

# XC6365 / 6366 Series



PWM Controlled, PWM/PFM Switchable Step-down DC/DC Converters

- ◆ **Input Voltage Range** : 2.2~10.0V
- ◆ **Output Voltage Range** : 1.5~6.0V(±2.5%)
- ◆ **Oscillator Frequency** : 300kHz(±15%)
- ◆ **Maximum Duty Ratio** : 100%
- ◆ **High Efficiency** : 92%
- ◆ **PWM/PFM Switching Control (XC6366)**
- ◆ **SOT-25 Package**

## General Description

The XC6365/66 series are multi-functional step-down DC/DC converters with built-in high speed, low ON resistance drivers. An output current of more than 1A is possible using an externally connected transistor, coil, diode and capacitor.

Output voltage is programmable in 0.1V steps between 1.5V to 6.0V ( $V_{OUT}$ ) (±2.5% accuracy). Further, with 1.0V of standard voltage supply internal and using externally connected components, output voltage can be set up freely (FB).

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

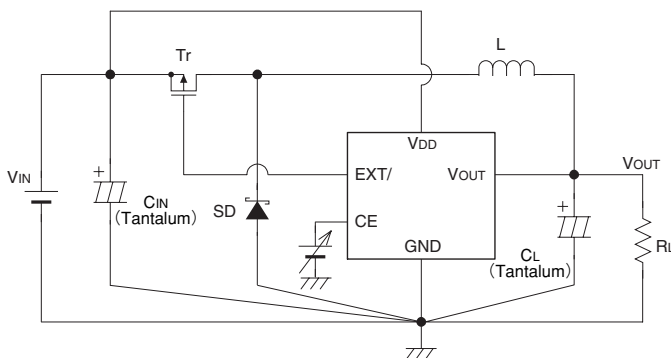
Control switches from PWM to PFM during light loads with the XC6366 (PWM/PFM switchable) and the series is highly efficient from light loads to large output currents.

In relation to soft-start time, both internally set-up 10msec types (A,B) and external resistor or capacitor regulated types (C,D) are available.

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

With U.V.L.O internal, the external Tr. will be forcibly switched off if used below the stipulated voltage.

## Typical Application Circuit



## Applications

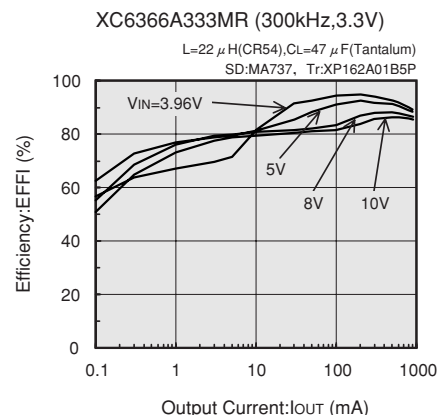
- Electronic Information Organizers
- Palmtops
- Cellular and portable phones
- Portable Audio Systems
- Various Multi-function Power Supplies

## Features

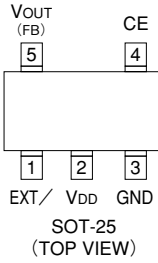
- Input voltage range** : 2.2V~10V ( $V_{OUT}$  type)
- Output voltage range** : 1.5V~6.0V programmable in 0.1V steps (±2.5%)
- Oscillator frequency** : 300kHz (±15%)  
: Custom products for 180, 500kHz
- Output Current** : 1.0A + ( $V_{IN}=5.0V, V_{OUT}=3.0V$ )
- High Efficiency** : 92% (typ.)
- Stand-by capability** :  $I_{STB}=0.5\mu A$  (max.)
- Soft-start time set-up externally type possible**
- Internally set-up output voltage type possible (Vout)**
- Externally set-up output voltage type possible (FB)**
- Package** : SOT-25

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## Typical Performance Characteristic



## Pin Configuration



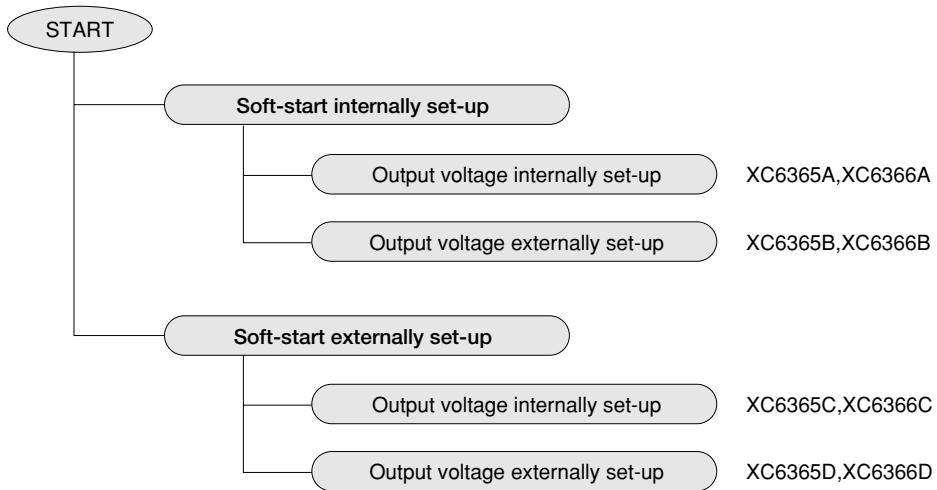
## Pin Assignment

PIN NUMBER	PIN NAME	FUNCTION
1	EXT/	External Transistor Connection
2	V <sub>DD</sub>	Power Supply
3	GND	Ground
4	CE	Chip Enable Soft-start capacitor connection with soft-start externally set-up types (C,D)
5	V <sub>OUT</sub> (FB)	Output Voltage Monitor FB with externally set-up types (B,D)

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## Product Classification

### ● Selection Guide



●Ordering Information

**XC6365**①②③④⑤⑥

XC6365 Series PWM Control

①	A	V <sub>OUT</sub> type - internally set-up soft-start
	B	FB type - internally set-up soft-start
	C	V <sub>OUT</sub> type - externally set-up soft-start
	D	FB type - externally set-up soft-start
② ③		Output voltage e.g. 3.0V output : (②=3, ③=0), N.B. with FB (B,D) types (②=1, ③=0)
④	3	Oscillator frequency 300kHz
	5	Oscillator frequency 500kHz (Custom)
	2	Oscillator frequency 180kHz (Custom)
⑤	M	Package SOT-25
⑥	R	Embossed Tape : Standard Feed
	L	: Reverse Feed

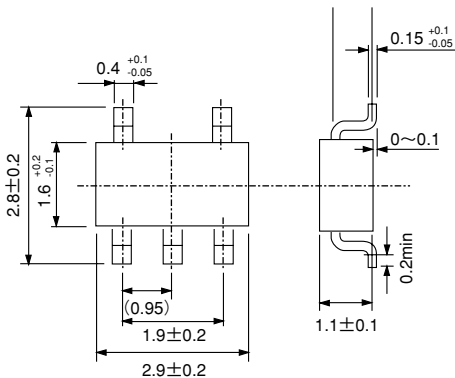
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**XC6366**①②③④⑤⑥

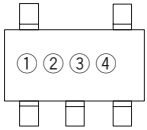
XC6366 Series PWM/PFM switching control  
(same as XC6365 series)

■Packaging Information

●SOT-25



## Marking



SOT-25  
(TOP VIEW)

① Represents the Product Classification

PRODUCT NAME	DESIGNATOR
XC6365/66A	<u>A</u>
XC6365/66B	<u>B</u>
XC6365/66C	<u>C</u>
XC6365/66D	<u>D</u>
XC6365/66E	<u>E</u>
XC6365/66F	<u>F</u>

② Represents the integer of the Output Voltage and Oscillator Frequency

INTEGRAR OF THE OUTPUT VOLTAGE	OSCILLATOR FREQUENCY (kHz)			
	100	180	300	500
1	<u>B</u>	<u>1</u>	<u>1</u>	<u>B</u>
2	<u>C</u>	<u>2</u>	<u>2</u>	<u>C</u>
3	<u>D</u>	<u>3</u>	<u>3</u>	<u>D</u>
4	<u>E</u>	<u>4</u>	<u>4</u>	<u>E</u>
5	<u>F</u>	<u>5</u>	<u>5</u>	<u>F</u>
6	<u>H</u>	<u>6</u>	<u>6</u>	<u>H</u>

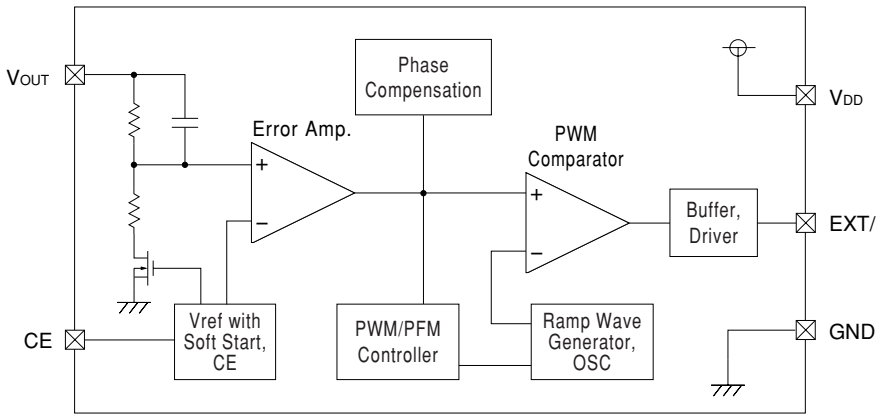
③ Represents the decimal number of the Output Voltage and Oscillation Frequency

THE DECIMAL NUMBER 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)

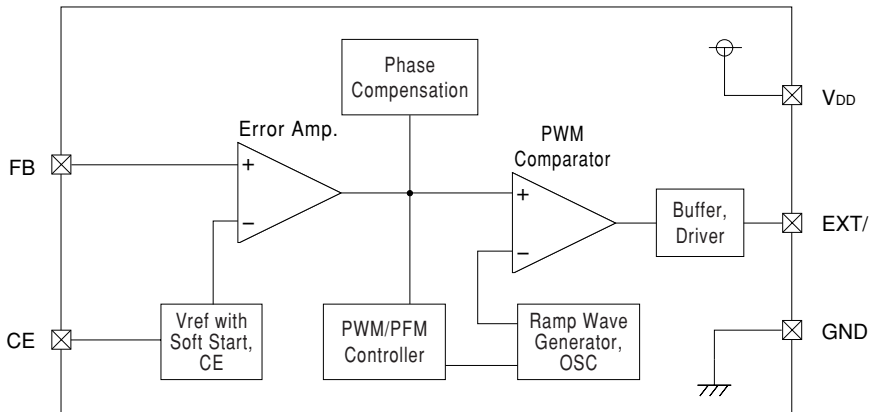
## Block Diagram

XC6365, XC6366 Series A,C type (V<sub>out</sub>)



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XC6365, XC6366 Series B,D type (FB)



## Absolute Maximum Ratings

Ta=25°C

PARAMETER	SYMBOL	RATINGS	UNITS
V <sub>IN</sub> Pin Voltage	V <sub>DD</sub>	-0.3 ~ +12	V
V <sub>OUT</sub> Pin Voltage	V <sub>OUT</sub>	-0.3 ~ V <sub>IN</sub> +0.3	V
FB Pin Voltage	V <sub>FB</sub>	-0.3 ~ V <sub>IN</sub> +0.3	V
CE Pin Voltage	V <sub>CE</sub>	-0.3 ~ V <sub>IN</sub> +0.3	V
EXT/ Pin Voltage	V <sub>EXT/</sub>	-0.3 ~ V <sub>IN</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

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## Electrical Characteristics

XC6365A333MR, XC6366A333MR (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
Maximum Input Voltage	V <sub>IN</sub>		10.0			V
UVLO Voltage (min. operating voltage)	V <sub>UVLO</sub>	Same as I <sub>DD1</sub> , voltage required to maintain H at EXT/	0.9		2.2	V
Supply Current 1	I <sub>DD1</sub>	No external components, CE=V <sub>IN</sub> , V <sub>OUT</sub> =0V		57	102	μA
Supply Current 2	I <sub>DD2</sub>	No external components, CE=V <sub>OUT</sub> =V <sub>DD</sub>		57	102	μA
				15	27	μA
Stand-by Current	I <sub>STB</sub>	No external components, CE=V <sub>OUT</sub> =0V			0.5	μA
Oscillator Frequency	F <sub>OSC</sub>	Measuring of EXT/ waveform, V <sub>IN</sub> =output voltage + 0.1V	255	300	345	kHz
Maximum Duty Ratio	MAXDTY		100			%
PFM Duty Ratio	PFMDTY	No load (XC6366 only)	15	25	35	%
CE "High" Voltage	V <sub>CEH</sub>	No external components, V <sub>OUT</sub> =0V, determine EXT/ "Low"	0.65			V
CE "Low" Voltage	V <sub>CEL</sub>	Same as V <sub>CEH</sub> , determine EXT/ "High"			0.20	V
EXT "High" ON Resistance	R <sub>EXTBH</sub>	Same as I <sub>DD2</sub> , V <sub>EXT/</sub> =V <sub>IN</sub> -0.4V		16	22	μA
EXT "Low" ON Resistance	R <sub>EXTBL</sub>	Same as I <sub>DD1</sub> , V <sub>EXT/</sub> =0.4V		14	19	μA
Efficiency	EFFI	Use of a XP162A01B5 transistor recommended		92		%
Soft-Start Time	T <sub>SS</sub>		5	10	20	msec

Measuring conditions: Unless otherwise specified, connect external components. V<sub>IN</sub>=V<sub>DD</sub>=5.0V, I<sub>OUT</sub>=220mA

Series Amendments:

XC6365C, XC6366C series

External Components : C<sub>SS</sub>=0.033μF, R<sub>SS</sub>=470kΩ

The following parameter applies :

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

**XC6365A503MR, XC6366A503MR**

( $V_{OUT}=5.0V$ ,  $F_{OSC}=300kHz$ )

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	$V_{OUT}$		4.875	5.000	5.125	V
Maximum Input Voltage	$V_{IN}$		10.0			V
UVLO Voltage (min. operating voltage)	$V_{UVLO}$	Same as $I_{DD1}$ , voltage required to maintain H at EXT/	0.9		2.2	V
Supply Current 1	$I_{DD1}$	No external components, $CE=V_{DD}$ , $V_{OUT}=0V$		67	122	$\mu A$
Supply Current 2	$I_{DD2}$	No external components, $CE=V_{OUT}=V_{DD}$		67	122	$\mu A$
				16	29	$\mu A$
Stand-by Current	$I_{STB}$	No external components, $CE=V_{OUT}=0V$			0.5	$\mu A$
Oscillator Frequency	$F_{OSC}$	Measuring of EXT/ waveform, $V_{IN}=\text{output voltage} + 1.0V$	255	300	345	kHz
Maximum Duty Ratio	MAXDTY		100			%
PFM Duty Ratio	PFMDTY	No load (XC6366 only)	15	25	35	%
CE "High" Voltage	$V_{CEH}$	No external components, $V_{OUT}=0V$ , determine EXT/ "Low"	0.65			V
CE "Low" Voltage	$V_{CEL}$	Same as $V_{CEH}$ , determine EXT/ "High"			0.20	V
EXT "High" ON Resistance	$R_{EXTBH}$	Same as $I_{DD2}$ , $V_{EXT}/=V_{IN}-0.4V$		12	17	$\mu A$
EXT "Low" ON Resistance	$R_{EXTBL}$	Same as $I_{DD1}$ , $V_{EXT}/=0.4V$		10	14	$\mu A$
Efficiency	EFFI	Use of a XP162A01B5 transistor recommended		93		%
Soft-Start Time	$T_{SS}$		5	10	20	msec

Measuring conditions: Unless otherwise specified, connect external components.  $V_{IN}=V_{DD}=7.5V$ ,  $I_{OUT}=330mA$

Series Amendments:

XC6365C, XC6366C series

External Components :  $C_{SS}=0.033\mu F$ ,  $R_{SS}=470k\Omega$

The following parameter applies :

Soft Start Time ( $T_{SS}$ ) : Connect  $R_{SS}$ ,  $C_{SS}$ .  $CE, 0V \rightarrow 3.0V$  (When  $V_{IN}<3.0V$ ,  $V_{IN}=3.0V$ )

XC6365B103MR, XC6366B103MR

( $V_{OUT}=3.0V$  [when set up],  $F_{osc}=300kHz$ )

$T_a=25^\circ C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	$V_{OUT}$		2.925	3.000	3.075	V
Maximum Input Voltage	$V_{IN}$		10.0			V
UVLO Voltage (min. operating voltage)	$V_{UVLO}$	No external components, $CE=V_{DD}$ , $V_{OUT}=1.2V$ Same as $I_{DD1}$ , voltage required to maintain H at EXT/	0.9		2.2	V
Supply Current 1	$I_{DD1}$	No external components, $CE=V_{DD}$ , $FB=1.2V$		55	100	$\mu A$
Supply Current 2	$I_{DD2}$	No external components, XC6365		55	100	$\mu A$
		CE= $V_{DD}$ , $FB=1.2V$ XC6366		15	27	$\mu A$
Stand-by Current	$I_{STB}$	No external components, $CE=FB=0V$			0.5	$\mu A$
Oscillator Frequency	$F_{OSC}$	Measuring of EXT/ waveform, $V_{IN}=\text{output voltage} + 1.0V$	255	300	345	kHz
Maximum Duty Ratio	MAXDTY		100			%
PFM Duty Ratio	PFMDTY	No load (XC6366 only)	15	25	35	%
CE "High" Voltage	$V_{CEH}$	No external components, $FB=0V$ , determine EXT/ "Low"	0.65			V
CE "Low" Voltage	$V_{CEL}$	Same as $V_{CEH}$ , determine EXT/ "High"			0.20	V
EXT "High" ON Resistance	$R_{EXTBH}$	Same as $I_{DD2}$ , $V_{EXT}/=V_{IN}-0.4V$		17	24	$\mu A$
EXT "Low" ON Resistance	$R_{EXTBL}$	Same as $I_{DD1}$ , $V_{EXT}/=0.4V$		15	20	$\mu A$
Efficiency	EFFI	Use of a XP162A01B5 transistor recommended		92		%
Soft-Start Time	$T_{SS}$		5	10	20	msec

Measuring conditions: Unless otherwise specified, connect external components.  $V_{IN}=V_{DD}=4.5V$ ,  $I_{OUT}=200mA$

External components:  $R_{FB1} = 400k\Omega$ ,  $R_{FB2} = 200k\Omega$ ,  $C_{FB} = 100pF$

Series Amendments:

XC6365D, XC6366D series

External Components :  $C_{SS}=0.033\mu F$ ,  $R_{SS}=330k\Omega$

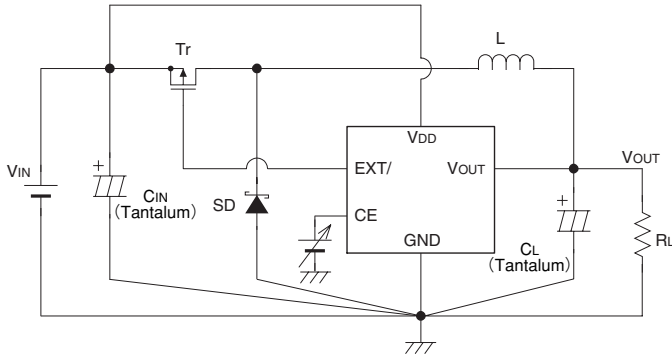
The following parameter applies :

Soft Start Time ( $T_{SS}$ ) : Connect  $R_{SS}$ ,  $C_{SS}$ .  $CE, 0V \rightarrow 3.0V$

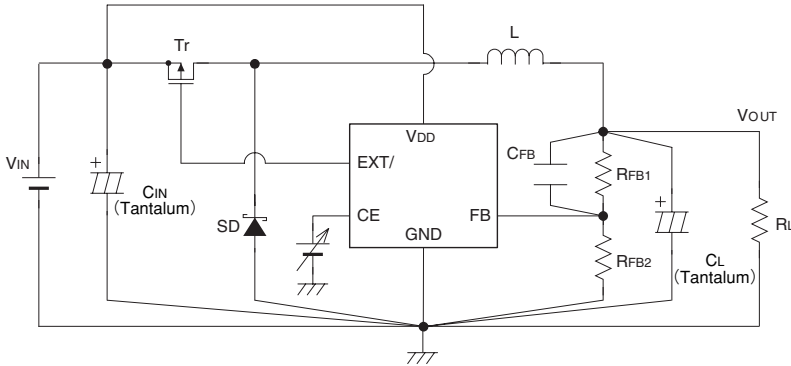


## Typical Application Circuits

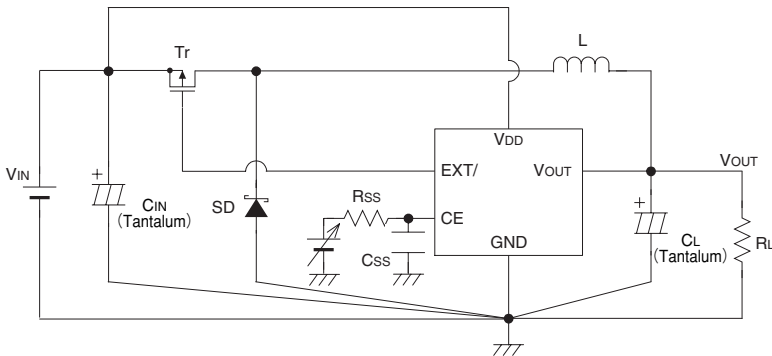
Circuit 1. XC6365A, XC6366A



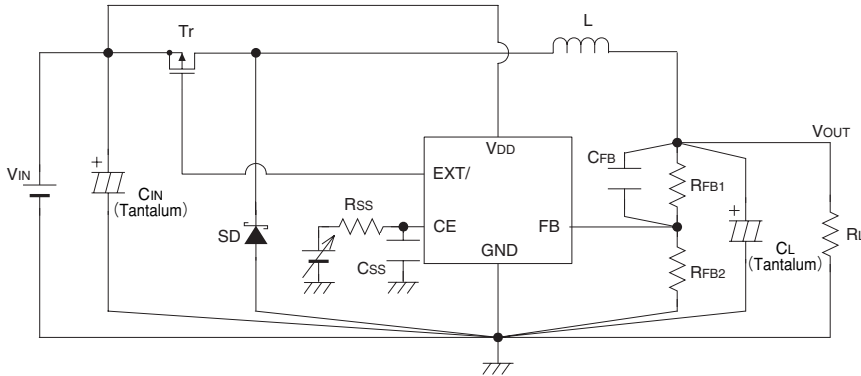
Circuit 2. XC6365B, XC6366B



Circuit 3. XC6365C, XC6366C

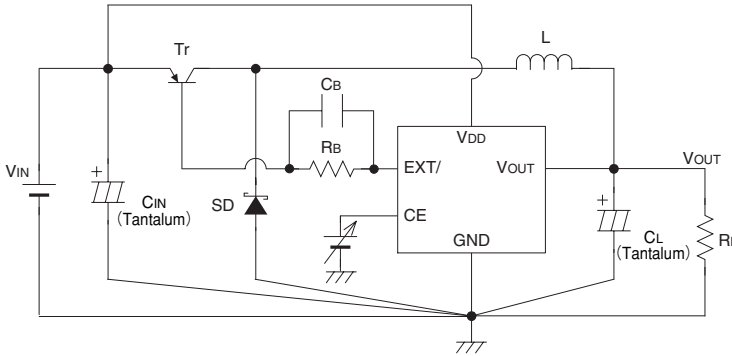


Circuit 4. XC6365D, XC6366D

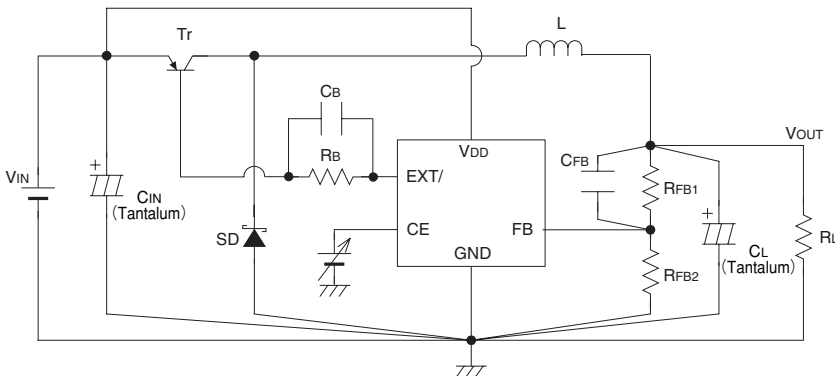


Circuit 5. XC6365A, XC6366A (when used with a PNP transistor)

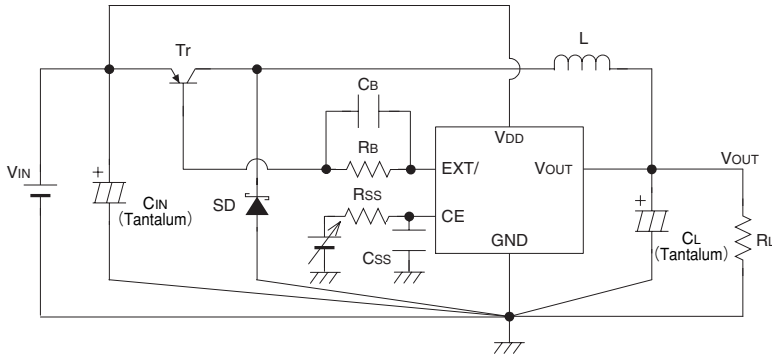
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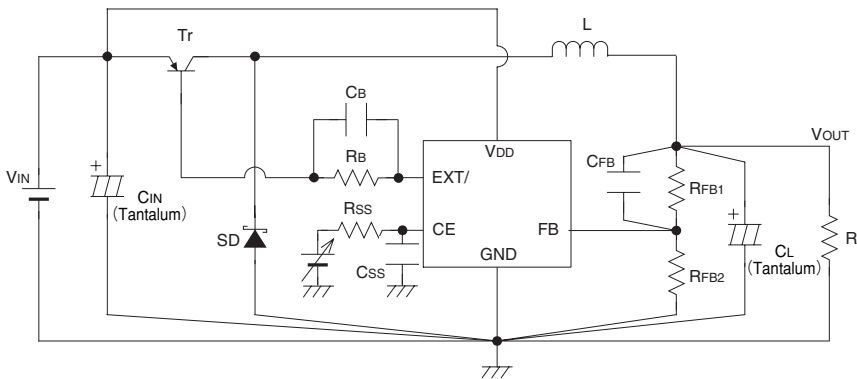
Circuit 6. XC6365B, XC6366B (when used with a PNP transistor)



Circuit 7. XC6365C, XC6366C (when used with a PNP transistor)



Circuit 8. XC6365D, XC6366D (when used with a PNP transistor)



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**Recommended Components**

- Tr : XP162A12A6PR (Torex P-channel Power MOSFET)  
Please use a PNP transistor where  $V_{IN} < 2.5V$
- L : 22 $\mu$ H (Sumida CR54,  $F_{osc}=300kHz$ )  
47 $\mu$ H (Sumida CR75,  $F_{osc}=180kHz$ )  
10 $\mu$ H (Sumida CR54,  $F_{osc}=500kHz$ )
- SD : MA2Q735 (Schottky Diode, Matsushita)
- CL : 10V 47 $\mu$ F (Tantalum capacitor, Nichicon MCE)
- CIN : 16V 10 $\mu$ F (Tantalum capacitor, Nichicon MCE)

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

- CSS : 0.033 $\mu$ F (Ceramic capacitor)
- RSS : 470k $\Omega$ (C type), 330k $\Omega$ (D type)

**B, D type (FB versions)**

- RFB : Set up so that  $R_{FB1} \div R_{FB2} = V_{OUT} - 1$  ( $V_{OUT}$  = set output voltage),  
 $R_{FB1} = R_{FB2} \leq 2M\Omega$
- CFB : Set up so that  $f_{zfb} = 1 \div (2\pi \times C_{FB} \times R_{FB1})$  is within the 0.5 to 20kHz range (10kHz conventional)  
Adjustments necessary in respect of L, CL.
- e. g :  $V_{OUT} = 3.0V$   
 $R_{FB1} = 400k\Omega$ ,  $R_{FB2} = 200k\Omega$ ,  $C_{FB} = 100pF$

**PNP Tr type :**

- Tr : 2SA1213 (Toshiba)
- RB : 500 $\Omega$   
(Adjust according to load and Tr.  $h_{FE}$  levels)
- CB : 2200pF (Ceramic type)  
Set up so that  $CB \leq 1 \div (2\pi \times RB \times F_{osc} \times 0.7)$

## 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

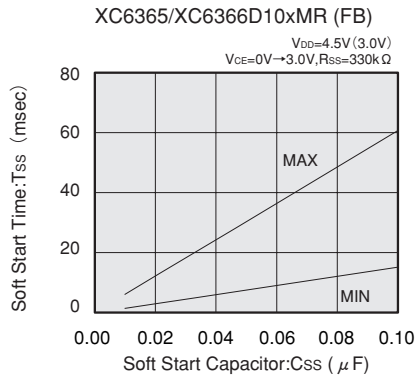
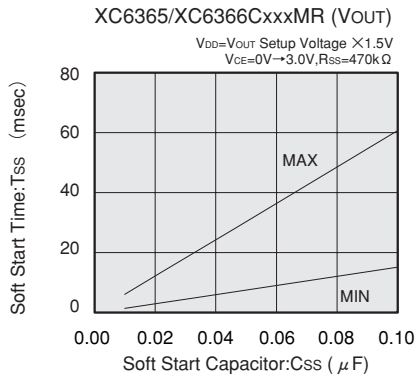
#### 1. Setting soft start time

To set a longer soft start time, please use XC6365C or XC6365D series which soft start function is externally set up.

For the measurement of soft start time  $T_{SS}$ , the time is needed to be between the max. and the min. value indicated in the chart below.

Please set a soft start capacitor  $C_{SS}$  according to the application.

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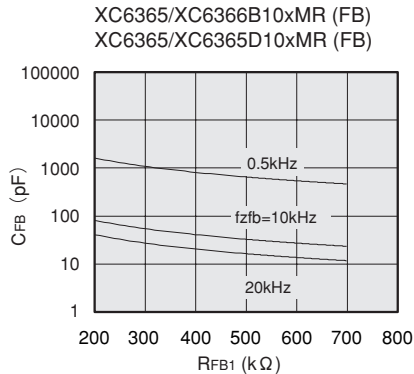


#### 2. Setting RFB1 and CFB

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

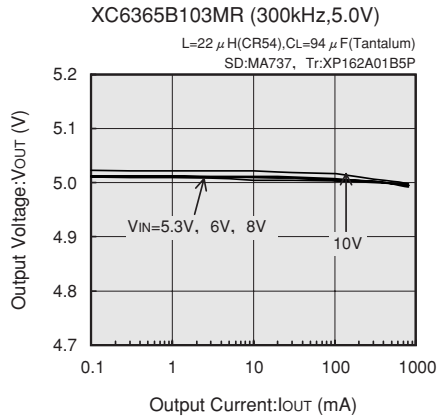
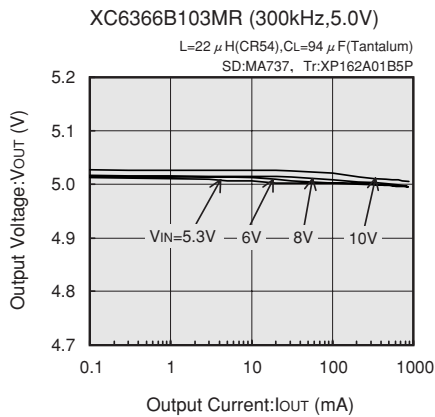
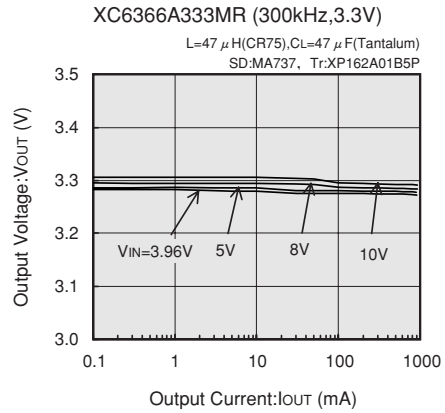
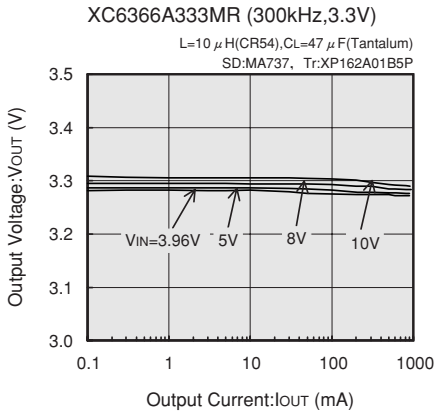
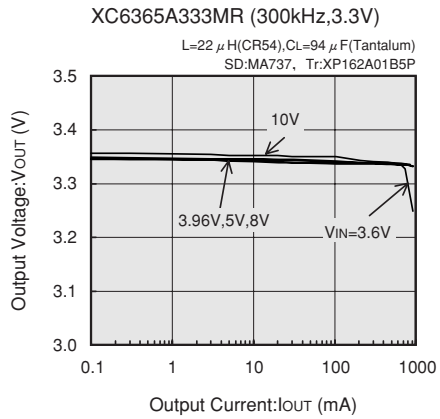
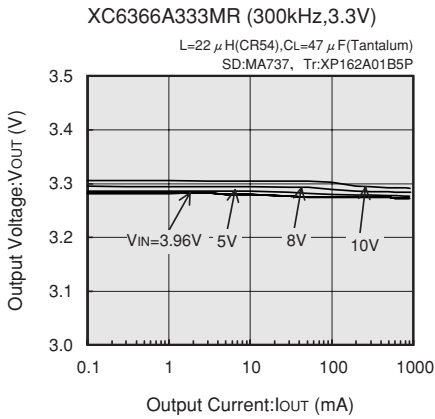
As the combination of  $R_{FB1}$  and  $C_{FB}$  enable to set  $f_{zfb}$  between 0.5kHz to 20kHz, within the realm of  $f_{zfb}=0.5kHz$  to  $f_{zfb}=20kHz$  as the chart below can be effective.

Under normal condition, please set the combination to configure around  $f_{zfb}=10kHz$ .



## Typical Performance Characteristics

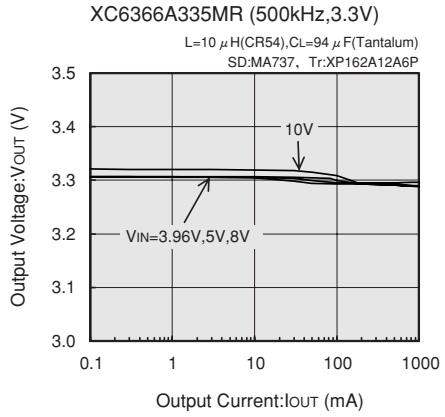
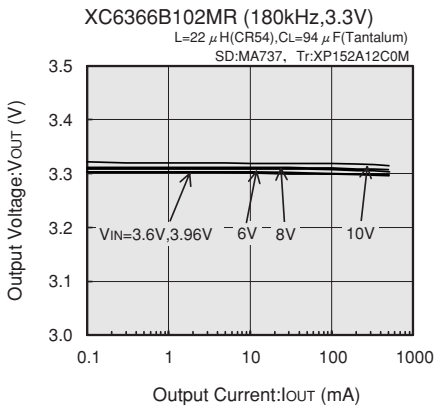
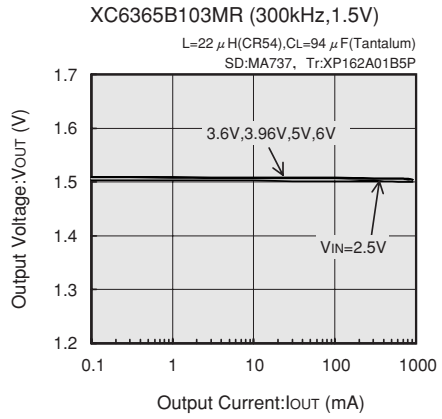
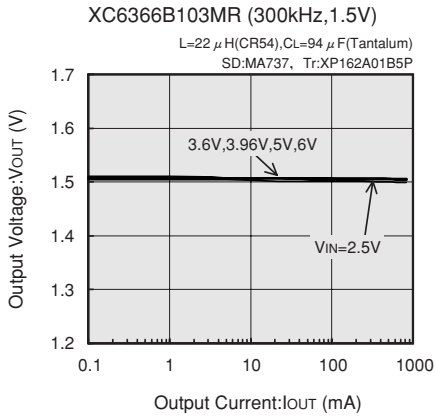
### (1) OUTPUT VOLTAGE vs. OUTPUT CURRENT



Note: <External component> CIN=47  $\mu$ F(Tantalum)

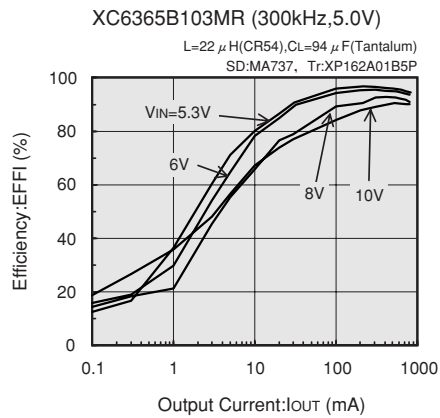
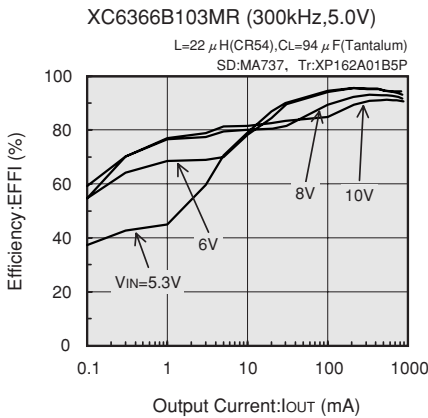
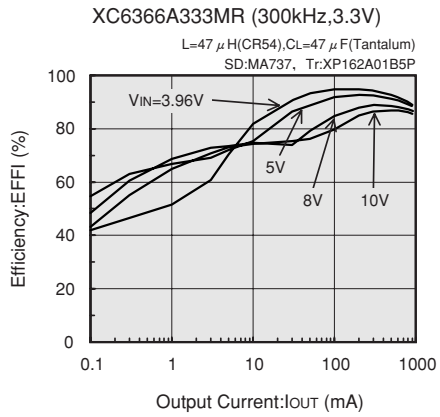
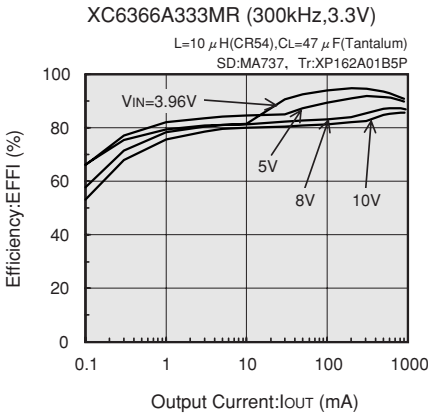
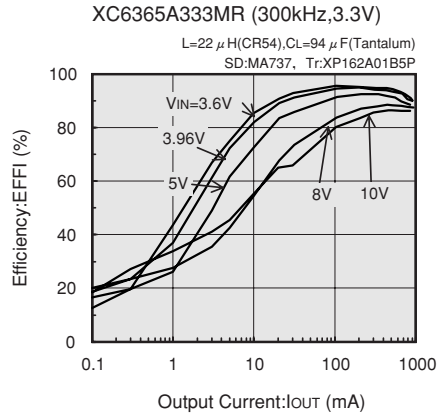
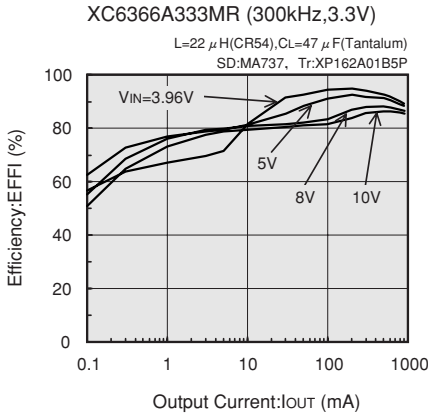
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## (1) OUTPUT VOLTAGE vs. OUTPUT CURRENT



Note: <External component> CIN=47  $\mu$ F(Tantalum)

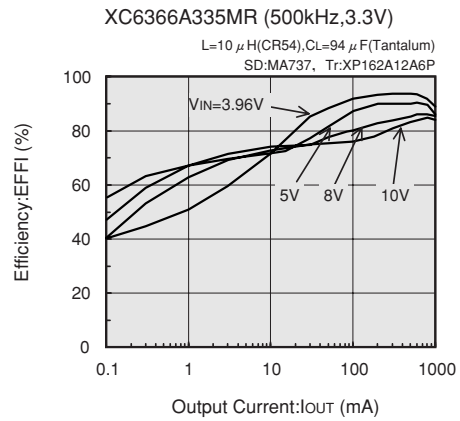
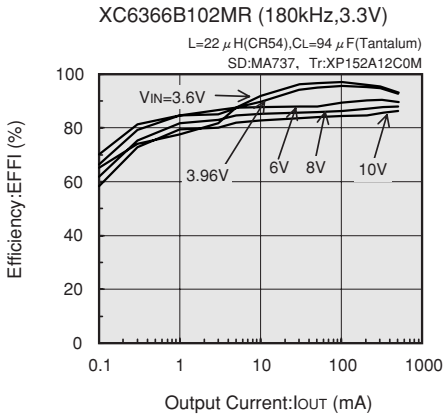
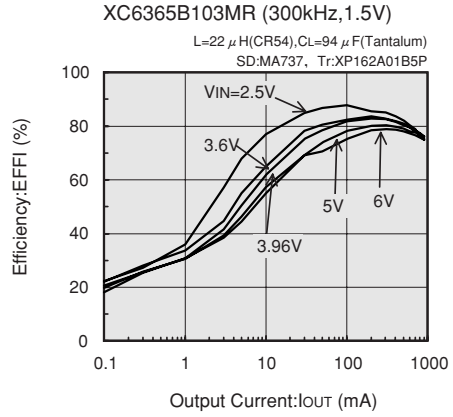
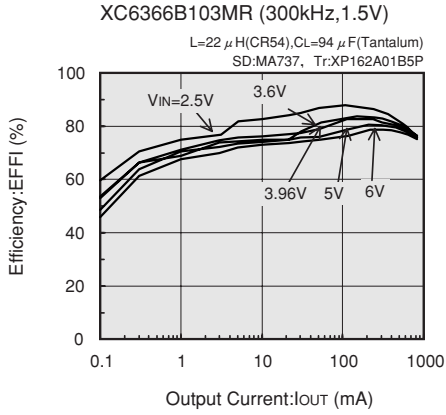
(2) EFFICIENCY vs. OUTPUT CURRENT



Note: <External component> CIN=47  $\mu$ F(Tantalum)

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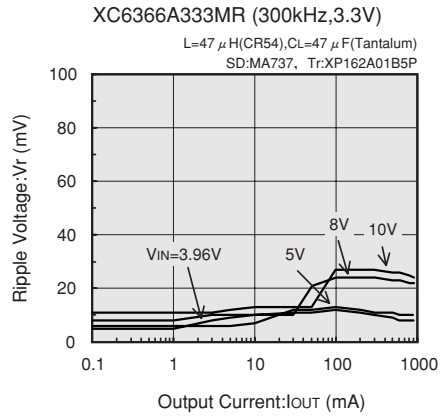
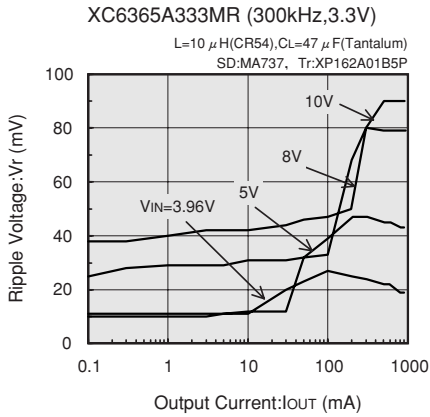
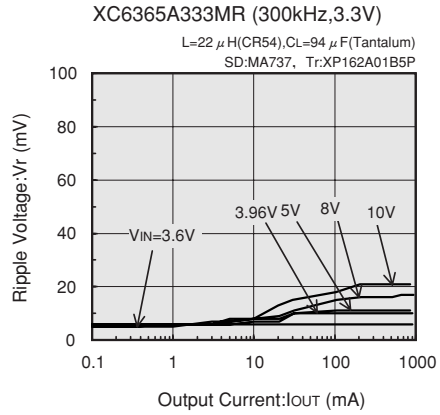
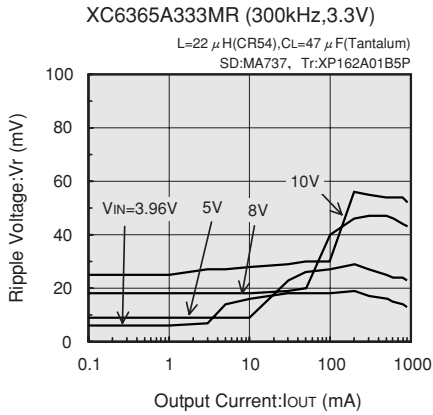
## (2) EFFICIENCY vs. OUTPUT CURRENT



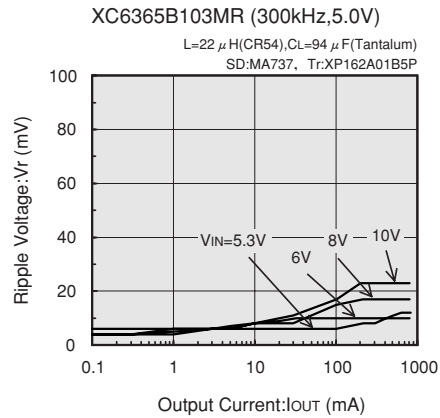
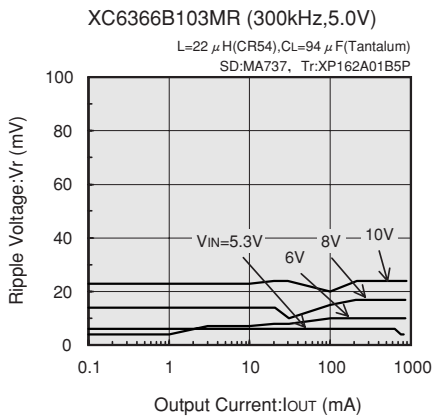
Note:<External component> CIN=47  $\mu$ F(Tantalum)



(3) RIPPLE VOLTAGE vs. OUTPUT CURRENT

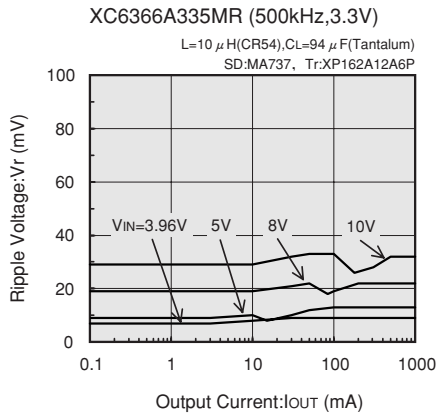
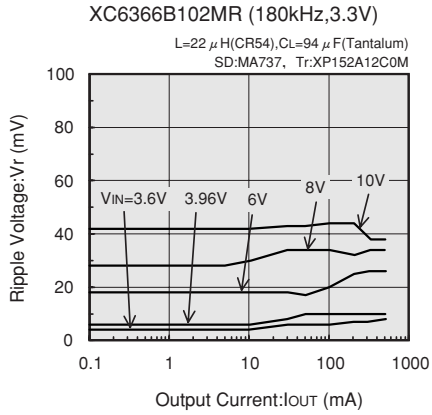
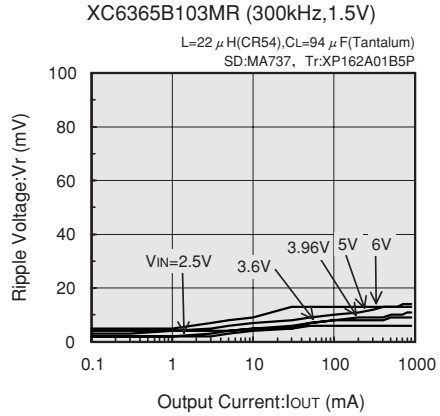
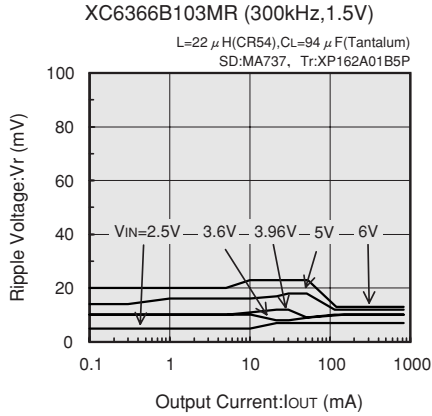


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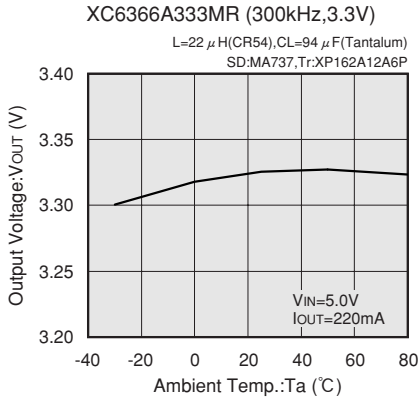
Note:<External component> CIN=47  $\mu$ F(Tantalum)

## (3) RIPPLE VOLTAGE vs. OUTPUT CURRENT

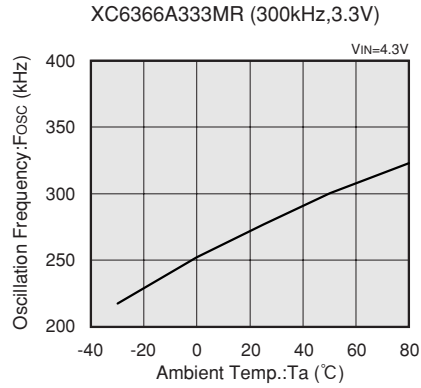


Note:<External component> CIN=47  $\mu$ F(Tantalum)

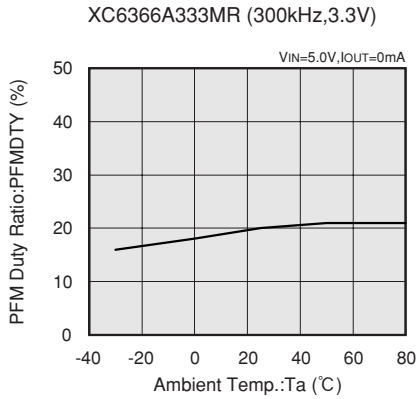
(4) OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



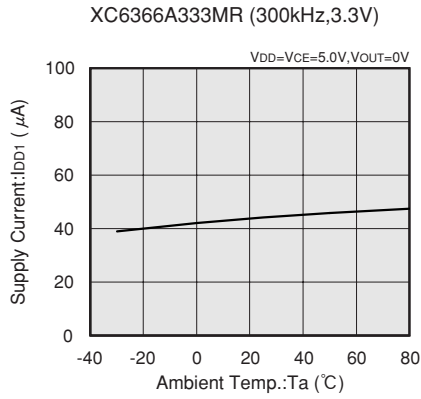
(5) OSCILLATION FREQUENCY vs. AMBIENT TEMPERATURE



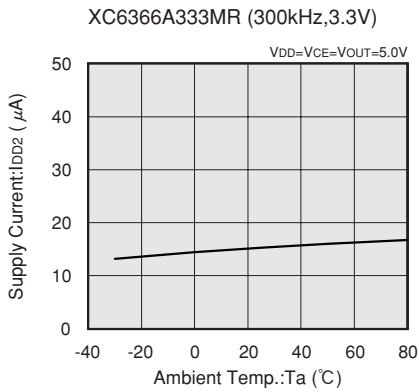
(6) PFM DUTY RATIO vs. AMBIENT TEMPERATURE



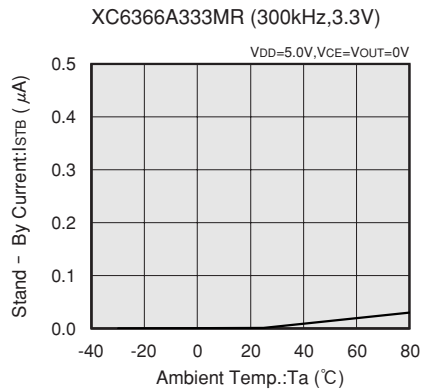
(7) SUPPLY CURRENT 1 vs. AMBIENT TEMPERATURE



(8) SUPPLY CURRENT 2 vs. AMBIENT TEMPERATURE

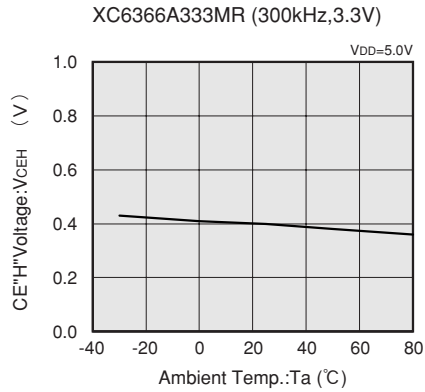
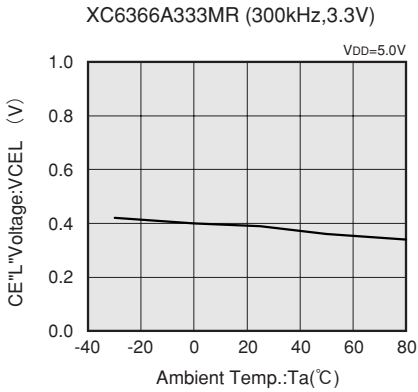


(9) STAND-BY CURRENT vs. AMBIENT TEMPERATURE



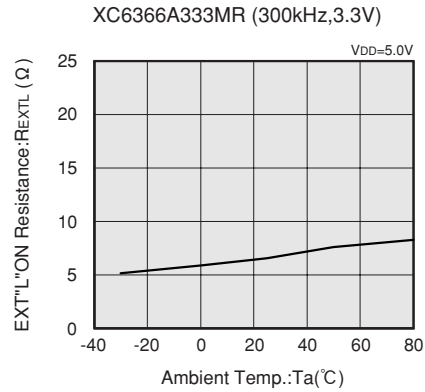
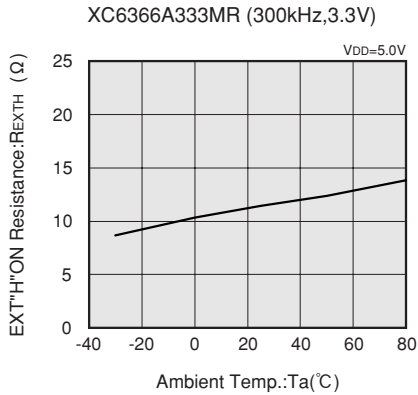
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(10) CE "L" VOLTAGE vs. AMBIENT TEMPERATURE (11) CE "H" VOLTAGE vs. AMBIENT TEMPERATURE

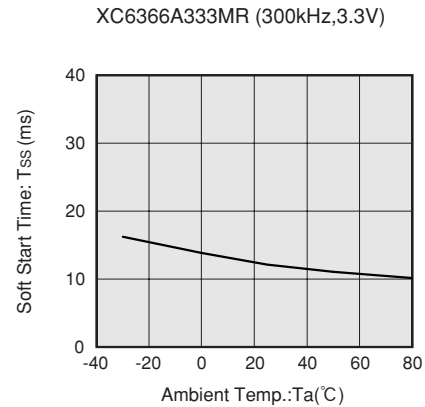
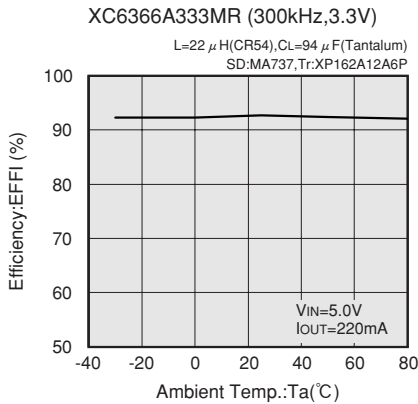


(12) EXT "H" ON RESISTANCE vs. AMBIENT TEMPERATURE (13) EXT "L" ON RESISTANCE vs. AMBIENT TEMPERATURE

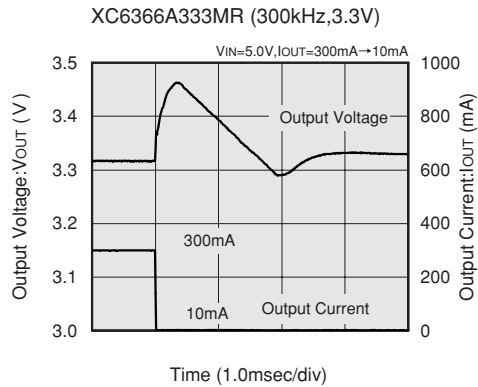
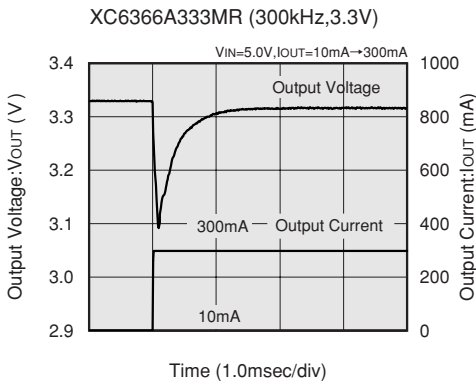
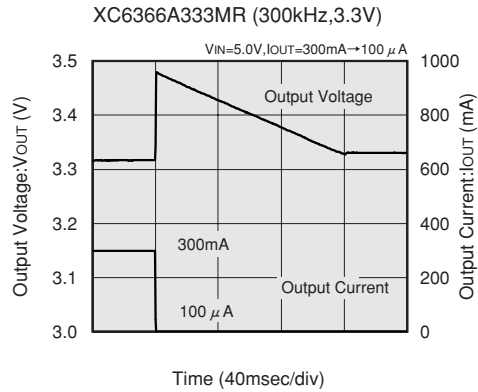
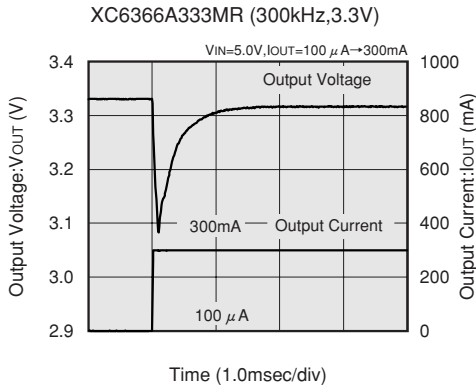
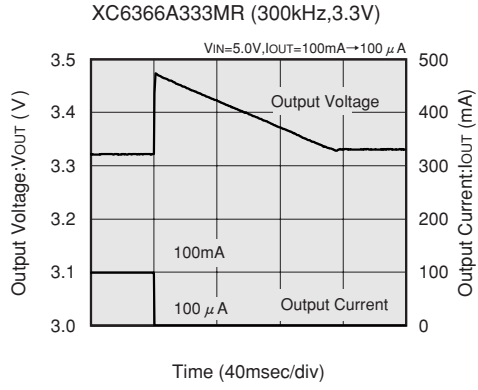
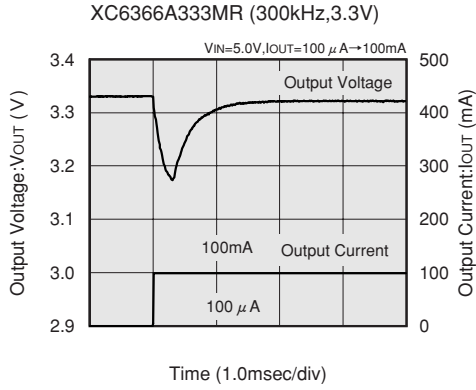
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(14) EFFICIENCY vs. AMBIENT TEMPERATURE (15) SOFT START TIME vs. AMBIENT TEMPERATURE



(16) LOAD TRANSIENT RESPONSE



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