XC6365/XC6366 Series

ETR0501_006

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

☆GreenOperation Compatible

■GENERAL DESCRIPTION

The XC6365/XC6366 series are multi-functional step-down DC/DC controllers which have 1A output current capability by using an externally connected transistor, coil, diode and capacitor.

Output voltage is programmable in 0.1V increments between 1.5V to 6.0V (VOUT) (±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.

Soft start time of XC6365/ XC6366A, B series is internally set to 10ms and XC6365/66C, D 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.

With UVLO internal, the external transistor will be forcibly switched off if used below the stipulated voltage.

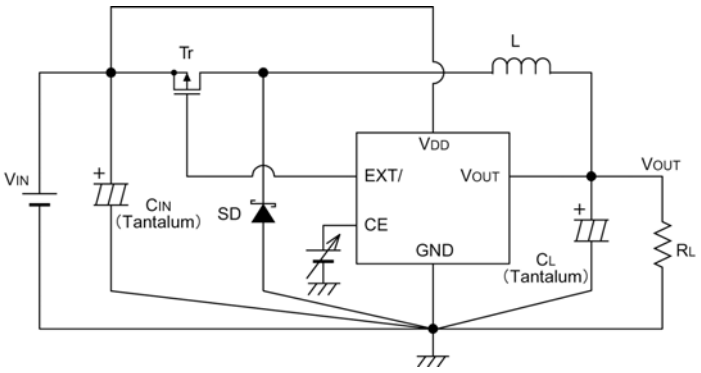
■APPLICATIONS

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

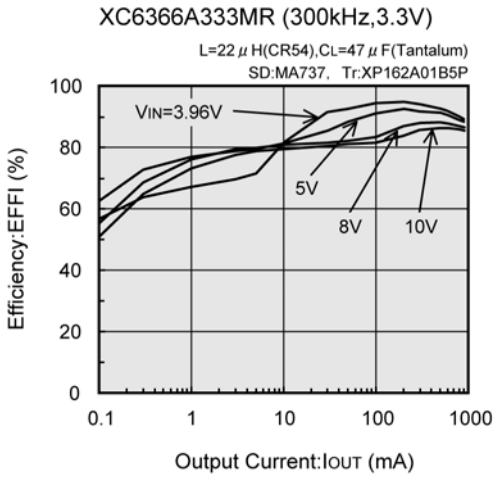
■FEATURES

Input Voltage Range : 2.2V ~ 10V (VOUT type)
Output Voltage Range : 1.5V ~ 6.0V (0.1V increments) (±2.5%)
Oscillation Frequency : 300kHz (±15%)
Custom products for 180, 500kHz
Output Current : More than 1.0A (VIN=5.0V, VOUT=3.0V)
High Efficiency : 92% (TYP.)
Stand-by Capability : I_{STB}=0.5μA (MAX.)
Selection : Soft-start set-up external
Output voltage set-up internal (VOUT)
Output voltage set-up external (FB)
PWM/PFM Control (XC6366)
Maximum Duty Cycle : 100%
Packages : SOT-25, USP-6C
Environmentally Friendly : EU RoHS Compliant, Pb Free

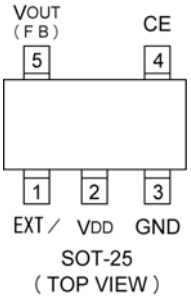
■TYPICAL APPLICATION CIRCUIT

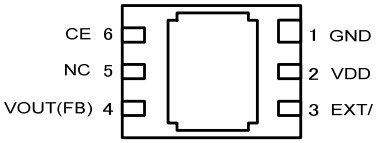


■TYPICAL PERFORMANCE CHARACTERISTICS



■PIN CONFIGURATION





USP-6C
(BOTTOM VIEW)

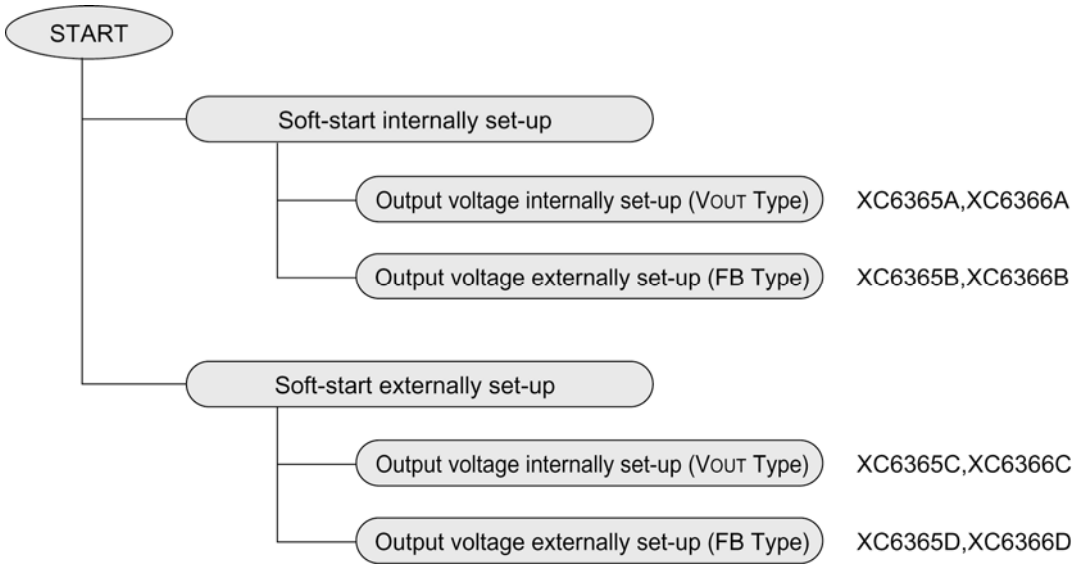
*The dissipation pad of the USP-6C package should be left open. If the circuit needs to be connected to other pin, it should be connected to the VDD (No.2) pin.

■PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTION
SOT-25	USP-6		
1	3	EXT/	External Transistor Connection
2	2	VDD	Power Supply
3	1	GND	Ground
4	6	CE	Chip Enable Soft-Start Capacitor Connection with Soft-Start Externally Set-Up Types (C, D)
5	4	VOUT (FB)	Output Voltage Monitor FB with Externally Set-Up Types (B, D)
-	5	NC	No Connection

■PRODUCT CLASSIFICATION

●Selection Guide



■PRODUCT CLASSIFICATION (Continued)

●Ordering Information

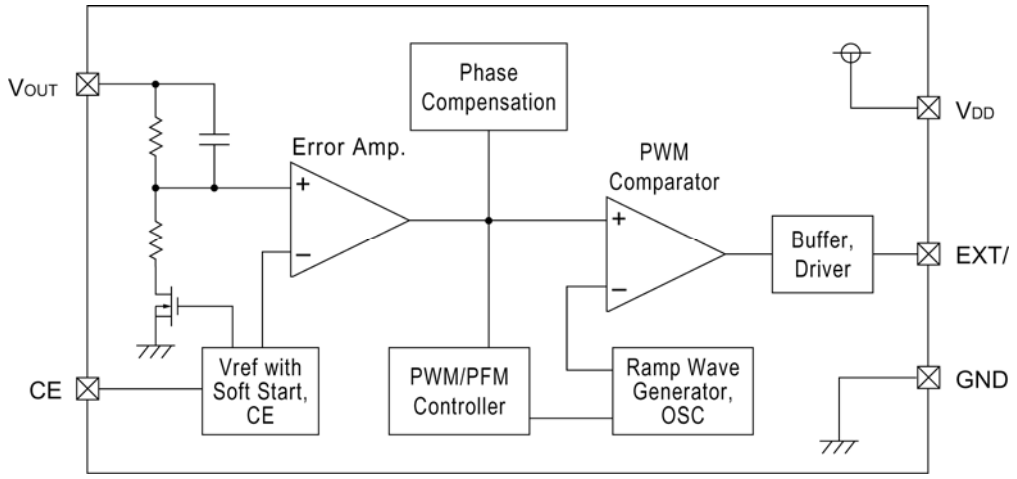
XC6365①②③④⑤⑥-⑦(*1) PWM control
XC6366①②③④⑤⑥-⑦(*1) PWM/PFM switching control

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Type of DC/DC Converter	A	VOUT type: Internally set-up, soft-start internally set-up
		B	FB type: Externally set-up, soft-start internally set-up
		C	VOUT type: Internally set-up, soft-start externally set-up
		D	FB type: Externally set-up, soft-start internally set-up
②③	Output Voltage	15～60	VOUT type: 3.0V output → ②=3, ③=0
		10	FB type: 10 fixed → ②=1, ③=0 fixed
④	Oscillation Frequency	3	300kHz
		5	500kHz (custom)
		2	180kHz (custom)
⑤⑥-⑦	Packages (Order Unit)	MR	SOT-25 (3,000/Reel)
		MR-G	SOT-25 (3,000/Reel)
		ER	USP-6C (3,000/Reel)
		ER-G	USP-6C (3,000/Reel)

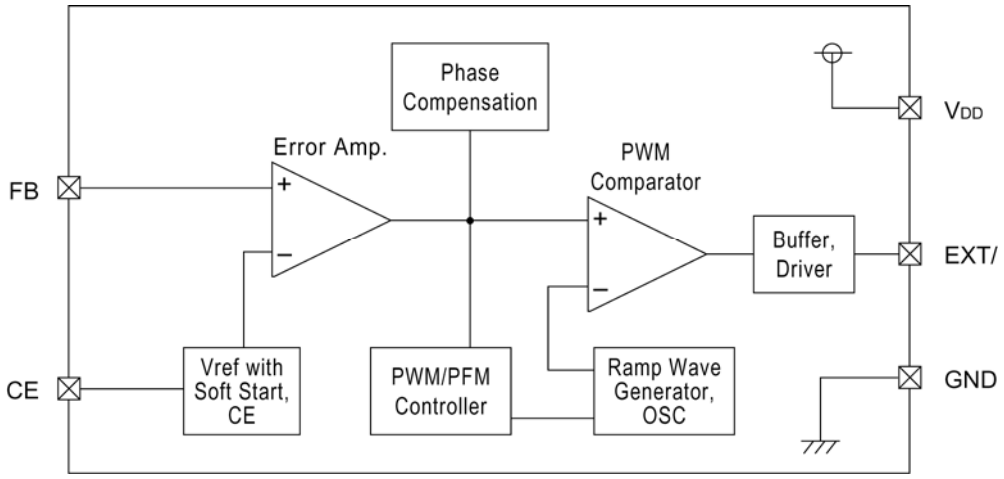
(*1) The “-G” suffix indicates that the products are Halogen and Antimony free as well as being fully EU RoHS compliant.

■BLOCK DIAGRAMS

XC6365, XC6366 Series A, C type (VOUT)



XC6365, XC6366 Series B, D type (FB)



■ABSOLUTE MAXIMUM RATINGS

Ta = 25℃

PARAMETER		SYMBOL	RATINGS	UNITS
V_{IN} Pin Voltage		V_{DD}	-0.3 ~ +12	V
V_{OUT} Pin Voltage		V_{OUT}	-0.3 ~ V_{IN} +0.3	V
FB Pin Voltage		V_{FB}	-0.3 ~ V_{IN} +0.3	V
CE Pin Voltage		V_{CE}	-0.3 ~ V_{IN} +0.3	V
EXT/ Pin Voltage		$V_{EXT/}$	-0.3 ~ V_{IN} +0.3	V
EXT/ Pin Current		$I_{EXT/}$	±100	mA
Power Dissipation	SOT-25	Pd	150	mW
	USP-6C		100	
Operating Temperature Range		Topr	-30 ~ +80	℃
Storage Temperature Range		Tstg	-40 ~ +125	℃

Note: Voltage is all ground standardized.

■ELECTRICAL CHARACTERISTICS

XC6365A333MR, XC6366A333MR (V_{OUT}=3.3V, f_{OSC}=300kHz) Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	V_{OUT}			3.218	3.300	3.383	V
Maximum Input Voltage	V_{IN}			10.0	-	-	V
UVLO Voltage (Minimum Operating Voltage)	V_{UVLO}	Same as I_{DD1}, Voltage which EXT/pin voltage holding “H” level		0.9	-	2.2	V
Supply Current 1	I_{DD1}	No external components, CE=V_{DD}, V_{OUT}=0V		-	57	102	μA
Supply Current 2	I_{DD2}	No external components, CE=V_{OUT}=V_{DD}	XC6365	-	57	102	μA
			XC6366	-	15	27	μA
Stand-by Current	ISTB	No external components, CE=V_{OUT}=0V		-	-	0.5	μA
Oscillation Frequency	f_{OSC}	Measuring of EXT/ waveform, V_{IN}=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_{CEH}	No external components, V_{OUT}=0V, Voltage which EXT/pin voltage holding “L” level		0.65	-	-	V
CE "Low" Voltage	V_{CEL}	No external components, V_{OUT}=0V, Voltage which EXT/pin voltage holding “H” level		-	-	0.20	V
EXT "High" ON Resistance	R_{EXTBH}	Same as I_{DD2}, $V_{EXT/}$=V_{DD}-0.4V		-	16	22	μA
EXT "Low" ON Resistance	R_{EXTBL}	Same as I_{DD1}, $V_{EXT/}$=0.4V		-	14	19	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended		-	92	-	%
Soft-Start Time	tss	Connect R_{SS}, C_{SS}, CE, 0V→ 3.0V (When V_{IN}≦3.0V, V_{IN}=3.0V)		5	10	20	ms

Conditions: 1. Unless otherwise stated, connect external components. V_{IN}=V_{DD} = 5.0V, I_{OUT} = 220mA
2. XC6365/66C series external components: C_{SS}=0.033μF, R_{SS}=470kΩ

■ELECTRICAL CHARACTERISTICS (Continued)

XC6365A503MR, XC6366A503MR (V_{OUT}=5.0V, f_{OSC}=300kHz) Ta=25℃

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 (Minimum Operating Voltage)	V_{UVLO}	Same as I_{DD1}, Voltage which EXT/pin voltage holding “H” level		0.9	-	2.2	V
Supply Current 1	I_{DD1}	No external components, CE=V_{DD}, V_{OUT}=0V		-	67	122	μA
Supply Current 2	I_{DD2}	No external components, CE=V_{OUT}=V_{DD}	XC6365	-	67	122	μA
			XC6366	-	16	29	μA
Stand-by Current	ISTB	No external components, CE=V_{OUT}=0V		-	-	0.5	μA
Oscillation Frequency	f_{OSC}	Measuring of EXT/ waveform, V_{IN}=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_{CEH}	No external components, V_{OUT}=0V, Voltage which EXT/pin voltage holding “L” level		0.65	-	-	V
CE "Low" Voltage	V_{CEL}	No external components, V_{OUT}=0V, Voltage which EXT/pin voltage holding “H” level		-	-	0.20	V
EXT "High" ON Resistance	R_{EXTBH}	Same as I_{DD2}, $V_{EXT/}$=V_{IN}-0.4V		-	12	17	μA
EXT "Low" ON Resistance	R_{EXTBL}	Same as I_{DD1}, $V_{EXT/}$=0.4V		-	10	14	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended		-	93	-	%
Soft-Start Time	t_{SS}	Connect R_{SS}, C_{SS}, CE, 0V→ 3.0V (When V_{IN}≦3.0V, V_{IN}=3.0V)		5	10	20	ms

Conditions: 1. Unless otherwise stated, connect external components. V_{IN}=V_{DD} = 7.5V, I_{OUT} = 330mA
2. XC6365/66C series external components: C_{SS}=0.033μF, R_{SS}=470kΩ

■ELECTRICAL CHARACTERISTICS (Continued)

XC6365B103MR, XC6366B103MR (V_{OUT}=3.0V, f_{OSC}=300kHz) Ta=25℃

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 (Minimum Operating Voltage)	V_{UVLO}	Same as I_{DD1}, Voltage which EXT/pin voltage holding “H” level	0.9	-	2.2	V
Supply Current 1	I_{DD1}	No external components, CE=V_{IN}, V_{OUT}=0V	-	55	100	μA
Supply Current 2	I_{DD2}	No external components, CE=V_{DD}, FB=1.2V XC6365	-	55	100	μA
		XC6366	-	15	27	μA
Stand-by Current	ISTB	No external components, CE=FB=0V	-	-	0.5	μA
Oscillation Frequency	f_{OSC}	Measuring of EXT/ waveform, V_{IN}=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_{CEH}	No external components, FB=0V, Voltage which EXT/pin voltage holding “L” level	0.65	-	-	V
CE "Low" Voltage	V_{CEL}	No external components, V_{OUT}=0V, Voltage which EXT/pin voltage holding “H” level	-	-	0.20	V
EXT "High" ON Resistance	R_{EXTBH}	Same as I_{DD2}, $V_{EXT/}$=V_{IN}-0.4V	-	17	24	μA
EXT "Low" ON Resistance	R_{EXTBL}	Same as I_{DD1}, $V_{EXT/}$=0.4V	-	15	20	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended	-	92	-	%
Soft-Start Time	tss	Connect R_{SS}, C_{SS}, CE, 0V→ 3.0V (When V_{IN}≦3.0V, V_{IN}=3.0V)	5	10	20	ms

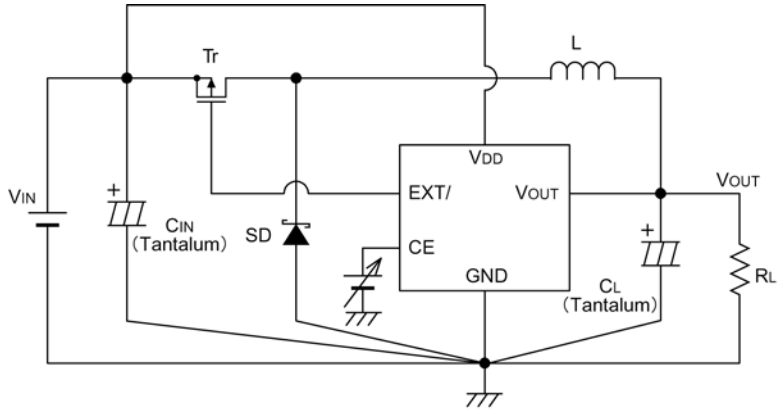
Conditions: 1. Unless otherwise stated, connect external components. V_{IN}=V_{DD} = 4.5V, I_{OUT} = 200mA

2. XC6365/66C series external components: C_{SS}=0.033μF, R_{SS}=470kΩ

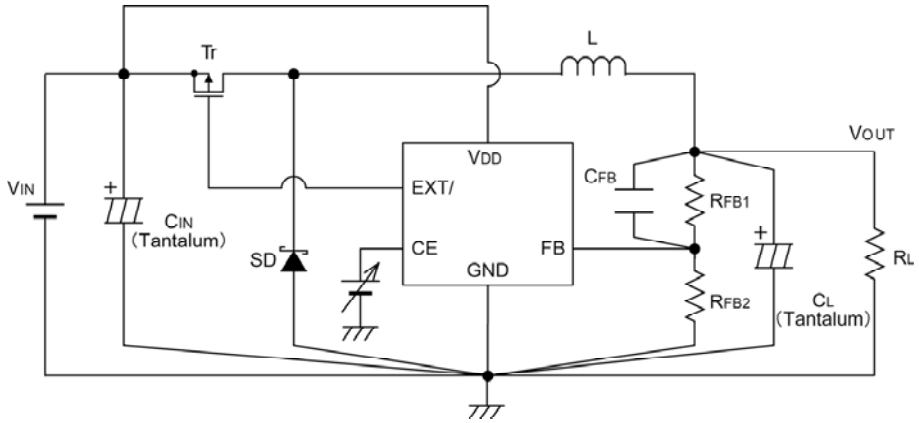
3. R_{FB1} = 400kΩ, R_{FB2} = 200kΩ, CFB = 100ppF

■TEST CIRCUITS

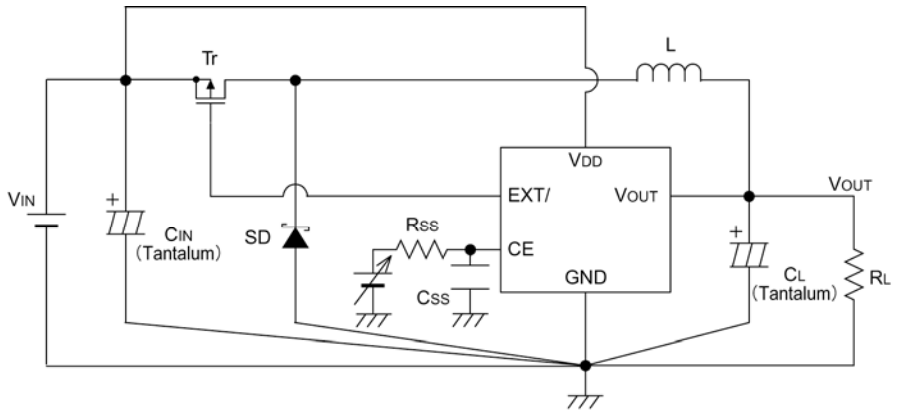
Circuit 1. XC6365A, XC6366A



Circuit 2. XC6365B, XC6366B

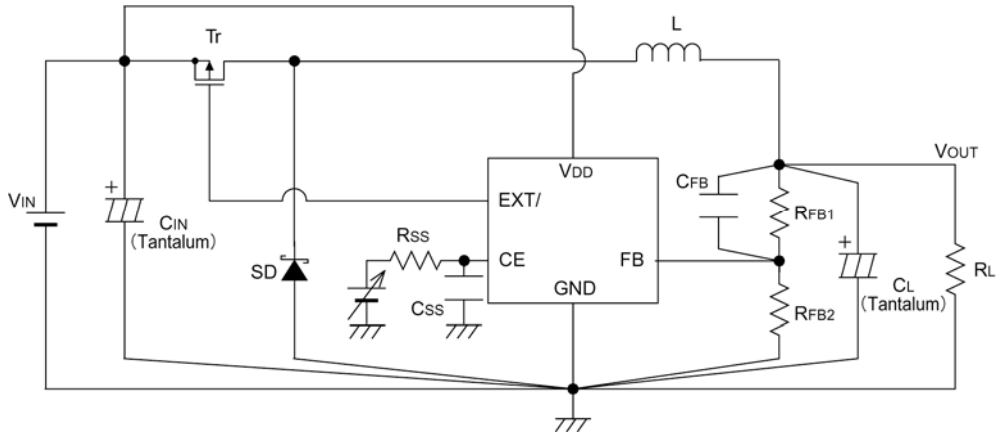


Circuit 3. XC6365C, XC6366C

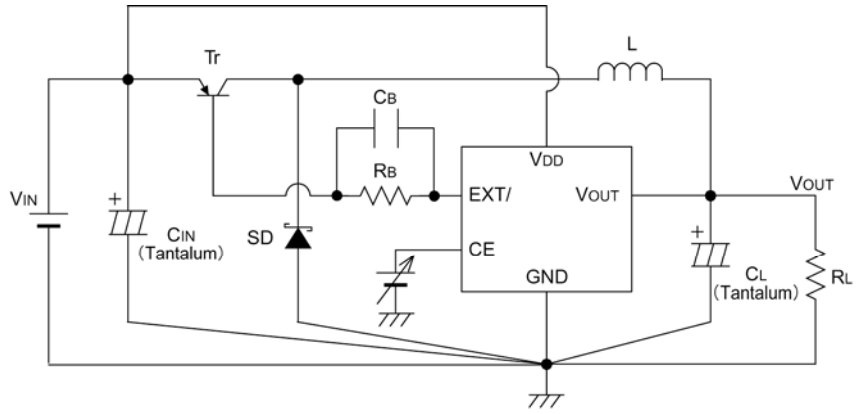


■TEST CIRCUITS (Continued)

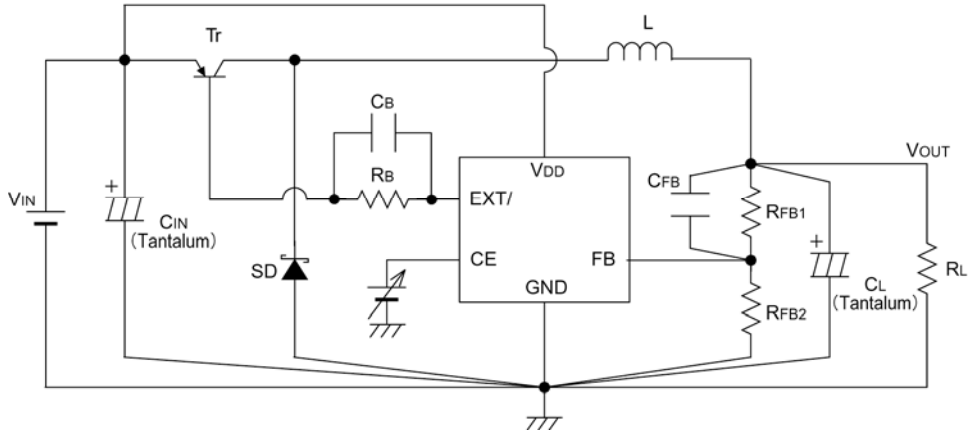
Circuit 4. XC6365D, XC6366D



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

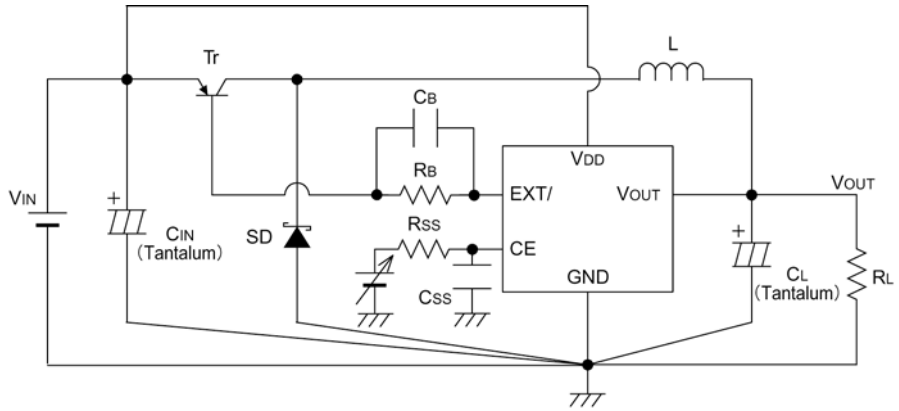


Circuit 6. XC6365B, XC6366B (when used with a PNP transistor)

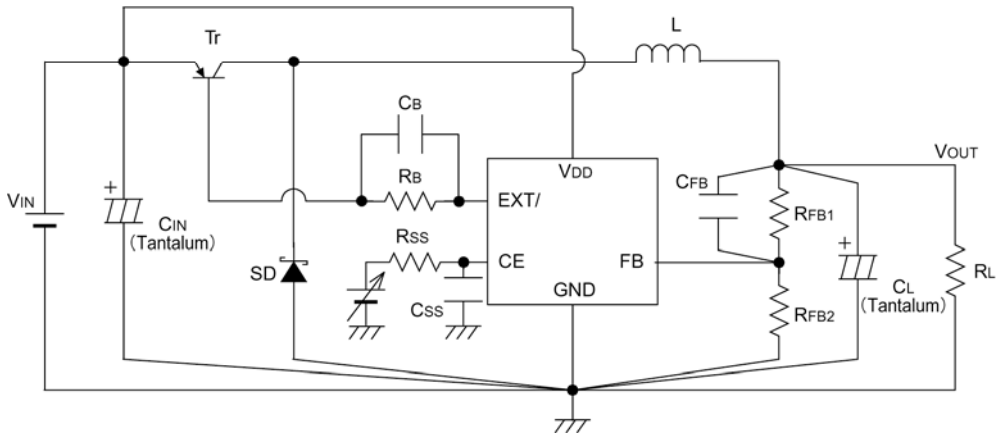


■TEST CIRCUITS (Continued)

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



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



Recommended Components

Tr : XP162A12A6PR (Torex P-channel Power MOSFET)
Please use a PNP transistor where V_{IN} < 2.5V

L : 22μH (CR54, SUMIDA, f_{OSC}=300kHz)
47μH (CR75, SUMIDA, f_{OSC}=180kHz)
10μH (CR54, SUMIDA, f_{OSC}=500kHz)

SD : MA2Q735 (Schottky Diode, MATSUSHITA)

C_L :10V, 47μF (Tantalum capacitor, NICHICHEMI MCE)

C_{IN} :16V 10μF (Tantalum capacitor, NICHICHEMI MCE)

PNP Tr. Type

Tr : 2SA1213 (TOSHIBA)

R_B : 500Ω (Adjust according to load and Tr. hFE levels)

C_B : 2200pF (Ceramic Type)
Set up so that $C_B \leqq 1 / (2\pi \times R_B \times f_{OSC} \times 0.7)$

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

C_{SS} : 0.033μF (Ceramic Capacitor)

R_{SS} : 470kΩ(C type), 330kΩ(D type)

B, D type (FB type)

R_{FB} : Set up so that $R_{FB1} / R_{FB2} = V_{OUT} - 1$
(V_{OUT} = setting output voltage),
$R_{FB1} = R_{FB2} \leqq 2M\Omega$

C_{FB} : Set up so that $fzfb = 1 \div (2\pi \times C_{FB} \times R_{FB1})$ is within the 0.5 to 20kHz range (10kHz conventional)
Adjustments necessary in respect of L, C_L.

e.g. : V_{OUT} = 3.0V
R_{FB1} = 400kΩ, R_{FB2} = 200kΩ, C_{FB} = 100pF

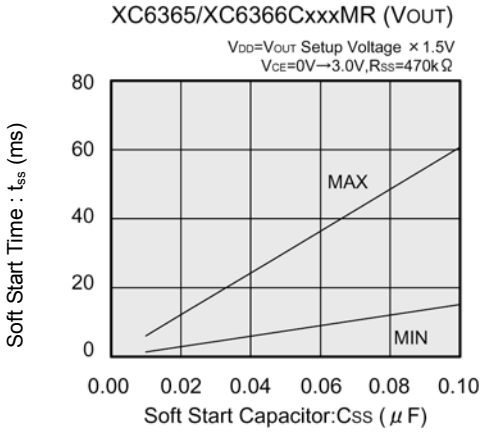
■NOTES ON USE

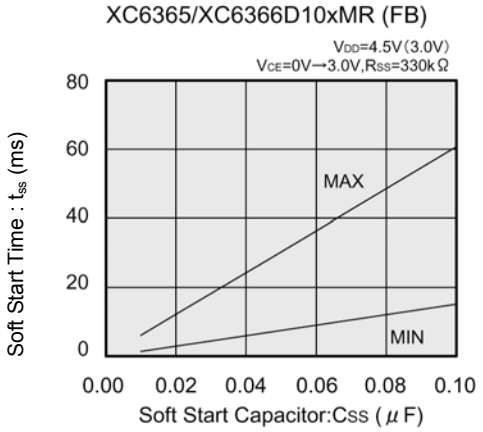
1. Take ample care to ensure that none of the IC's, nor the external component's, absolute maximum ratings are exceeded.
2. Be extremely careful when selecting parts and do not limit your reference to the specifications and characteristics for the DC/DC converter alone. The IC also depends, to a great 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

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 maximum and the minimum value indicated in the chart below. Please set a soft start capacitor C_{SS} according to the application.

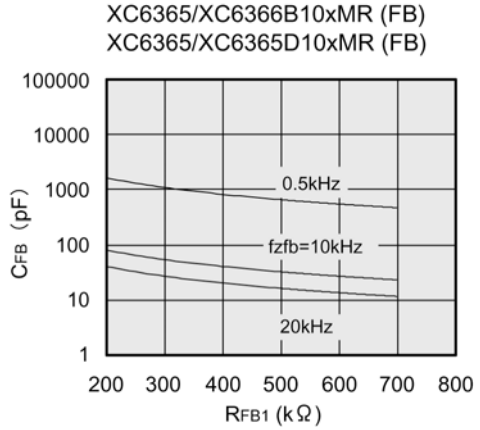




2. Setting R_{FB1} and C_{FB}

fzfb=1 ÷ (2 π × CFB × RFB1)

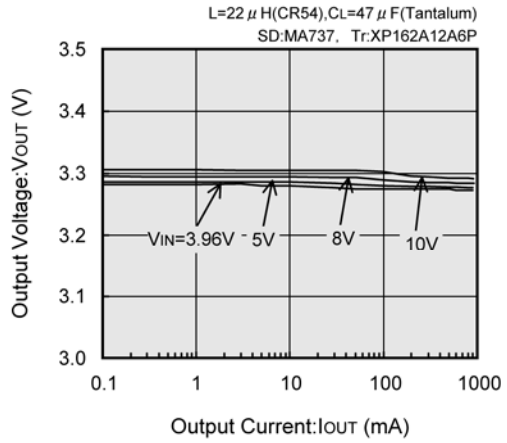
As the combination of R_{FB1} and C_{FB} enable to set fzfb between 0.5kHz to 20kHz, within the realm of fzfb=0.5kHz to fzfb=20kHz as the chart below can be effective.
Under normal condition, please set the combination to configure around fzfb=10kHz.



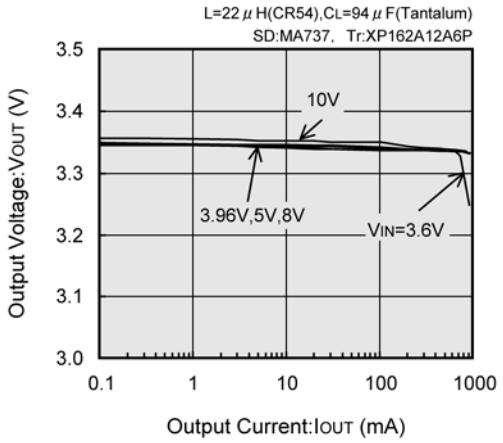
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

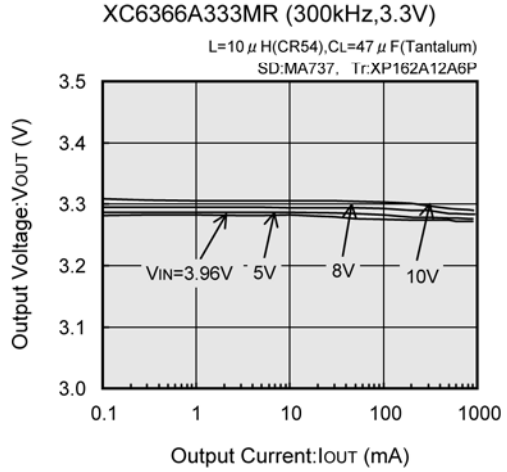
XC6366A333MR (300kHz,3.3V)



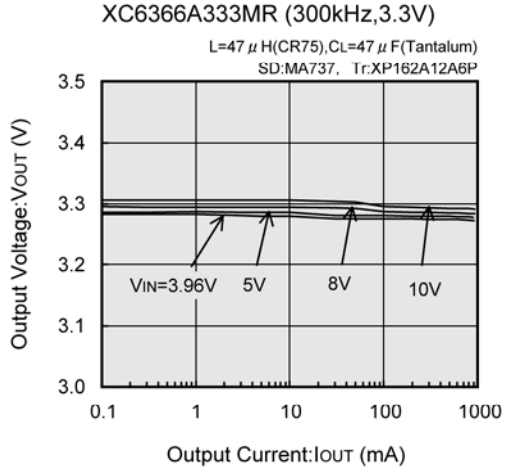
XC6365A333MR (300kHz,3.3V)



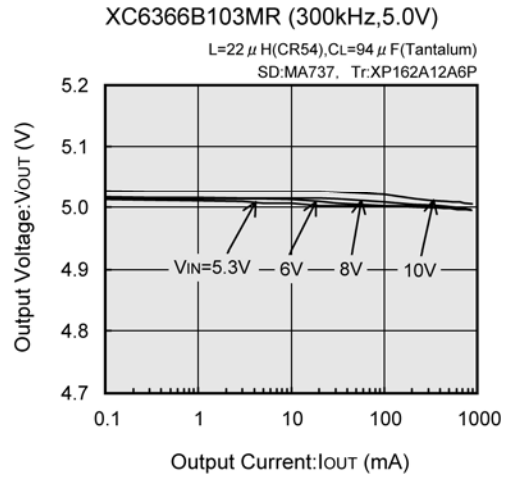
XC6366A333MR (300kHz,3.3V)



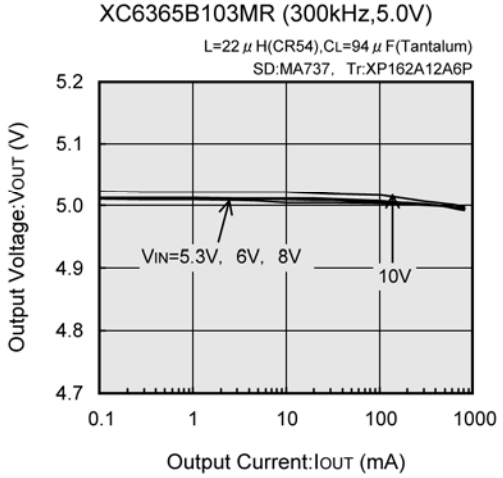
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



XC6365B103MR (300kHz,5.0V)

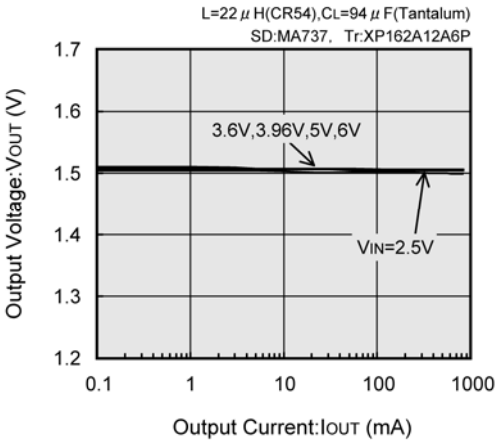


Note: CIN=47μF(Tantalum)

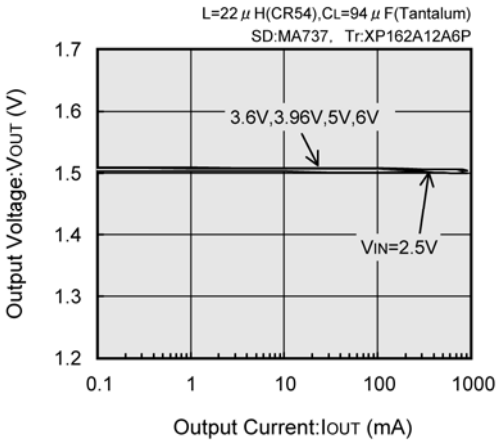
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

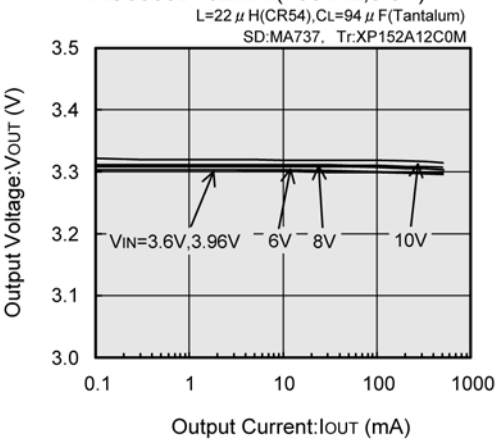
XC6366B103MR (300kHz,1.5V)



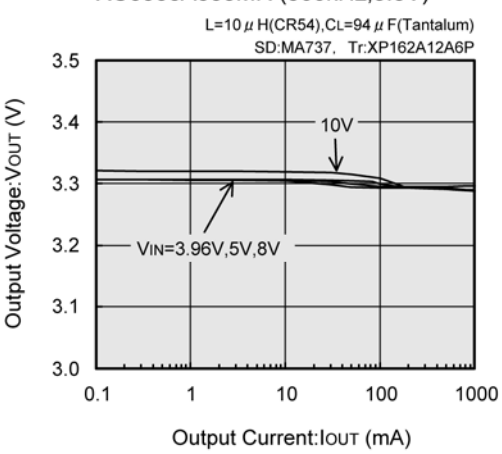
XC6365B103MR (300kHz,1.5V)



XC6366B102MR (180kHz,3.3V)



XC6366A335MR (500kHz,3.3V)

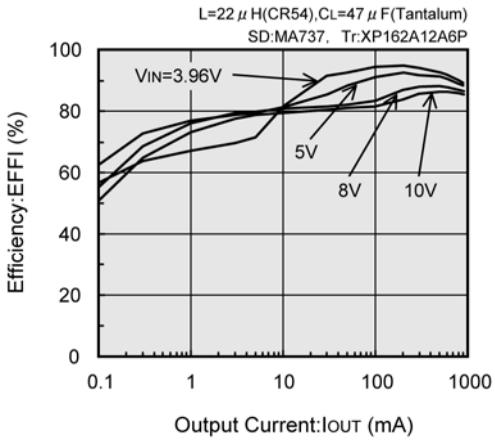


Note: CIN=47μF(Tantalum)

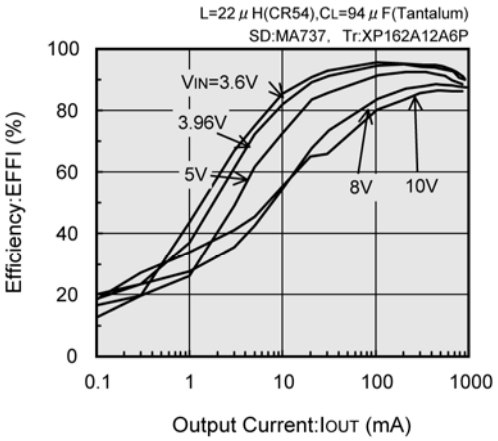
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Efficency vs. Output Current

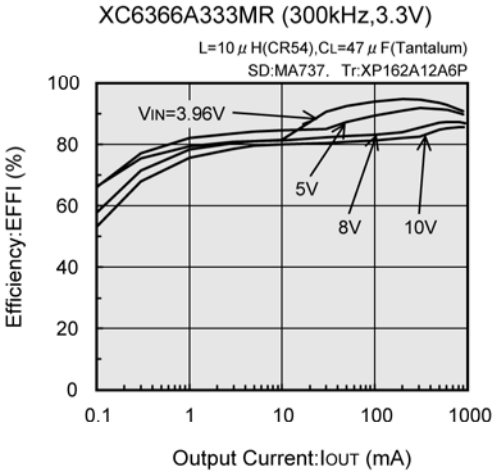
XC6366A333MR (300kHz,3.3V)



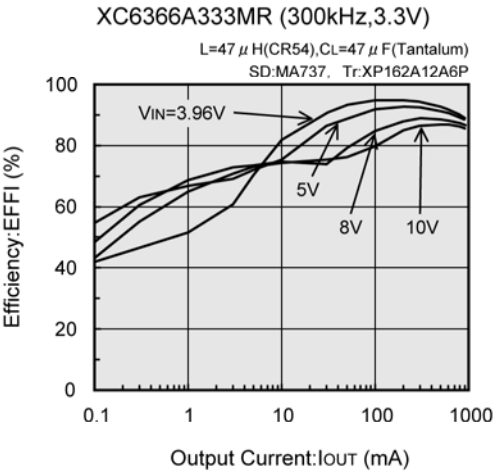
XC6365A333MR (300kHz,3.3V)



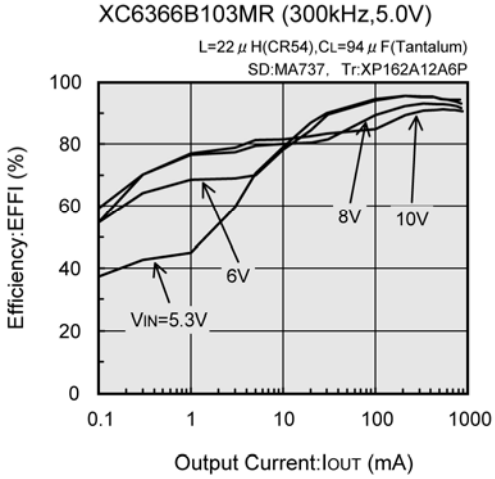
XC6366A333MR (300kHz,3.3V)



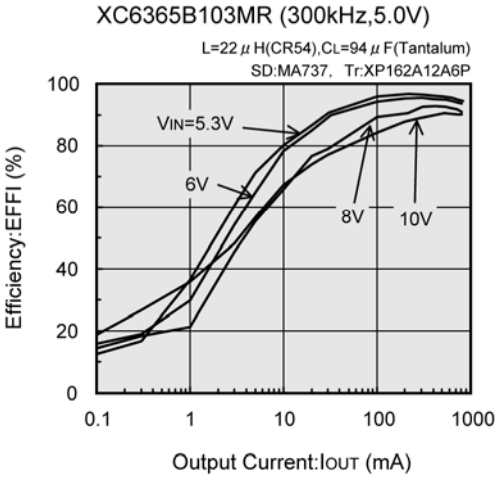
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



XC6365B103MR (300kHz,5.0V)

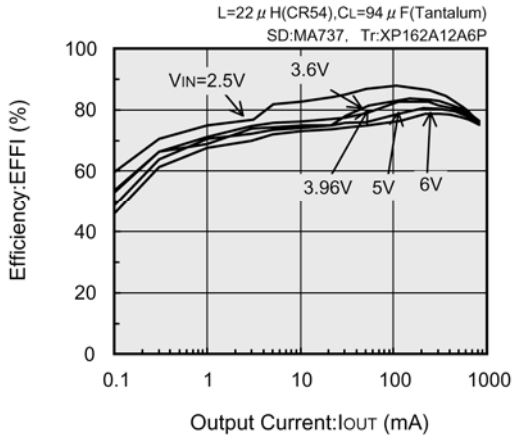


Note: CIN=47μF(Tantalum)

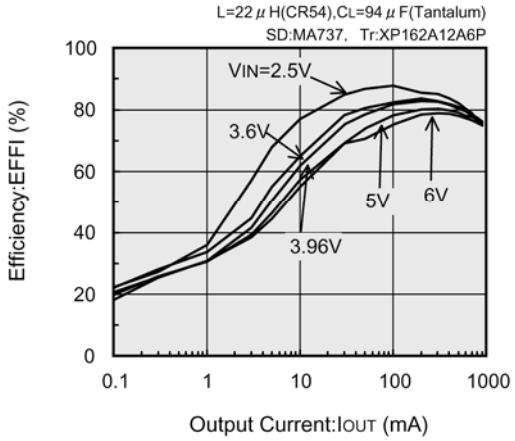
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Efficiency vs. Output Current (Continued)

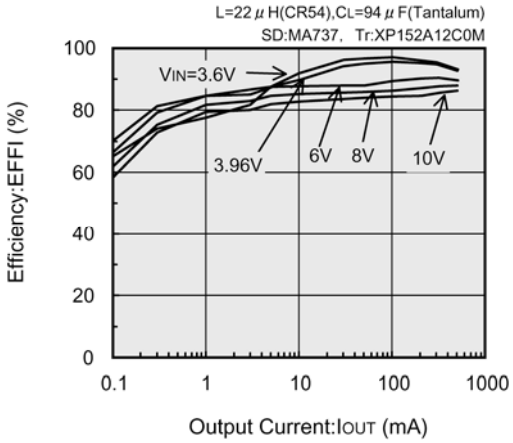
XC6366B103MR (300kHz,1.5V)



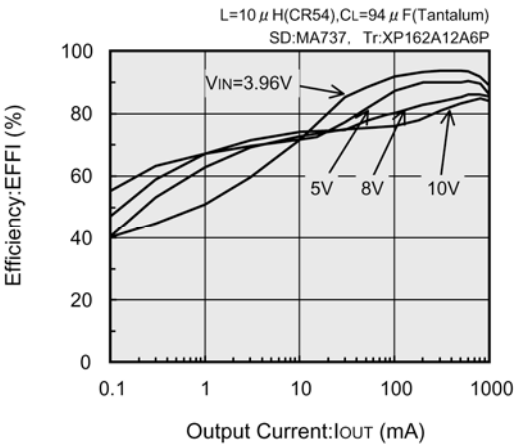
XC6365B103MR (300kHz,1.5V)



XC6366B102MR (180kHz,3.3V)



XC6366A335MR (500kHz,3.3V)

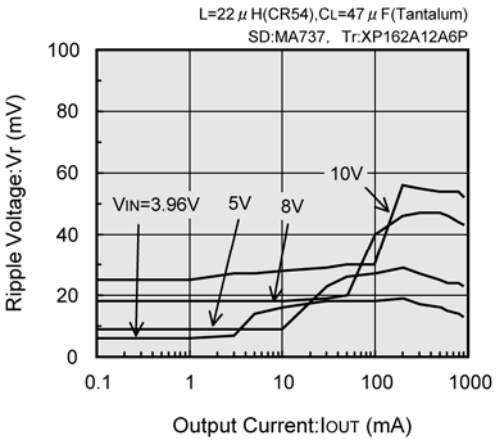


Note: CIN=47μF(Tantalum)

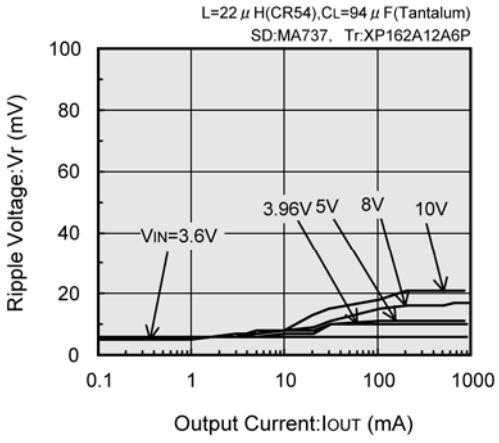
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Ripple Voltage vs. Output Current

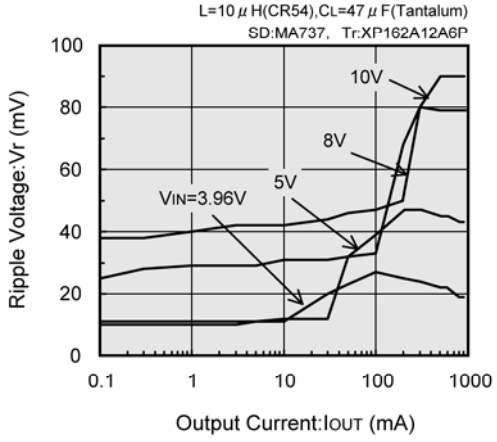
XC6365A333MR (300kHz,3.3V)



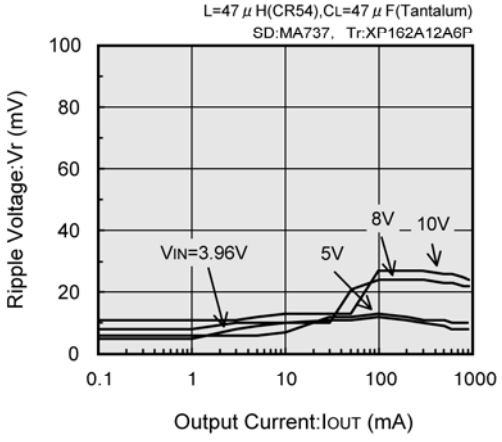
XC6365A333MR (300kHz,3.3V)



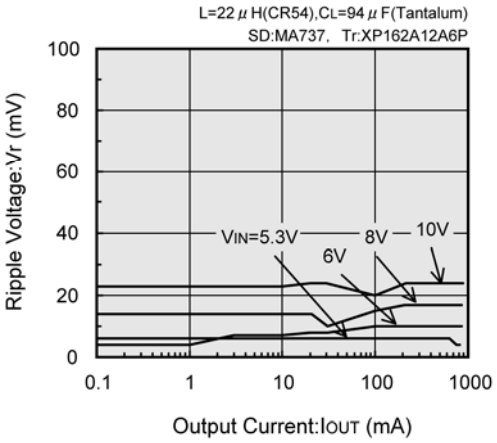
XC6365A333MR (300kHz,3.3V)



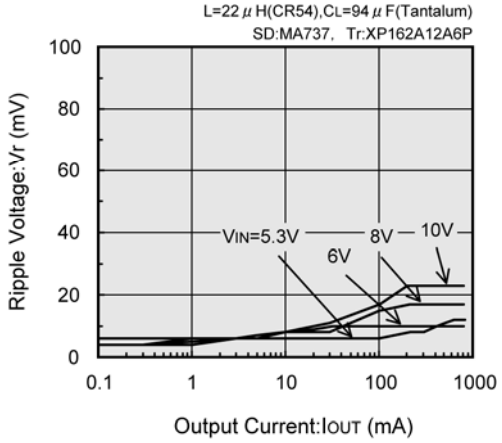
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



XC6365B103MR (300kHz,5.0V)

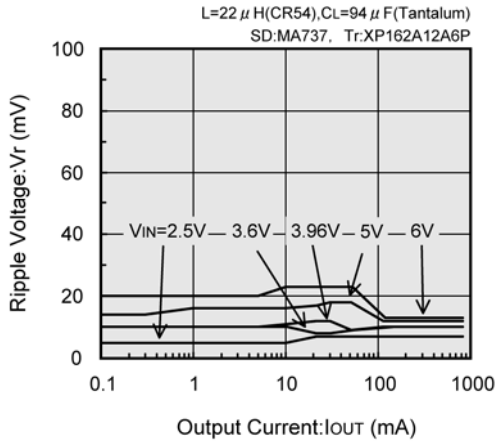


Note: CIN=47μF(Tantalum)

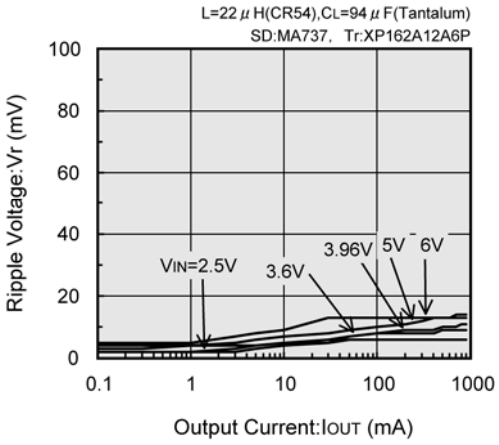
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

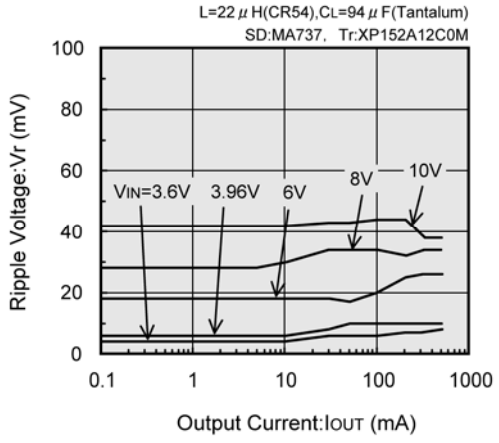
XC6366B103MR (300kHz,1.5V)



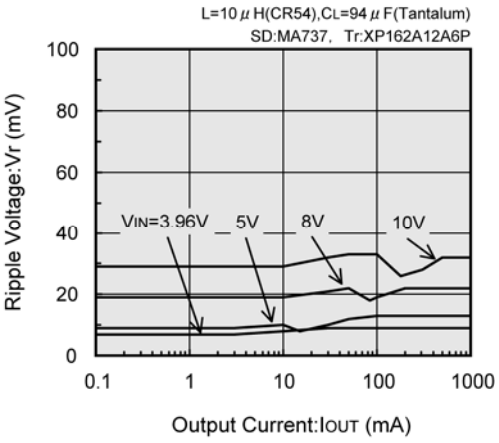
XC6365B103MR (300kHz,1.5V)



XC6366B102MR (180kHz,3.3V)



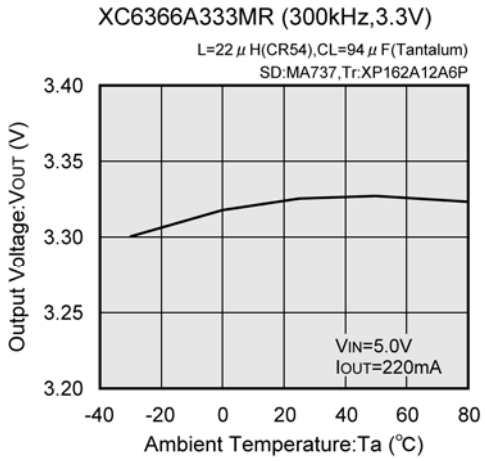
XC6366A335MR (500kHz,3.3V)



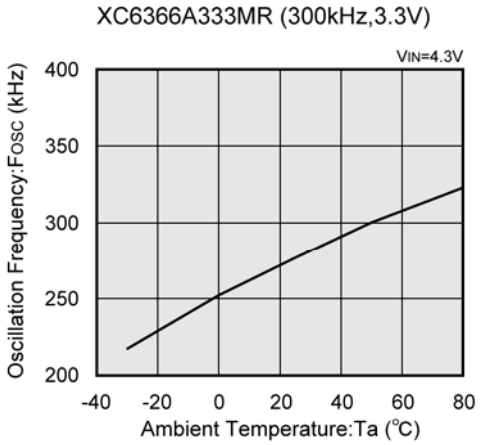
Note: CIN=47μF(Tantalum)

■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

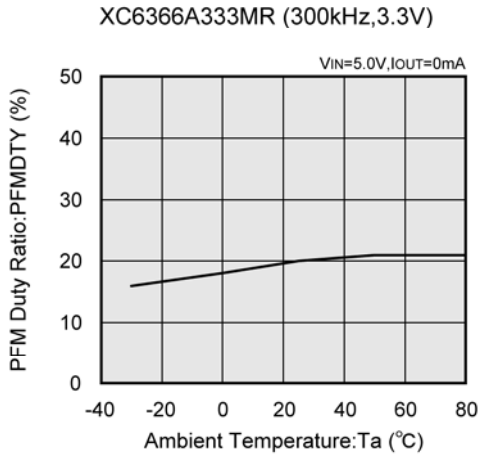
(4) Output Voltage vs. Ambient Temperature



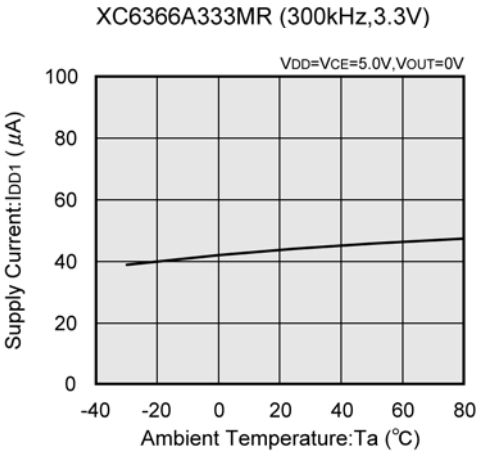
(5) Oscillation Frequency vs. Ambient Temperature



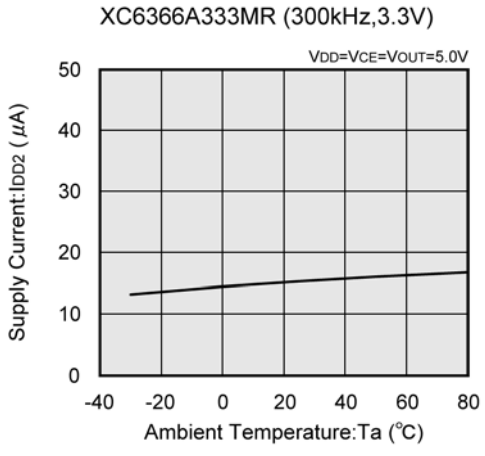
(6) PFM Duty Ratio vs. Ambient Temperature



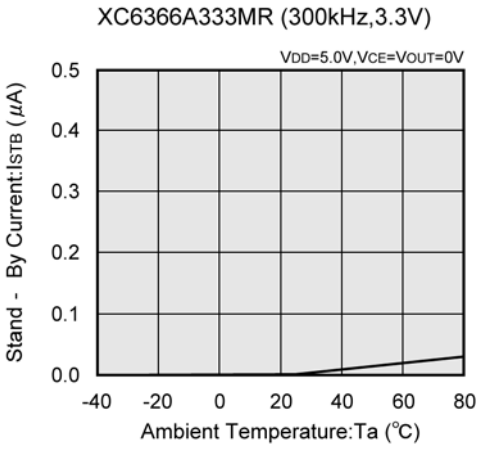
(7) Supply Current 1 vs. Ambient Temperature



(8) Supply Current 2 vs. Ambient Temperature

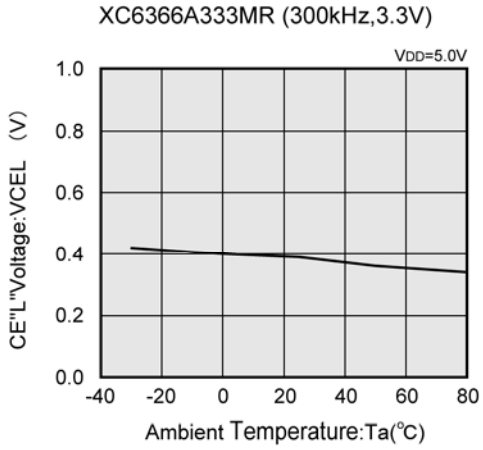


(9) Stand-By Current vs. Ambient Temperature

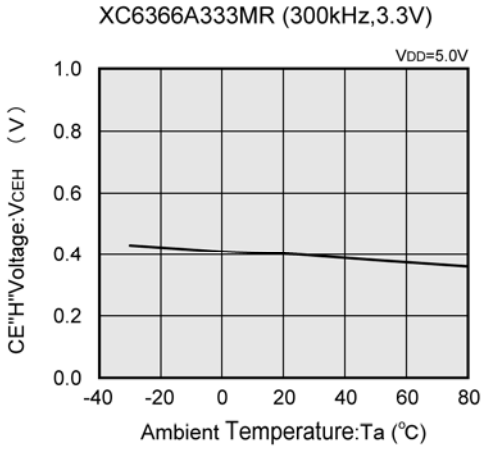


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

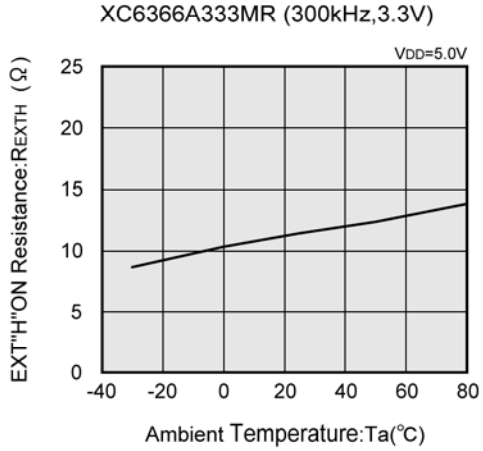
(10) CE "L"Voltage vs. Ambient Temperature



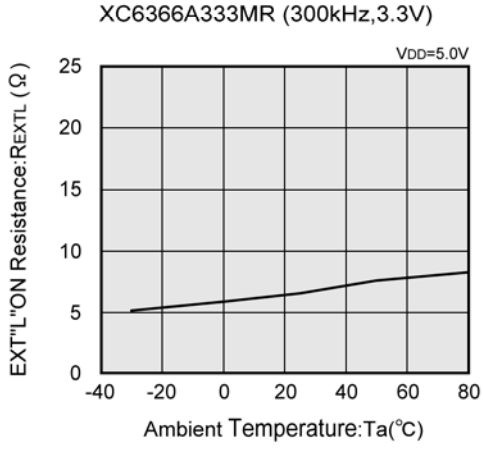
(11) CE"H"Voltage vs. Ambient Temperature



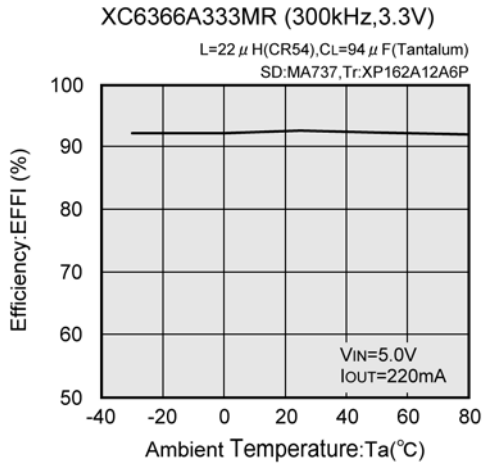
(12) EXT"H"On Resistance vs. Ambient Temperature



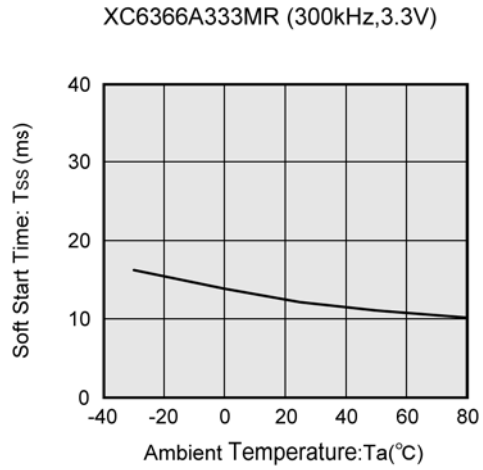
(13) EXT"L"On Resistance vs. Ambient Temperature



(14) Efficiency vs. Ambient Temperature



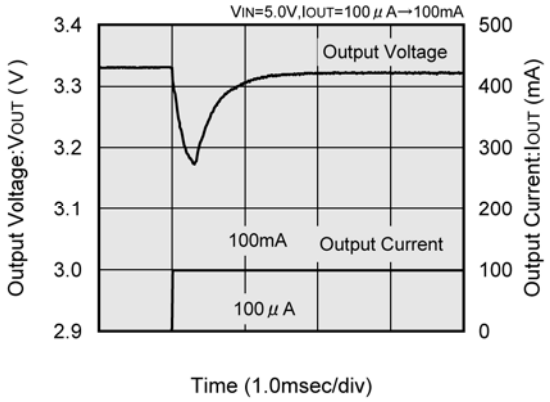
(15) Soft-Start Time vs. Ambient Temperature



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

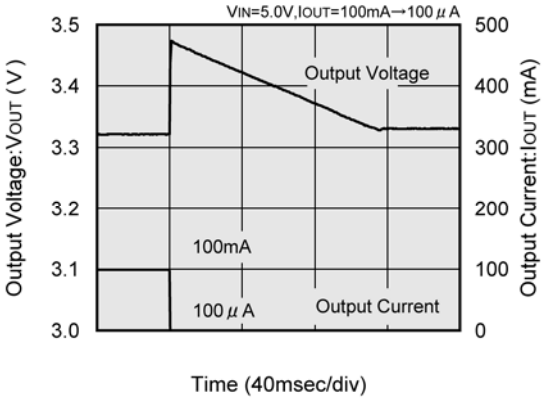
(16) Load Transient Response

XC6366A333MR (300kHz,3.3V)



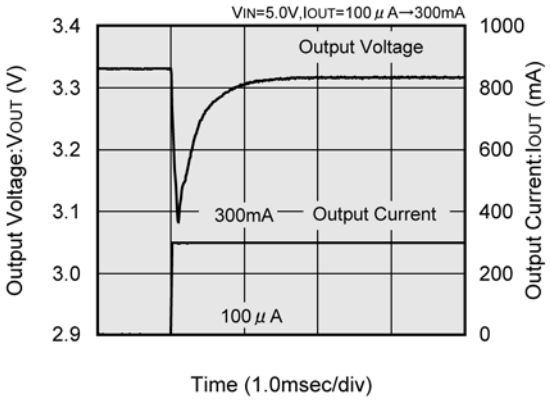
Time (1.0msec/div)

XC6366A333MR (300kHz,3.3V)



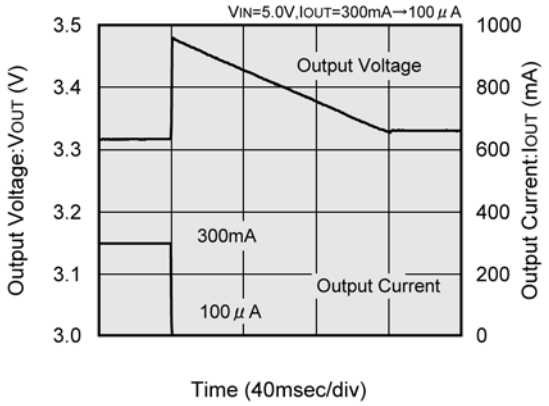
Time (40msec/div)

XC6366A333MR (300kHz,3.3V)



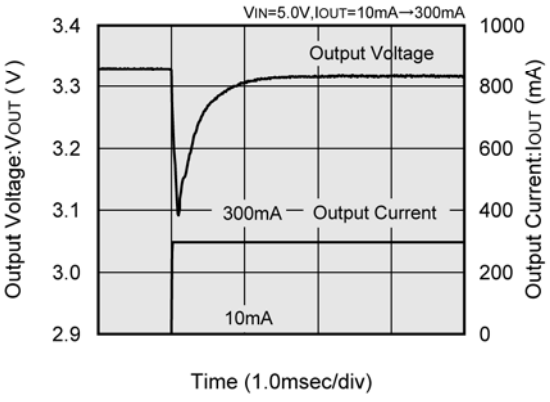
Time (1.0msec/div)

XC6366A333MR (300kHz,3.3V)



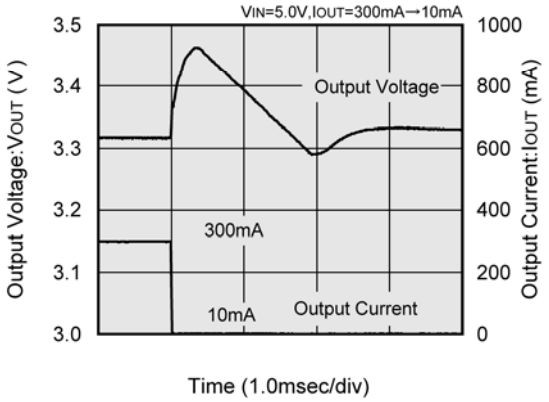
Time (40msec/div)

XC6366A333MR (300kHz,3.3V)



Time (1.0msec/div)

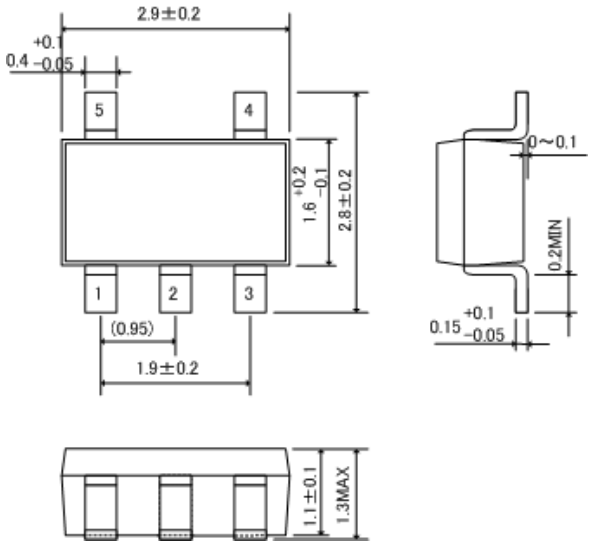
XC6366A333MR (300kHz,3.3V)



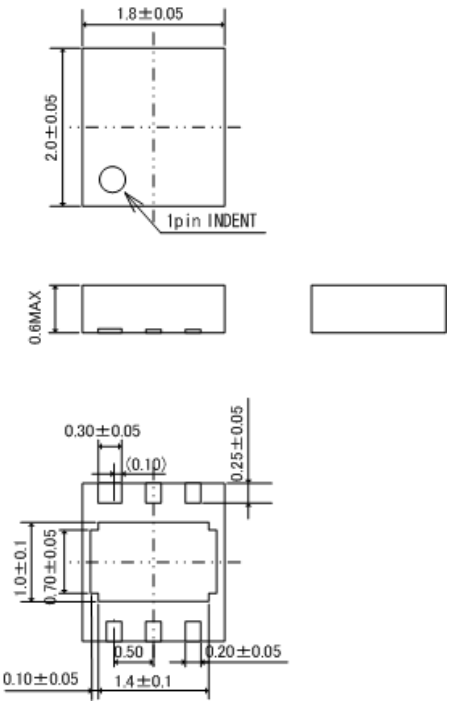
Time (1.0msec/div)

■PACKAGING INFORMATION

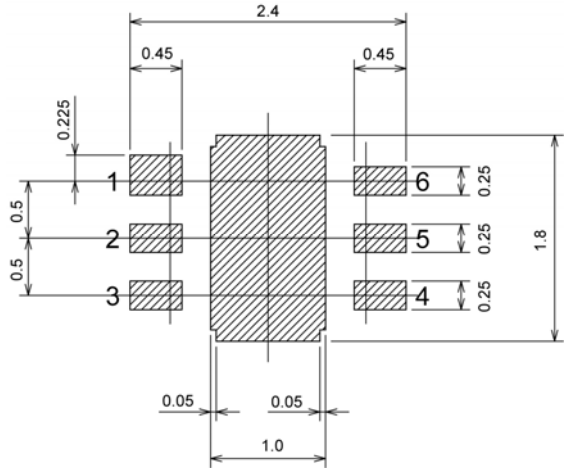
●SOT-25



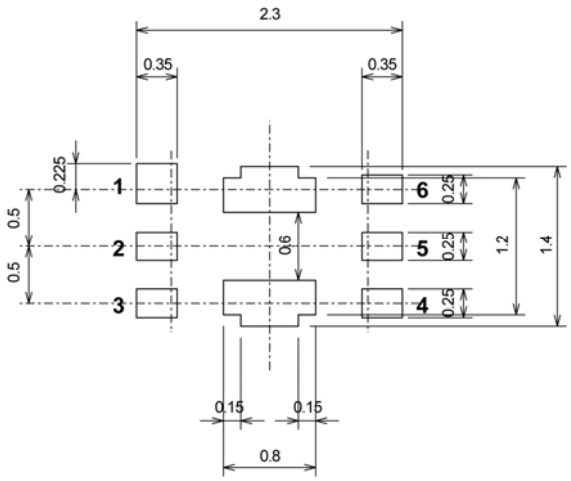
●USP-6C



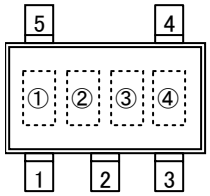
●USP-6C Reference Pattern Layout



●USP-6C Reference Metal Mask Design



■MARKING RULE



SOT-25
(TOP VIEW)

① represents product classification

MARK	PRODUCT SERIES	MARK	PRODUCT SERIES
A	XC6365A	K	XC6366A
B	XC6365B	L	XC6366B
C	XC6365C	M	XC6366C
D	XC6365D	N	XC6366D

② represents integer of output voltage and oscillation frequency

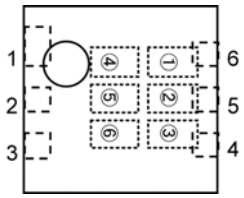
OUTPUT VOLTAGE	OSCILLATION FREQUENCY (kHz)			
	100	180	300	500
1.x	B	1	1	B
2.x	C	2	2	C
3.x	D	3	3	D
4.x	E	4	4	E
5.x	F	5	5	F
6.x	H	6	6	H

③ represents decimal number of output voltage and oscillation frequency

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

④ represents production lot number
0 to 9, A to Z repeated (G, I, J, O, Q, W excluded)

■MARKING RULE (Continued)



USP-6C
(TOP VIEW)

① represents product series

MARK	PRODUCT SERIES
2	XC6365****E*
0	XC6366****E*

② represents product classification

MARK	PRODUCT SERIES
A	XC6365/66A***E*
B	XC6365/66B***E*
C	XC6365/66C***E*
D	XC6365/66D***E*

③④ represents output voltage
e.g.:

MARK		OUTPUT VOLTAGE (V)	PRODUCT SERIES
③	④		
3	3	3.3	XC6365/66*33*E*
5	0	5.0	XC6365/66*50*E*

⑤ represents oscillation frequency

MARK	OCSILLATION FREQUENCY	PRODUCT SERIES
2	180kHz	XC6365/66***2E*
3	300kHz	XC6365/66***3E*
5	500kHz	XC6365/66***5E*

⑥ represents production lot number
0 to 9, A to Z repeated (G, I, J, O, Q, W excluded)

1. The products and product specifications contained herein are subject to change without notice to improve performance characteristics. Consult us, or our representatives before use, to confirm that the information in this datasheet is up to date.
2. We assume no responsibility for any infringement of patents, patent rights, or other rights arising from the use of any information and circuitry in this datasheet.
3. Please ensure suitable shipping controls (including fail-safe designs and aging protection) are in force for equipment employing products listed in this datasheet.
4. The products in this datasheet are not developed, designed, or approved for use with such equipment whose failure of malfunction can be reasonably expected to directly endanger the life of, or cause significant injury to, the user.
   (e.g. Atomic energy; aerospace; transport; combustion and associated safety equipment thereof.)
5. Please use the products listed in this datasheet within the specified ranges.
   Should you wish to use the products under conditions exceeding the specifications, please consult us or our representatives.
6. We assume no responsibility for damage or loss due to abnormal use.
7.

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