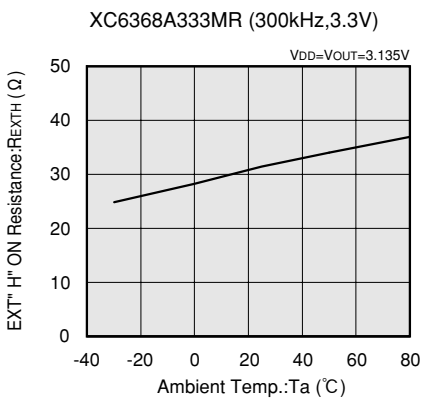
(6) SUPPLY CURRENT 2 vs. AMBIENT TEMPERATURE



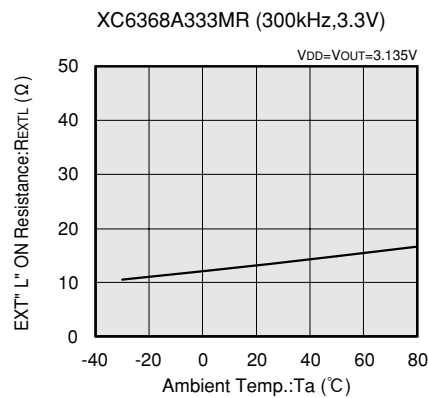
(7) STAND-BY CURRENT vs. AMBIENT TEMPERATURE



(8) EXT<sup>H</sup> ON RESISTANCE vs. AMBIENT TEMPERATURE

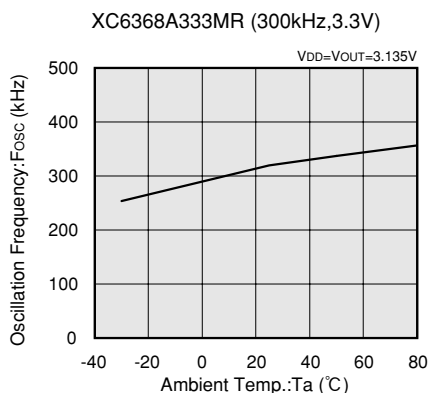


(9) EXT<sup>L</sup> ON RESISTANCE vs. AMBIENT TEMPERATURE

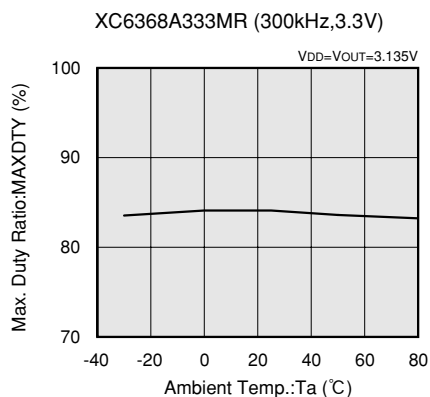


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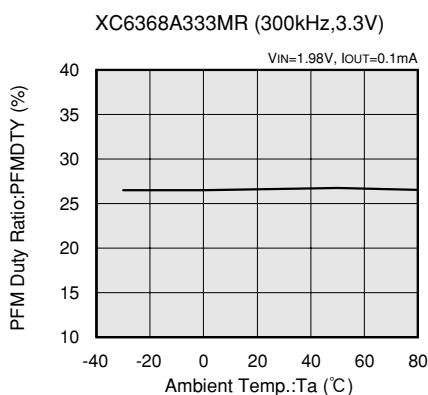
(10) OSCILLATION FREQUENCY vs. AMBIENT TEMPERATURE



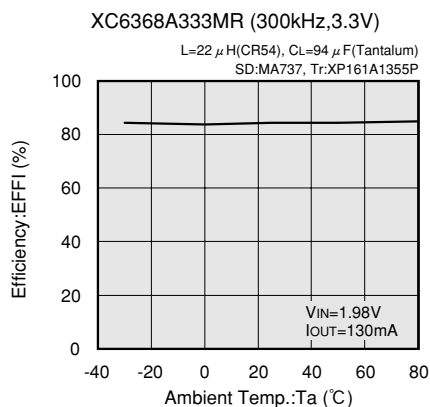
(11) MAX. DUTY RATIO vs. AMBIENT TEMPERATURE



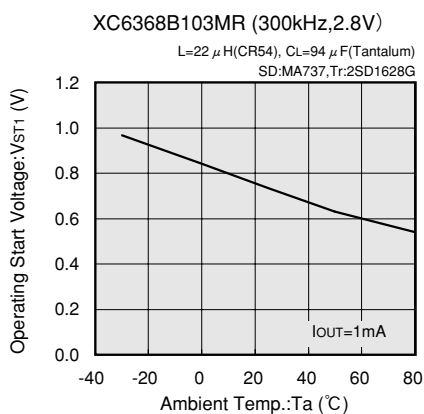
(12) PFM DUTY RATIO vs. AMBIENT TEMPERATURE



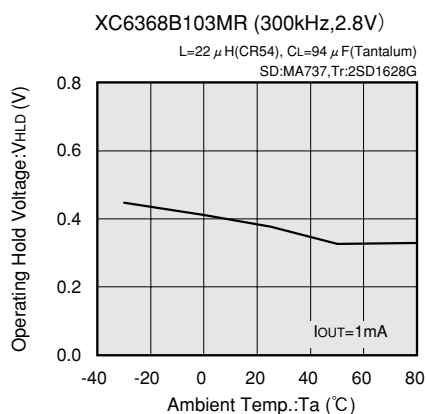
(13) EFFICIENCY vs. AMBIENT TEMPERATURE



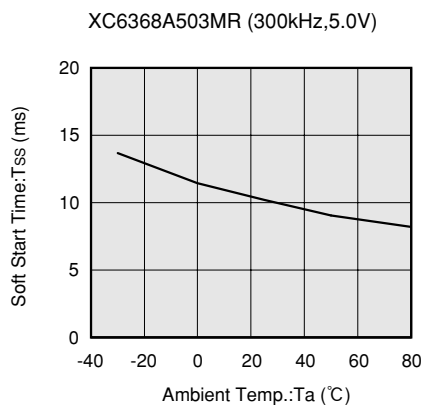
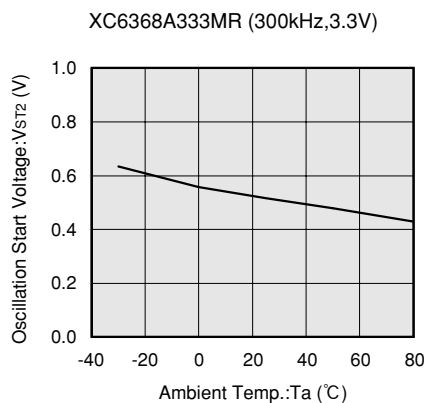
(14) OPERATING START VOLTAGE vs. AMBIENT TEMPERATURE



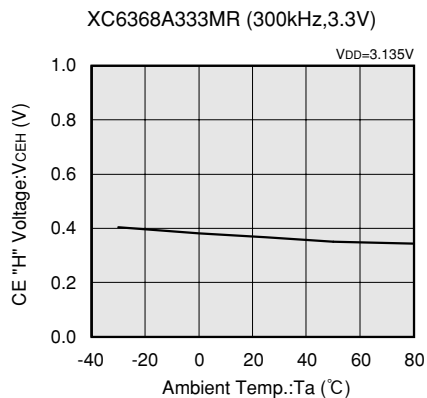
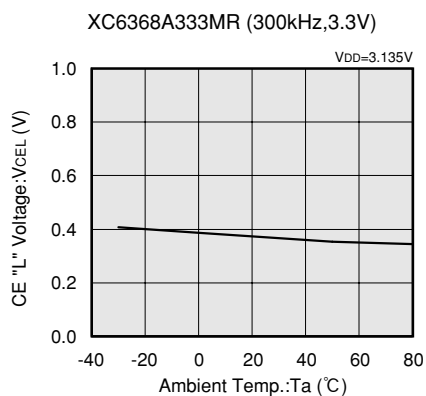
(15) OPERATING HOLD VOLTAGE vs. AMBIENT TEMPERATURE



(16) OSCILLATION START VOLTAGE vs. AMBIENT TEMPERATURE (17) SOFT START TIME vs. AMBIENT TEMPERATURE



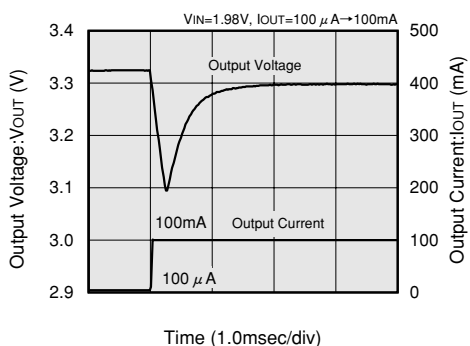
(18) CE "L" VOLTAGE vs. AMBIENT TEMPERATURE (19) CE "H" VOLTAGE vs. AMBIENT TEMPERATURE



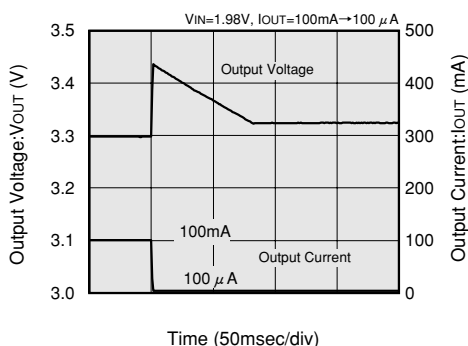
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## (20) LOAD TRANSIENT RESPONSE

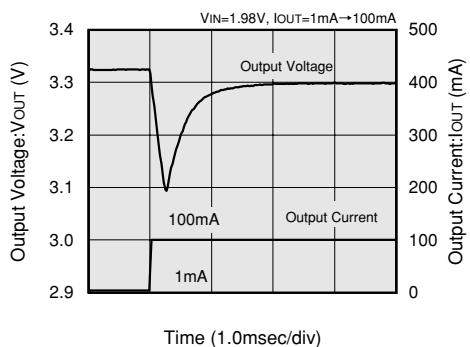
XC6368A333MR (300kHz, 3.3V)



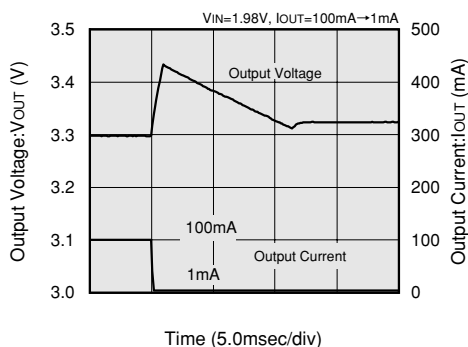
XC6368A333MR (300kHz, 3.3V)



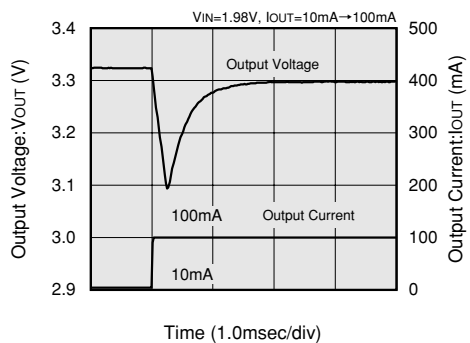
XC6368A333MR (300kHz, 3.3V)



XC6368A333MR (300kHz, 3.3V)



XC6368A333MR (300kHz, 3.3V)



XC6368A333MR (300kHz, 3.3V)

