XC6365/XC6366 Series

ETR0501_002

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

☆GreenOperation-Compatible

■GENERAL DESCRIPTION

The XC6365/XC6366 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 100mV 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.
In relation to soft-start time, both internally set-up 10ms 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 UVLO internal, the external transistor will be forcibly switched off if used below the stipulated voltage.

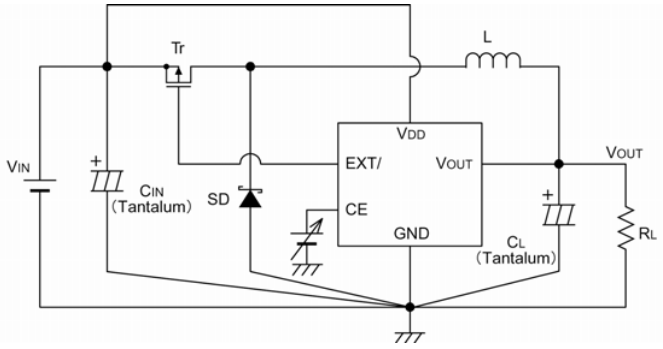
■APPLICATIONS

- ●Electronic information organizers
- ●Palmtops
- ●Cellular and portable phones
- ●Portable audio systems
- ●Various multi-function power supplies

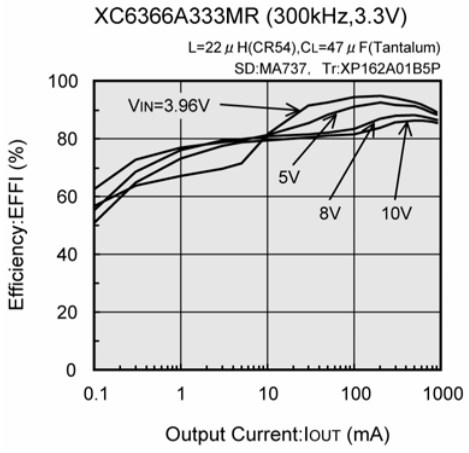
■FEATURES

Input Voltage Range : 2.2V ~ 10V (VOUT type)
Output Voltage Range : 1.5V ~ 6.0V programmable in 100mV 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 : ISTB=0.5μA (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)
Maximum Duty Ratio : 100%
PWM/PFM Switching Control (XC6366)
Package : SOT-25, USP-6C

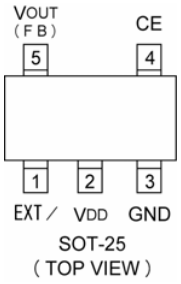
■TYPICAL APPLICATION CIRCUIT

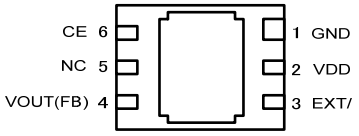


■TYPICAL PERFORMANCE CHARACTERISTICS



■PIN CONFIGURATION





USP-6C
(BOTTOM VIEW)

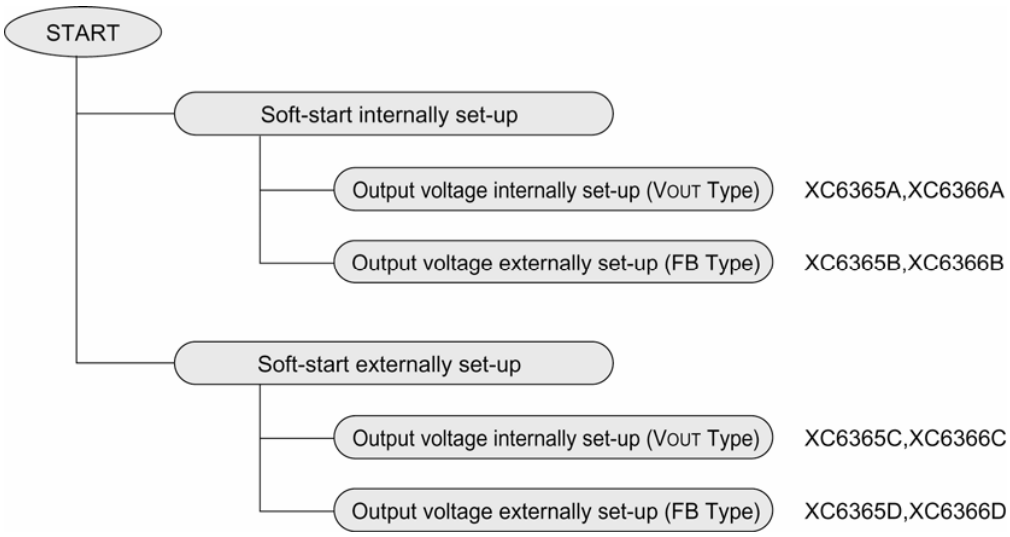
*The dissipation pad of the USP-6C package should be left open. If the circuit needs to be connected to other pin, it should be connected to the VDD (No.2) pin.

■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)

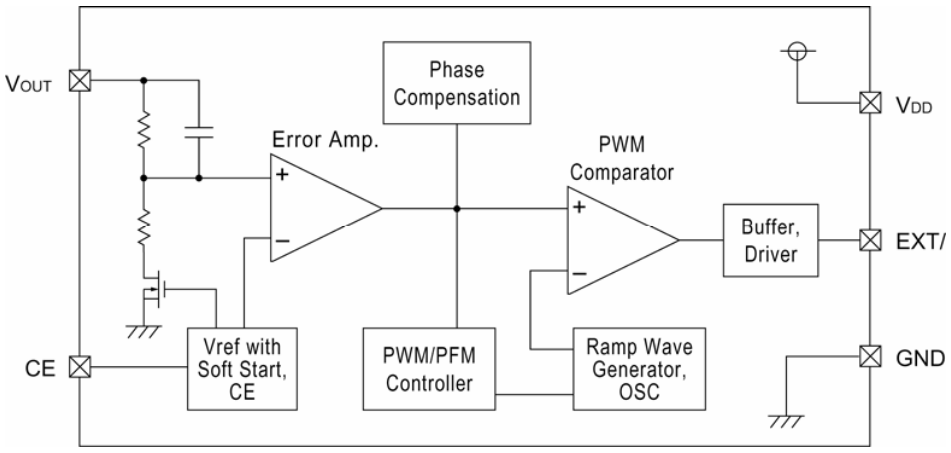
●Ordering Information

XC6365①②③④⑤⑥ PWM control
XC6366①②③④⑤⑥ PWM/PFM switching control

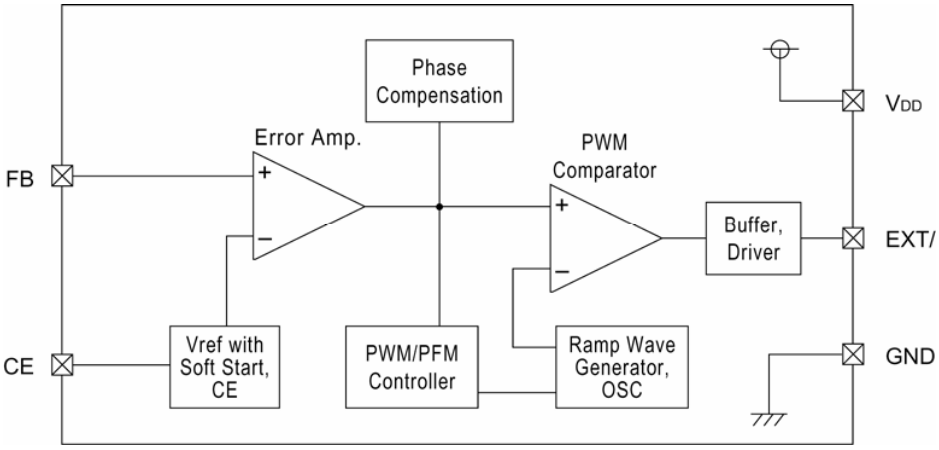
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of DC/DC Converter	A	: VOUT type: Internally set-up, soft-start internally set-up
		B	: FB type: Externally set-up, soft-start internally set-up
		C	: VOUT type: Internally set-up, soft-start externally set-up
		D	: FB type: Externally set-up, soft-start internally set-up
② ③	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)
⑤	Package	M	: SOT-25 (SOT-23-5)
		E	: USP-6C
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

■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
VIN Pin Voltage		VDD	-0.3 ~ +12	V
VOUT Pin Voltage		VOUT	-0.3 ~ VIN +0.3	V
FB Pin Voltage		VFB	-0.3 ~ VIN +0.3	V
CE Pin Voltage		VCE	-0.3 ~ VIN +0.3	V
EXT/ Pin Voltage		VEXT/	-0.3 ~ VIN +0.3	V
EXT/ Pin Current		IEXT/	±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

(VOUT=3.3V, FOSC=300kHz) Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	VOUT			3.218	3.300	3.383	V
Maximum Input Voltage	VIN			10.0	-	-	V
UVLO Voltage (Minimum Operating Voltage)	VUVLO	Same as IDD1, Voltage which EXT/pin voltage holding “H” level		0.9	-	2.2	V
Supply Current 1	IDD1	No external components, CE=VDD, VOUT=0V		-	57	102	μA
Supply Current 2	IDD2	No external components, CE=VOUT=VDD	XC6365	-	57	102	μA
			XC6366	-	15	27	μA
Stand-by Current	ISTB	No external components, CE=VOUT=0V		-	-	0.5	μA
Oscillation Frequency	FOSC	Measuring of EXT/ waveform, VIN=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	VCEH	No external components, VOUT=0V, Voltage which EXT/pin voltage holding “L” level		0.65	-	-	V
CE "Low" Voltage	VCEL	No external components, VOUT=0V, Voltage which EXT/pin voltage holding “H” level		-	-	0.20	V
EXT "High" ON Resistance	REXTBH	Same as IDD2, VEXT/=VDD-0.4V		-	16	22	μA
EXT "Low" ON Resistance	REXTBL	Same as IDD1, VEXT/=0.4V		-	14	19	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended		-	92	-	%
Soft-Start Time	TSS	Connect RSS, CSS, CE, 0V→ 3.0V (When VIN≦3.0V, VIN=3.0V)		5	10	20	ms

Conditions: 1. Unless otherwise stated, connect external components. VIN=VDD = 5.0V, IOUT = 220mA
2. XC6365/66C series external components: CSS=0.033μF, RSS=470kΩ

■ELECTRICAL CHARACTERISTICS (Continued)

XC6365A503MR, XC6366A503MR (VOUT=5.0V, FOSC=300kHz) Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	VOUT			4.875	5.000	5.125	V
Maximum Input Voltage	VIN			10.0	-	-	V
UVLO Voltage (Minimum Operating Voltage)	VUVLO	Same as IDD1, Voltage which EXT/pin voltage holding “H” level		0.9	-	2.2	V
Supply Current 1	IDD1	No external components, CE=VDD, VOUT=0V		-	67	122	μA
Supply Current 2	IDD2	No external components, CE=VOUT=VDD	XC6365	-	67	122	μA
			XC6366	-	16	29	μA
Stand-by Current	ISTB	No external components, CE=VOUT=0V		-	-	0.5	μA
Oscillation Frequency	FOSC	Measuring of EXT/ waveform, VIN=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	VCEH	No external components, VOUT=0V, Voltage which EXT/pin voltage holding “L” level		0.65	-	-	V
CE "Low" Voltage	VCEL	No external components, VOUT=0V, Voltage which EXT/pin voltage holding “H” level		-	-	0.20	V
EXT "High" ON Resistance	REXTBH	Same as IDD2, VEXT/=VIN-0.4V		-	12	17	μA
EXT "Low" ON Resistance	REXTBL	Same as IDD1, VEXT/=0.4V		-	10	14	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended		-	93	-	%
Soft-Start Time	TSS	Connect RSS, CSS, CE, 0V→ 3.0V (When VIN≦3.0V, VIN=3.0V)		5	10	20	ms

Conditions: 1. Unless otherwise stated, connect external components. VIN=VDD = 7.5V, IOUT = 330mA
2. XC6365/66C series external components: CSS=0.033μF, RSS=470kΩ

■ELECTRICAL CHARACTERISTICS (Continued)

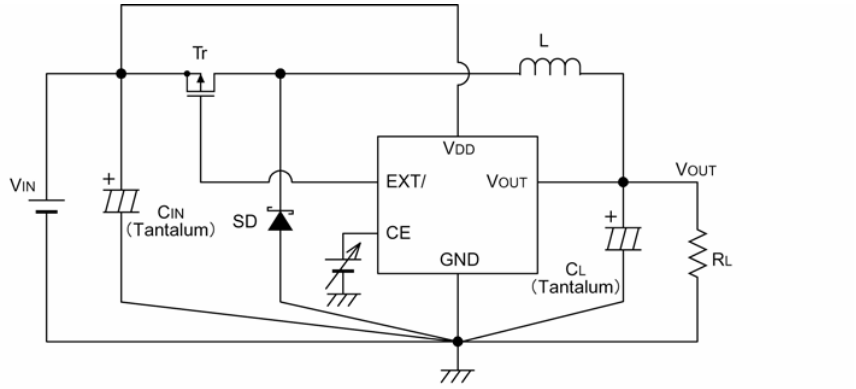
XC6365B103MR, XC6366B103MR (VOUT=3.0V, FOSC=300kHz) Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Output Voltage	VOUT			2.925	3.000	3.075	V
Maximum Input Voltage	VIN			10.0	-	-	V
UVLO Voltage (Minimum Operating Voltage)	VUVLO	Same as IDD1, Voltage which EXT/pin voltage holding “H” level		0.9	-	2.2	V
Supply Current 1	IDD1	No external components, CE=VIN, VOUT=0V		-	55	100	μA
Supply Current 2	IDD2	No external components, CE=VDD, 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	FOSC	Measuring of EXT/ waveform, VIN=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	VCEH	No external components, FB=0V, Voltage which EXT/pin voltage holding “L” level		0.65	-	-	V
CE "Low" Voltage	VCEL	No external components, VOUT=0V, Voltage which EXT/pin voltage holding “H” level		-	-	0.20	V
EXT "High" ON Resistance	REXTBH	Same as IDD2, VEXT/=VIN-0.4V		-	17	24	μA
EXT "Low" ON Resistance	REXTBL	Same as IDD1, VEXT/=0.4V		-	15	20	μA
Efficiency	EFFI	Use of a XP162A12A6 transistor recommended		-	92	-	%
Soft-Start Time	TSS	Connect RSS, CSS, CE, 0V→ 3.0V (When VIN≦3.0V, VIN=3.0V)		5	10	20	ms

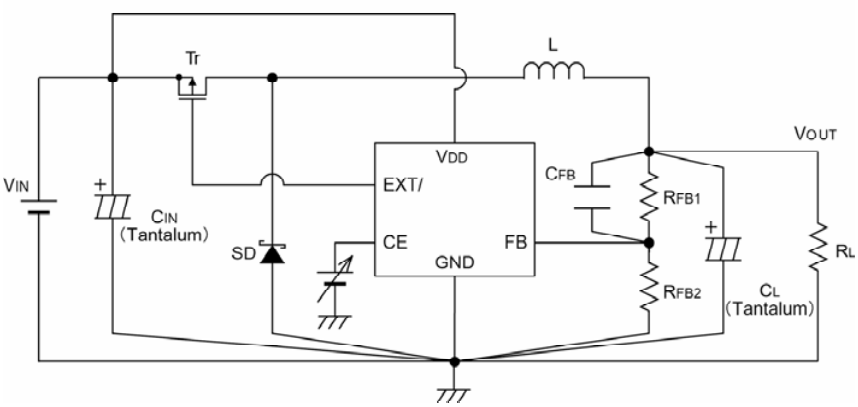
Conditions: 1. Unless otherwise stated, connect external components. VIN=VDD = 4.5V, IOUT = 200mA
2. XC6365/66C series external components: CSS=0.033μF, RSS=470kΩ
3. RFB1 = 400kΩ, RFB2 = 200kΩ, CFB = 100ppF

■TEST CIRCUITS

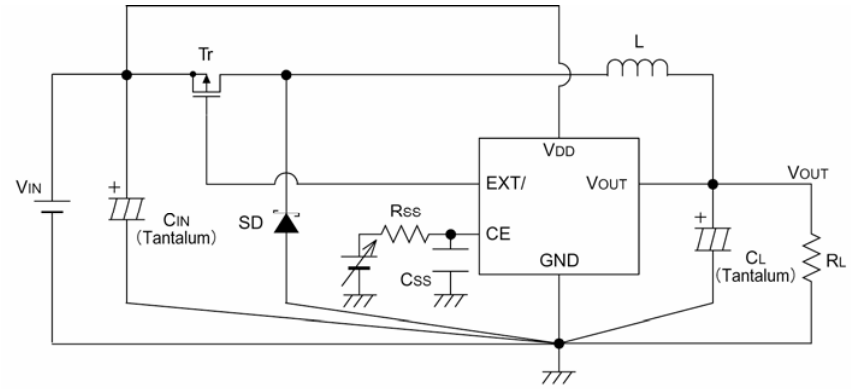
Circuit 1. XC6365A, XC6366A



Circuit 2. XC6365B, XC6366B

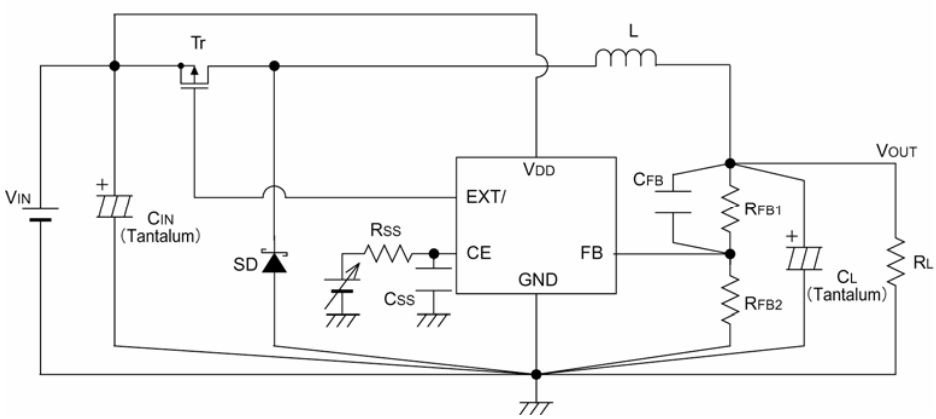


Circuit 3. XC6365C, XC6366C

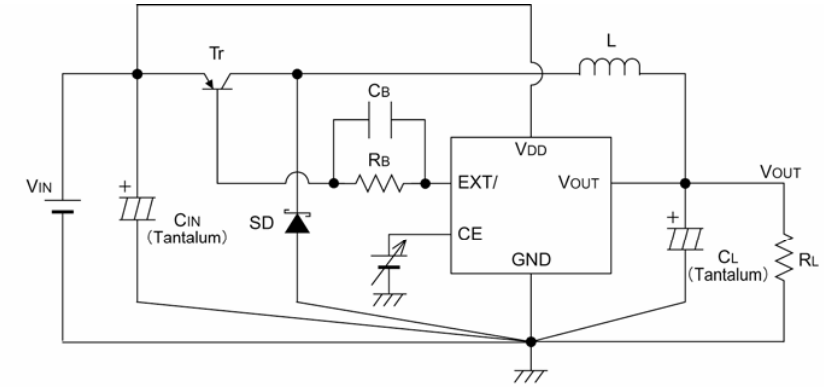


■TEST CIRCUITS (Continued)

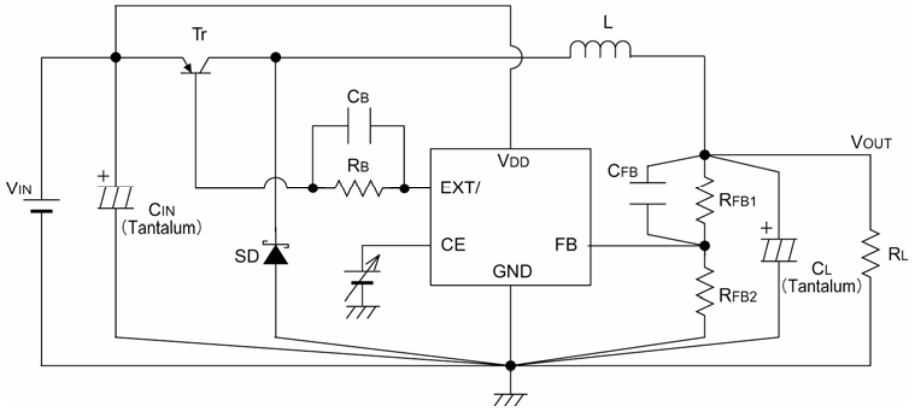
Circuit 4. XC6365D, XC6366D



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

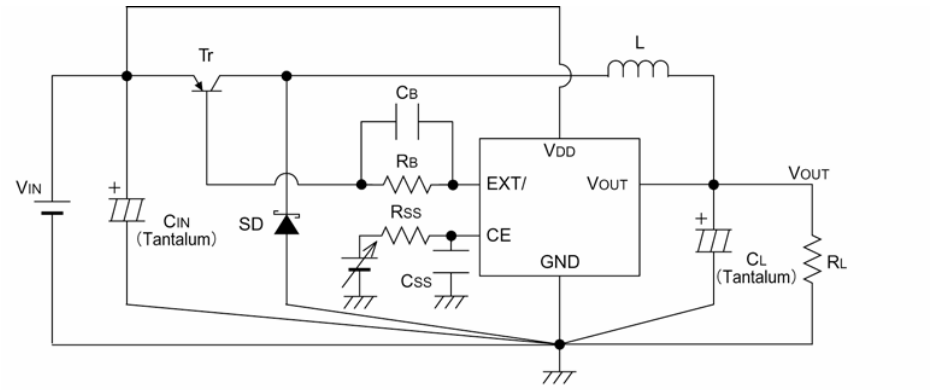


Circuit 6. XC6365B, XC6366B (when used with a PNP transistor)

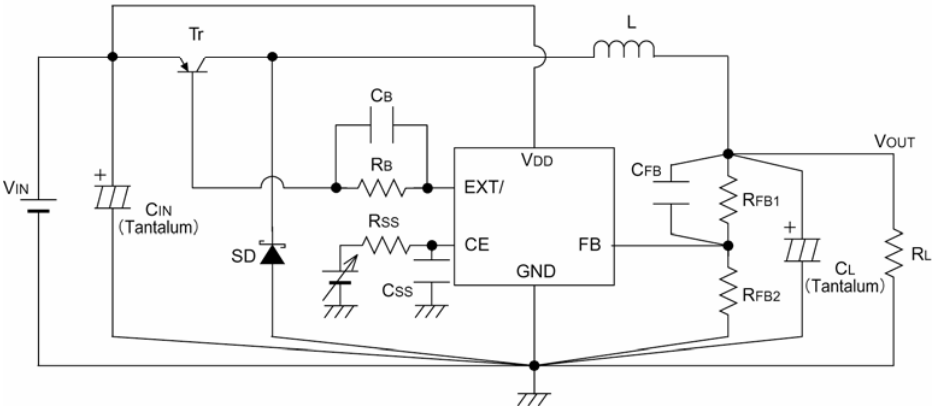


■TEST CIRCUITS (Continued)

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, FOSC=300kHz)
47μH (CR75, SUMIDA, FOSC=180kHz)
10μH (CR54, SUMIDA, FOSC=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 $C_B \leqq 1 / (2\pi \times R_B \times FOSC \times 0.7)$

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

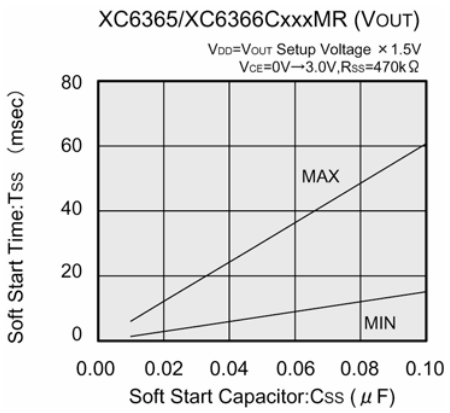
■NOTES ON USE

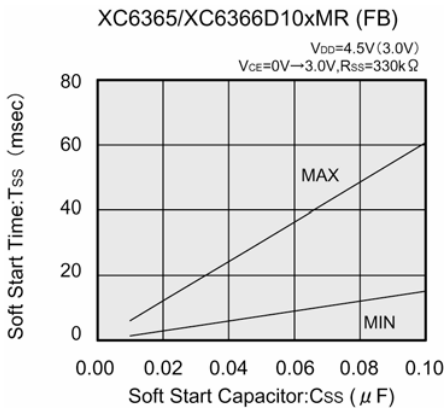
1. Take ample care to ensure that none of the IC's, nor the external component's, absolute maximum ratings are exceeded.
2. Be extremely careful when selecting parts and do not limit your reference to the specifications and characteristics for the DC/DC converter alone. The IC also depends, to a great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

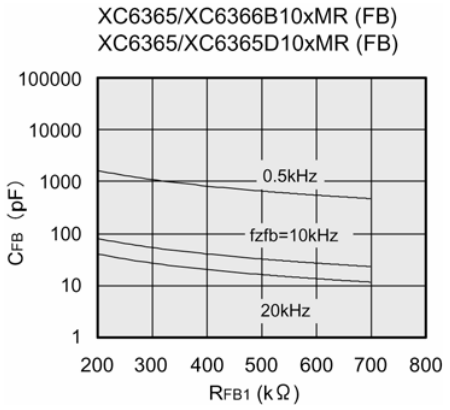




2. Setting R_{FB1} and C_{FB}

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

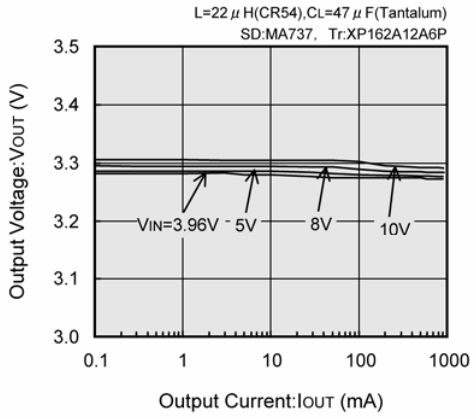
As the combination of R_{FB1} and C_{FB} enable to set fzfb between 0.5kHz to 20kHz, within the realm of fzfb=0.5kHz to fzfb=20kHz as the chart below can be effective.
Under normal condition, please set the combination to configure around fzfb=10kHz.



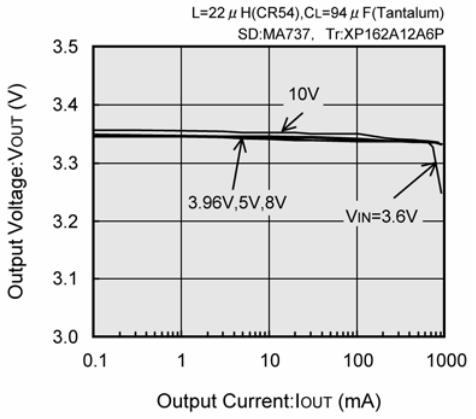
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

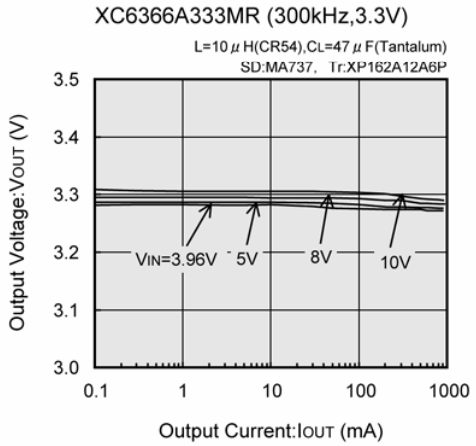
XC6366A333MR (300kHz,3.3V)



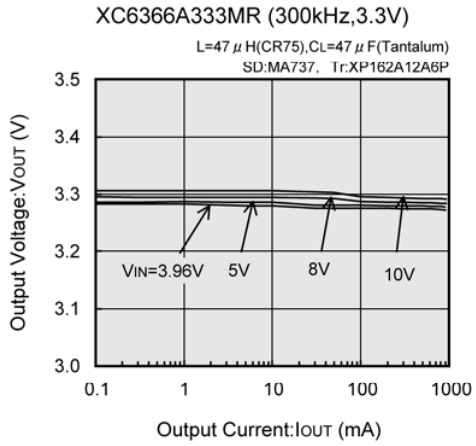
XC6365A333MR (300kHz,3.3V)



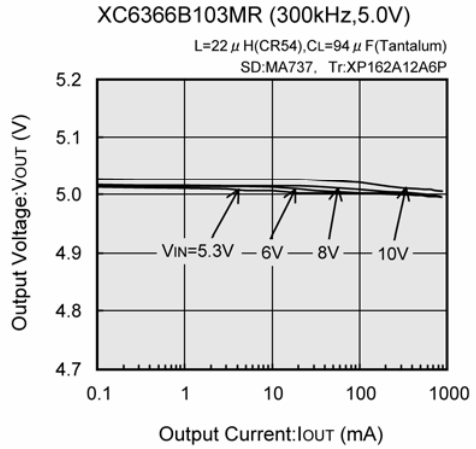
XC6366A333MR (300kHz,3.3V)



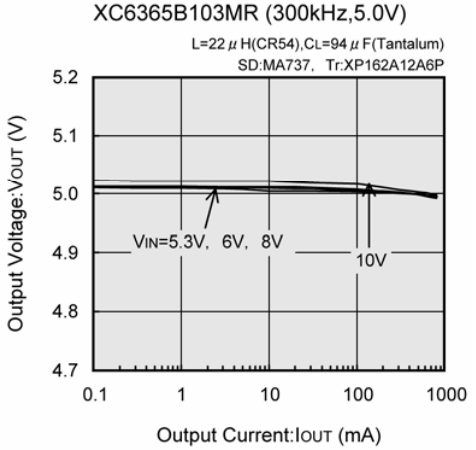
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



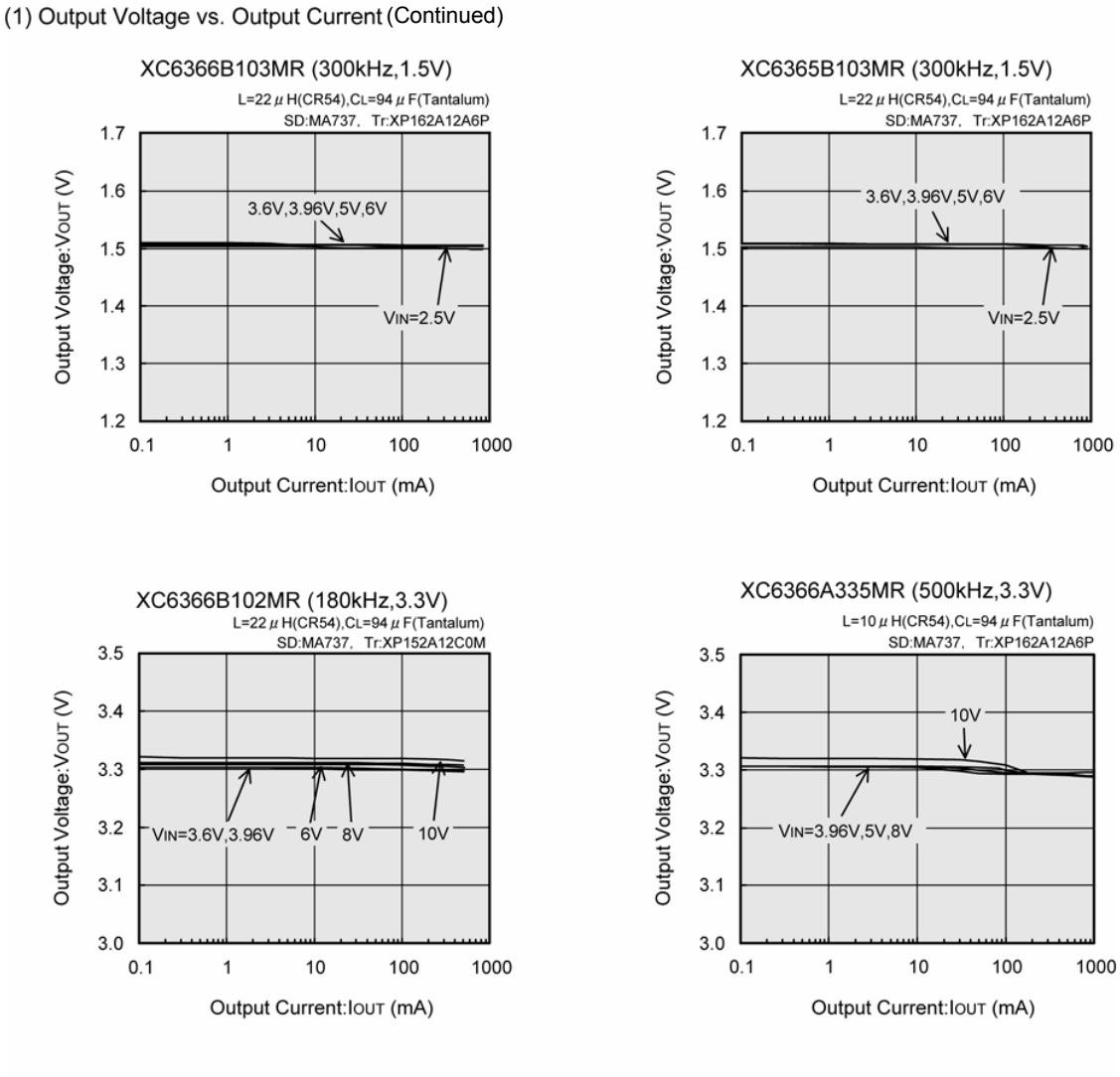
XC6365B103MR (300kHz,5.0V)



Note: CIN=47μF(Tantalum)

■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

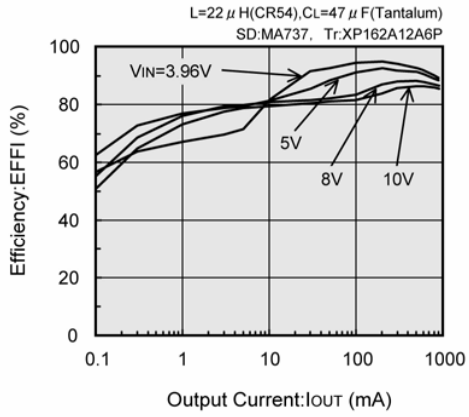


Note: CIN=47μF(Tantalum)

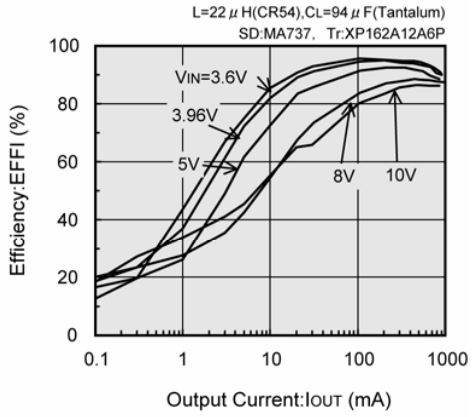
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Efficency vs. Output Current

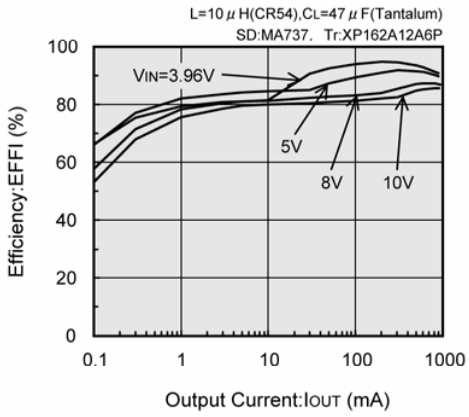
XC6366A333MR (300kHz,3.3V)



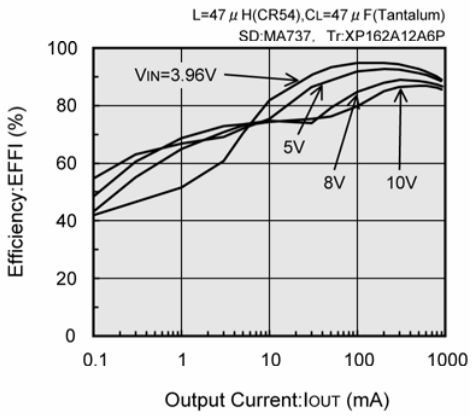
XC6365A333MR (300kHz,3.3V)



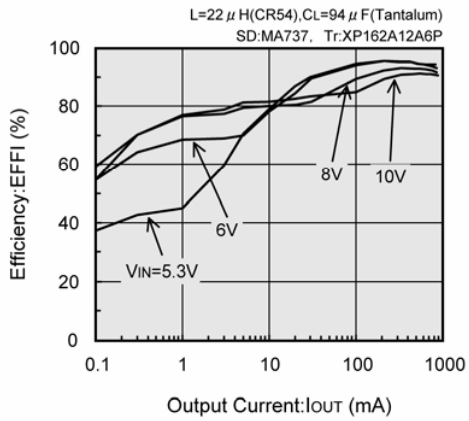
XC6366A333MR (300kHz,3.3V)



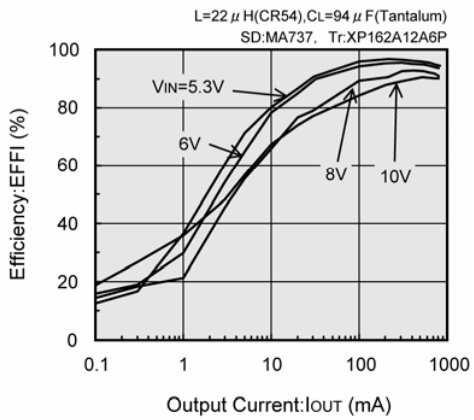
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



XC6365B103MR (300kHz,5.0V)

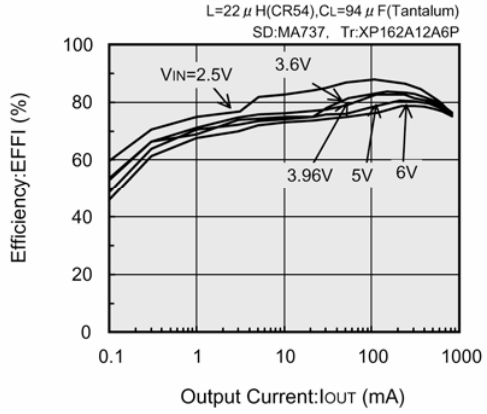


Note: CIN=47μF(Tantalum)

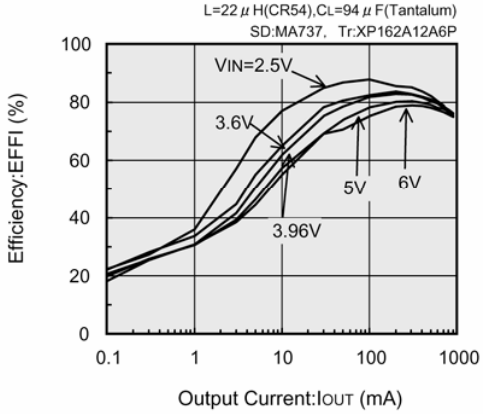
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Efficiency vs. Output Current (Continued)

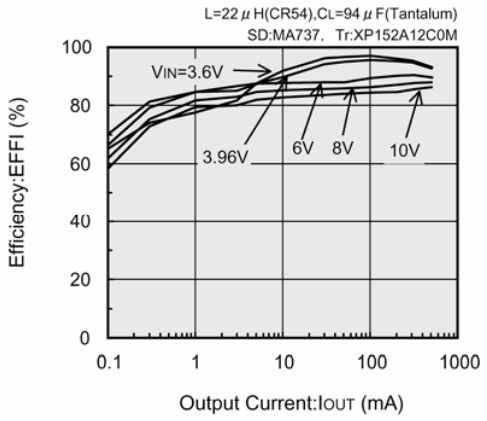
XC6366B103MR (300kHz,1.5V)



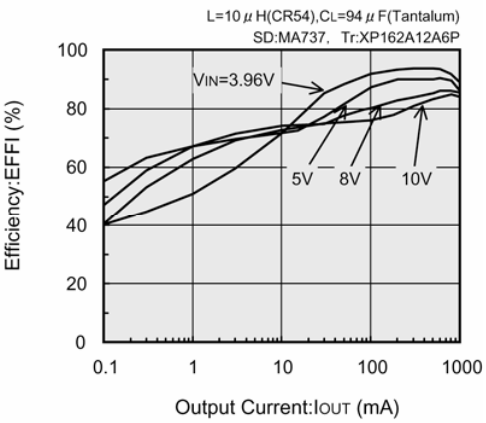
XC6365B103MR (300kHz,1.5V)



XC6366B102MR (180kHz,3.3V)



XC6366A335MR (500kHz,3.3V)

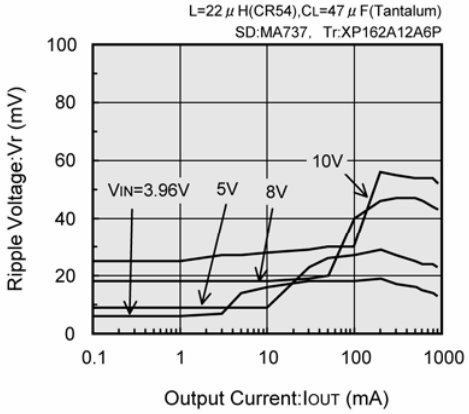


Note: CIN=47μF(Tantalum)

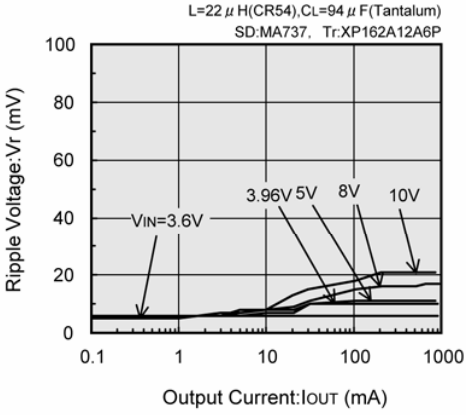
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Ripple Voltage vs. Output Current

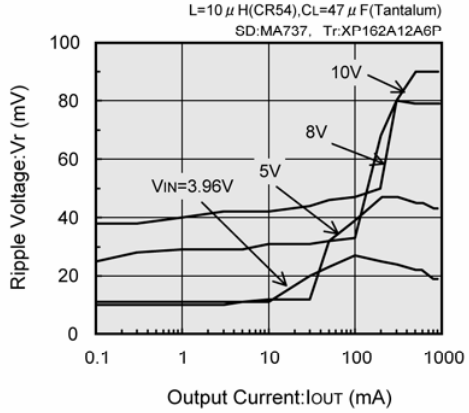
XC6365A333MR (300kHz,3.3V)



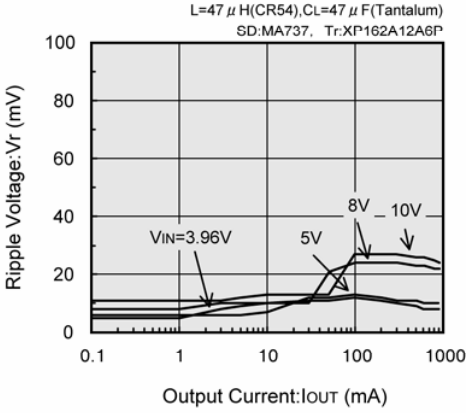
XC6365A333MR (300kHz,3.3V)



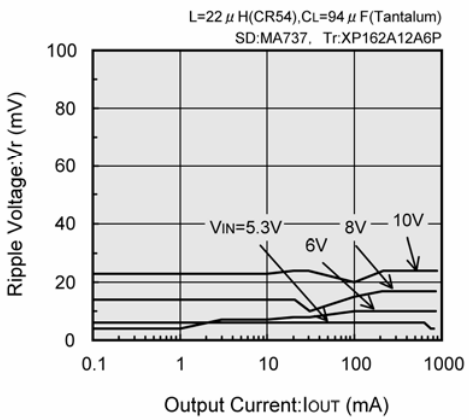
XC6365A333MR (300kHz,3.3V)



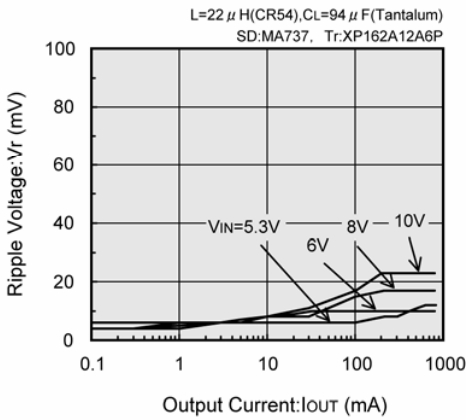
XC6366A333MR (300kHz,3.3V)



XC6366B103MR (300kHz,5.0V)



XC6365B103MR (300kHz,5.0V)

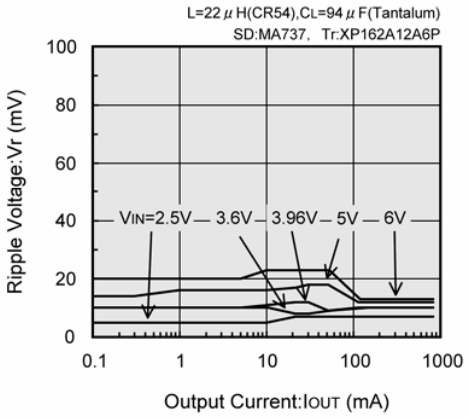


Note: CIN=47μF(Tantalum)

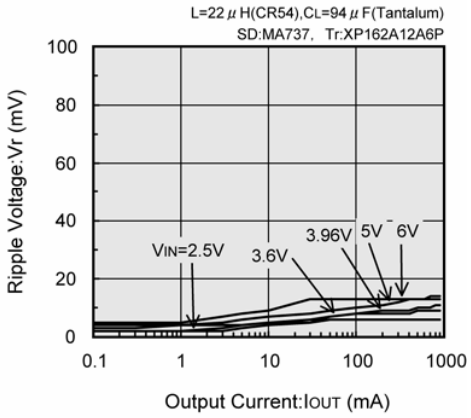
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

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

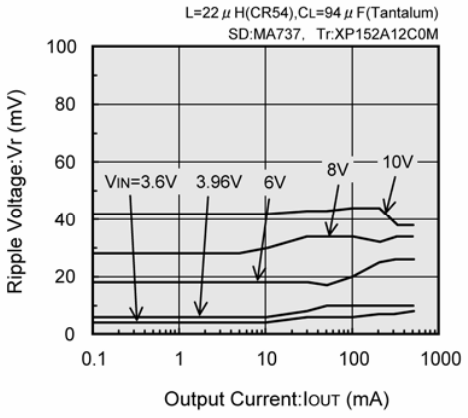
XC6366B103MR (300kHz,1.5V)



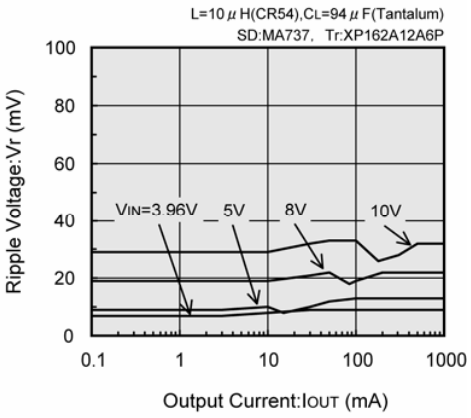
XC6365B103MR (300kHz,1.5V)



XC6366B102MR (180kHz,3.3V)



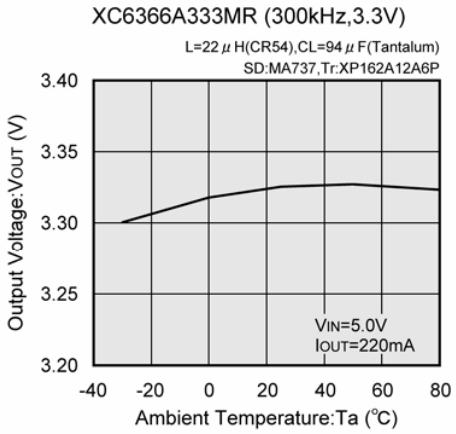
XC6366A335MR (500kHz,3.3V)



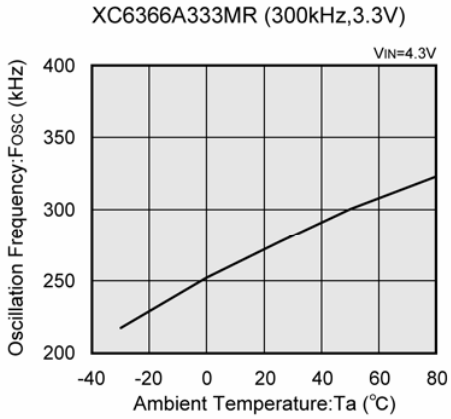
Note: CIN=47μF(Tantalum)

■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

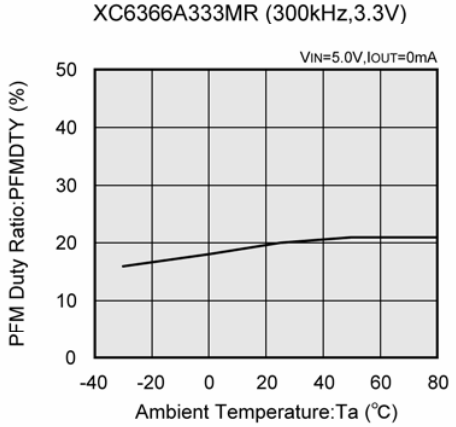
(4) Output Voltage vs. Ambient Temperature



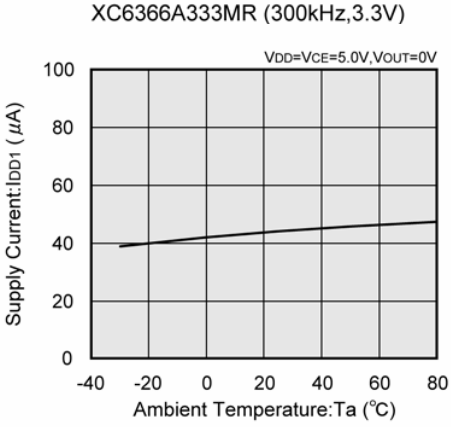
(5) Oscillation Frequency vs. Ambient Temperature



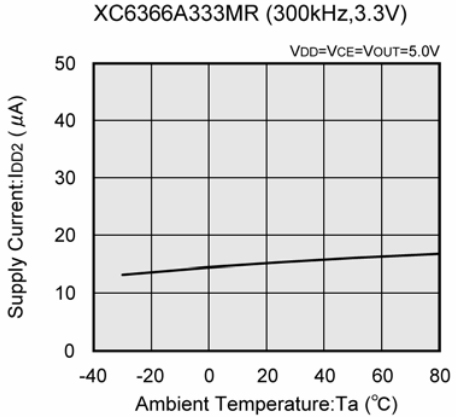
(6) PFM Duty Ratio vs. Ambient Temperature



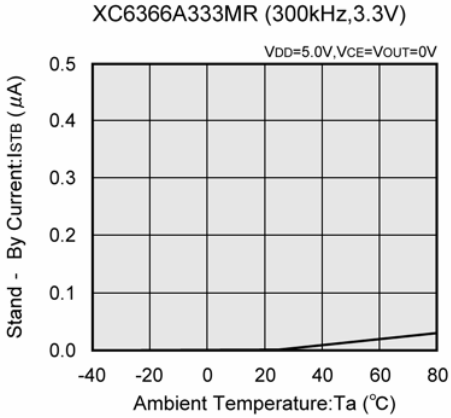
(7) Supply Current 1 vs. Ambient Temperature



(8) Supply Current 2 vs. Ambient Temperature

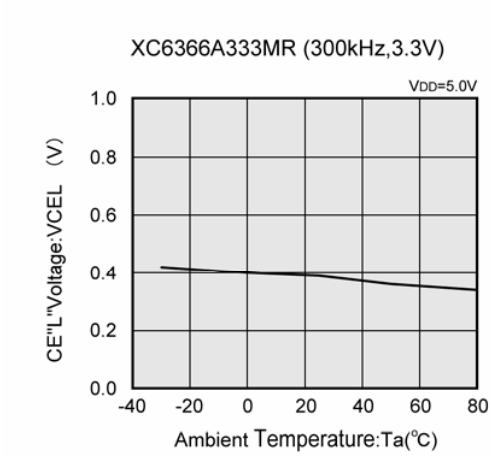


(9) Stand-By Current vs. Ambient Temperature

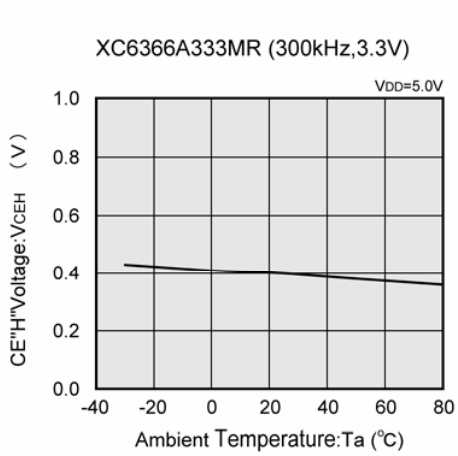


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

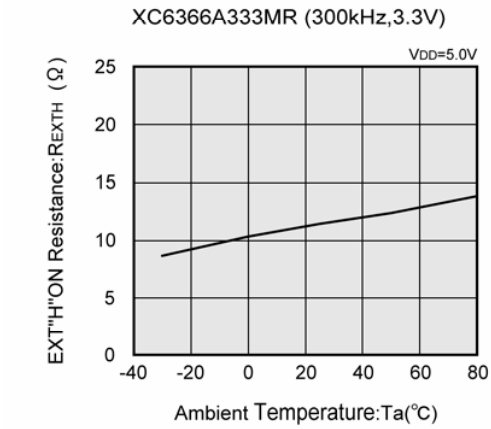
(10) CE "L"Voltage vs. Ambient Temperature



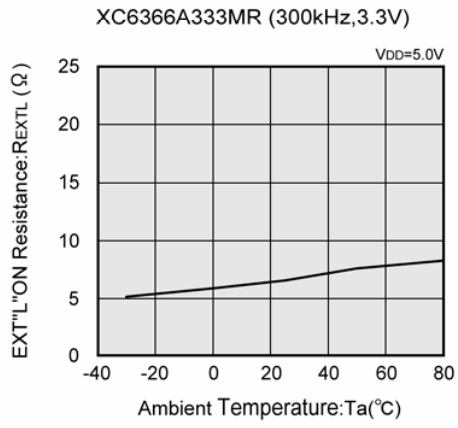
(11) CE"H"Voltage vs. Ambient Temperature



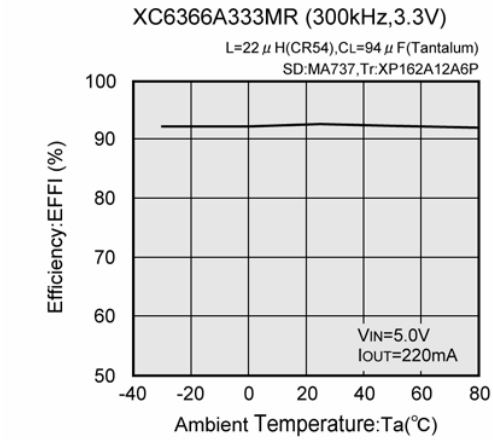
(12) EXT"H"On Resistance vs. Ambient Temperature



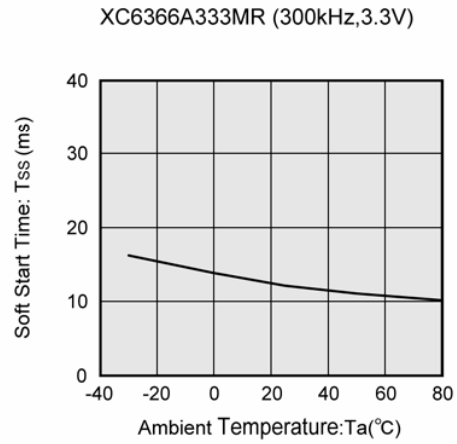
(13) EXT"L"On Resistance vs. Ambient Temperature



(14) Efficiency vs. Ambient Temperature



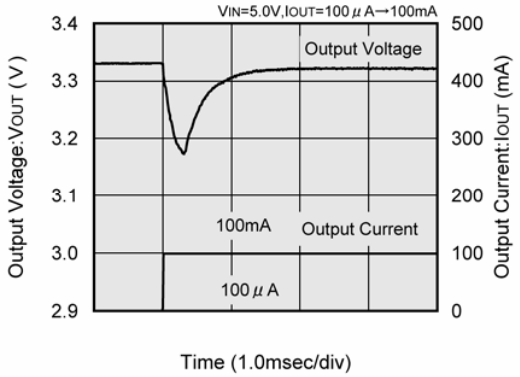
(15) Soft-Start Time vs. Ambient Temperature



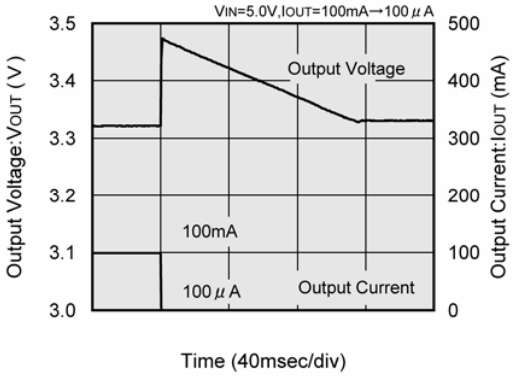
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(16) Load Transient Response

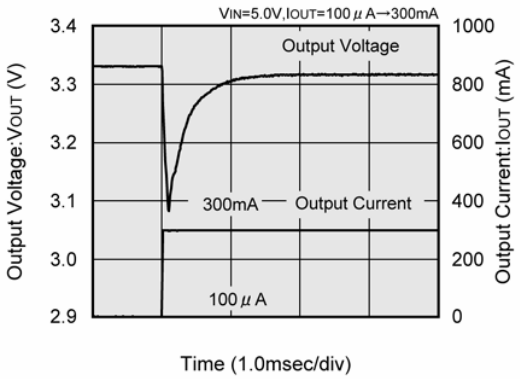
XC6366A333MR (300kHz,3.3V)



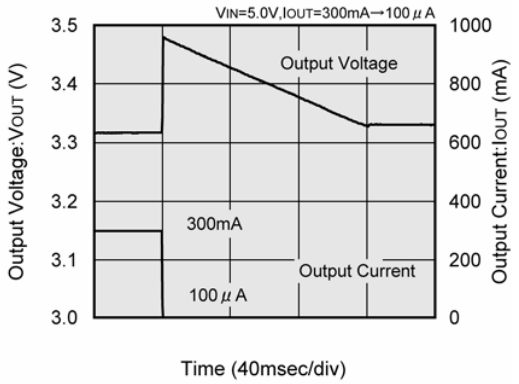
XC6366A333MR (300kHz,3.3V)



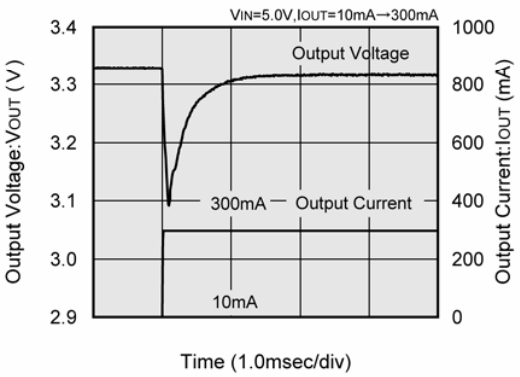
XC6366A333MR (300kHz,3.3V)



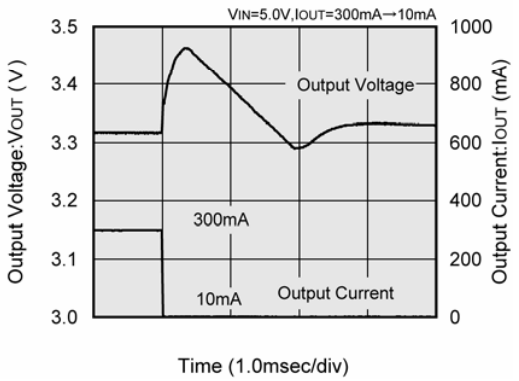
XC6366A333MR (300kHz,3.3V)



XC6366A333MR (300kHz,3.3V)

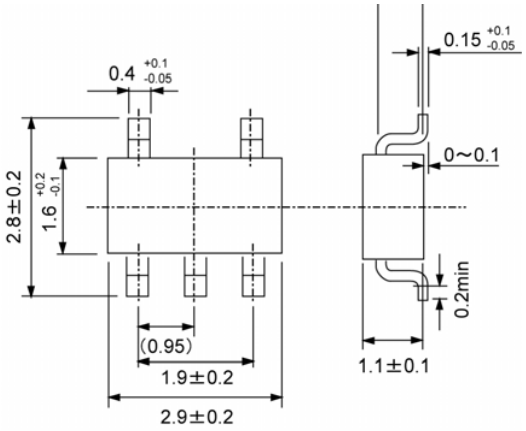


XC6366A333MR (300kHz,3.3V)

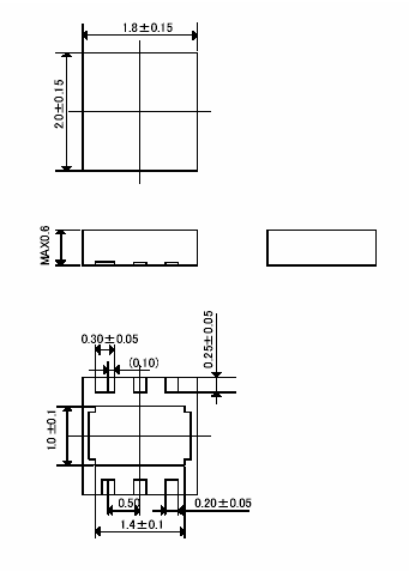


■PACKAGING INFORMATION

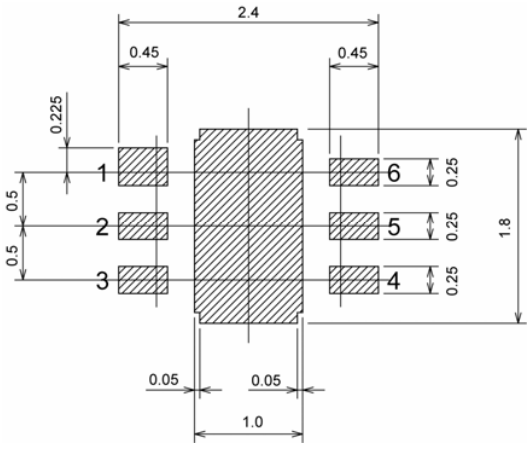
●SOT-25



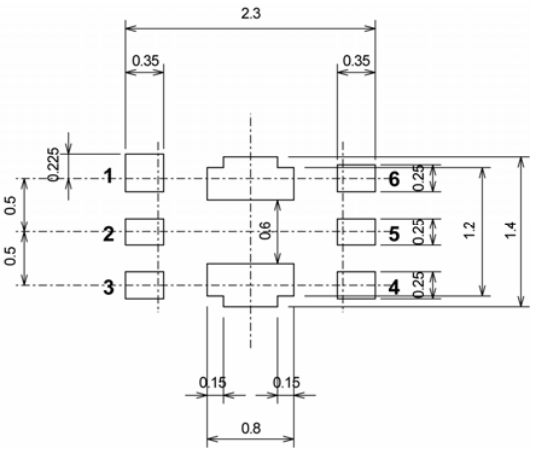
●USP-6C



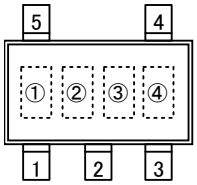
●USP-6C Recommended Pattern Layout



●USP-6C Recommended Metal Mask Design



■MARKING RULE



SOT-25
(TOP VIEW)

①Represents product classification

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

②Represents integer of output voltage and oscillation frequency

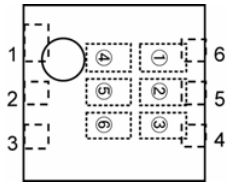
OUTPUT VOLTAGE	OSCILLATION FREQUENCY (kHz)			
	100	180	300	500
1.x	B	1	1	B
2.x	C	2	2	C
3.x	D	3	3	D
4.x	E	4	4	E
5.x	F	5	5	F
6.x	H	6	6	H

③Represents 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

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

■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 excepted)

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