XC6371/XC6372/XC6373 Series

ETR0402_002

PWM Controlled Step - Up DC/DC Contorollers/Convereters

☆GO-Compatible

■GENERAL DESCRIPTION

The XC6371/6372/6373 series are a group of PWM controlled and PWM/PFM controlled step-up DC/DC converters. The built-in 1.4Ω switching transistor type enables a step-up circuit to be configured using only three components, a coil, a diode, and a capacitor.

Output voltage can be selectable in the range from 2.0V to 7.0V in increments of 100mV (accuracy:±2.5%). Oscillation frequency is also selectable from 50kHz, 100kHz, and 180kHz (accuracy:±15%) for the XC6371 and the XC6372 series. Soft-start time is internally set and offers protection against in-rush currents when the power is switched on and prevents voltage overshoot. 5 pin packages, which are provided with either a CE (chip enable) function that reduces power consumption during shut-down mode, or a V_{DD} pin (separated power and voltage detect pins) are available.

The XC6371 series is the standard PWM controlled products. The control of the XC6372 series switches from PWM to PFM control during light loads when automatically switching is selected and the series is highly efficient from light loads to large output currents. Since the XC6373 series is a low noise, it is suitable for a wireless circuit. Also the series is particularly suited for use with pager applications because oscillation frequency is set at 30kHz (±20%) so as to attain the lowest consumption current possible.

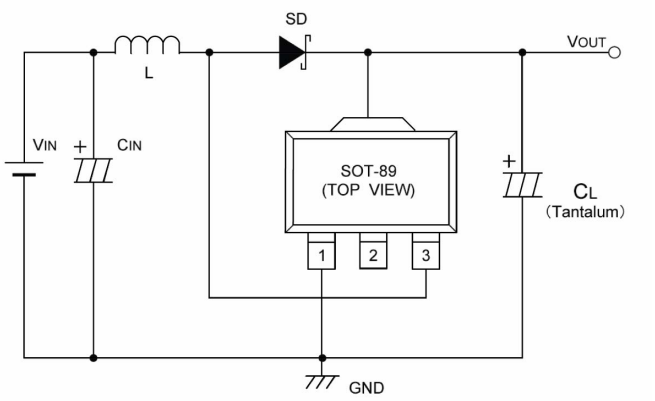
■APPLICATIONS

- ●Cellular phones, Pagers
- ●Palmtops
- ●Cameras, Video recorders
- ●Portable products

■FEATURES

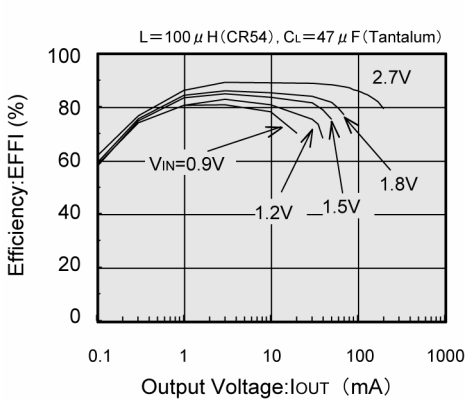
Operation Start Voltage Range : 0.9V~10V
Output Voltage Range : 2.0V~7.0V in 100mV increments
Highly Accurate : Setting voltage accuracy±2.5%
Oscillation Frequency : 50kHz, 100kHz, 180kHz (±15%) selectable (XC6371/72)
30kHz (XC6373)
Maximum Output Currents (Tr. built-in)
: 100mA(TYP.) @ V_{IN}=3.0V, V_{OUT}=5.0V *
Highly Efficient (Tr. built-in)
: 85%(TYP.) @ V_{IN}=3.0V, V_{OUT}=5.0V *
Built-in switching transistor type.
Five-lead packaged units offer either chip enable or independent V_{OUT} pin option.
Phase compensation and soft start-up circuits built-in.
CMOS Low Power Consumption
Small Packages : SOT-89, SOT-89-5,USP-6B
*: Performance depends on external components and PCB layout.

■TYPICAL APPLICATION CIRCUIT

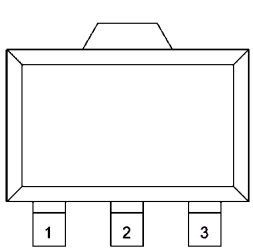


■TYPICAL PERFORMANCE CHARACTERISTICS

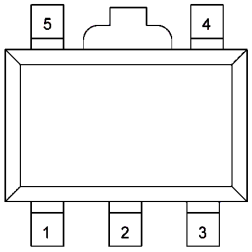
XC6371A301PR



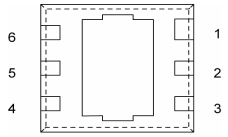
■PIN CONFIGURATION



SOT-89
(TOP VIEW)



SOT-89-5
(TOP VIEW)



USP-6B
(BOTTOM VIEW)

*The dissipation pad for the USP-6B package should be solder-plated in recommended mount pattern and metal masking so as to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the pin No.1.

■PIN ASSIGNMENT

XC6371/72/73A

PIN NUMBER		PIN NAME	FUNCTION
SOT-89	USP-6B		
1	6	VSS	Ground
2	1	VOUT	Output Voltage Monitor/IC Internal Power Supply
3	4	Lx	Switch
–	2, 3, 5	NC	No Connection

XC6371/72/73C

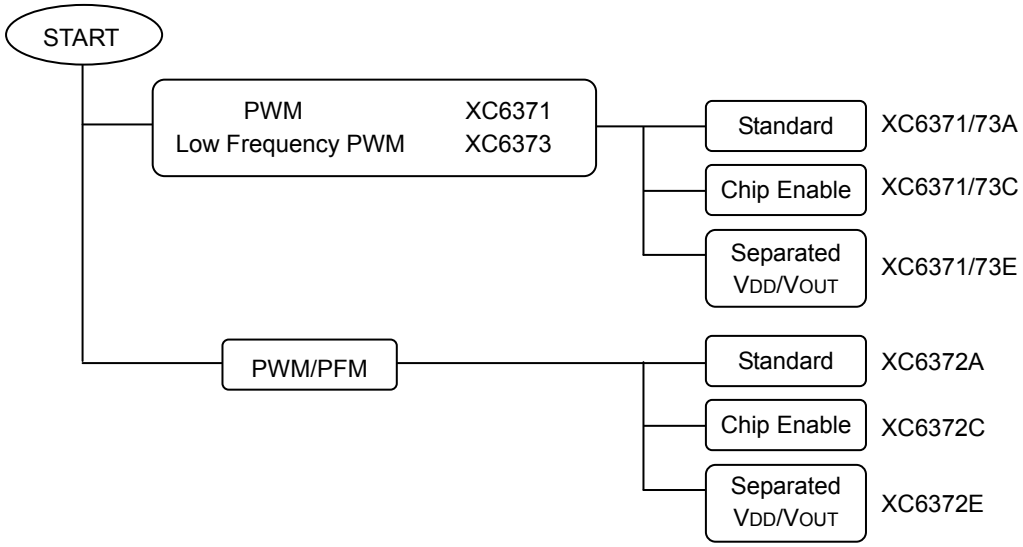
PIN NUMBER		PIN NAME	FUNCTION
SOT-89-5	USP-6B		
5	6	VSS	Ground
2	1	VOUT	Output Voltage Monitor/IC Internal Power Supply
4	4	Lx	Switch
3	3	CE	Chip Enable
1	2, 5	NC	No Connection

XC6371/72/73E

PIN NUMBER		PIN NAME	FUNCTION
SOT-89-5	USP-6B		
5	6	VSS	Ground
2	1	VDD	IC Internal Power Supply
4	4	Lx	Switch
3	3	VOUT	Output Voltage Monitor
1	2, 5	NC	No Connection

■PRODUCT CLASSIFICATION

●Selection Guide



●Ordering Information

XC6371①②③④⑤⑥ : PWM controlled
XC6372①②③④⑤⑥ : PWM/PFM switching control

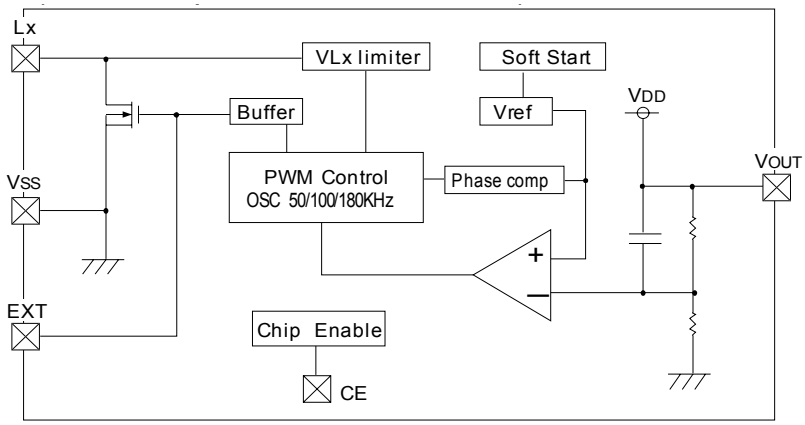
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of DC/DC Converter	A	: 3-pin DC/DC converter with built-in switching transistor
		C	: Stand-by capability with built-in switching transistor
		E	: Separated VDD and VOUT with built-in switching transistor
② ③	Output Voltage	Integer	: e.g. VOUT=3.5V→②=3, ③=5
④	Oscillation Frequency	0	: 50kHz
		1	: 100kHz
		2	: 180kHz
⑤	Package	P	: SOT-89 (XC6371/72 A type)
			: SOT-89-5 (XC6371/72 C/D type)
		D	: USP-6B
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

XC6373①②③④⑤⑥ : PWM controlled

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of DC/DC Converter	A	: 3-pin DC/DC converter with built-in switching transistor
		C	: Stand-by capability with built-in switching transistor
		E	: Separated VDD and VOUT with built-in switching transistor
② ③	Output Voltage	Integer	: e.g. VOUT=3.5V→②=3, ③=5
④	Oscillation Frequency	0	: 30kHz
⑤	Package	P	: SOT-89 (XC6373 A type)
			: SOT-89-5 (XC6373 C/D type)
		D	: USP-6B
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

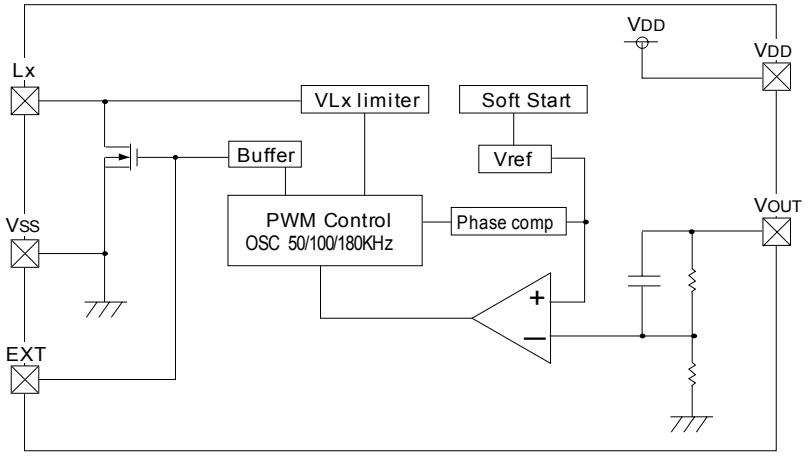
■BLOCK DIAGRAMS

XC6371/72/73A, C
(The VOUT pin serves also as VDD)



Note: The CE pin is only used with the XC6371C.

XC6371/72/73E



Note: Built-in transistor type units use the Lx pin.

■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNITS
VOUT Input Voltage		VOUT	12	V
Lx pin Voltage		VLX	12	V
Lx pin Current		ILX	400	mA
CE Input Voltage		VCE	12	V
Power Dissipation	SOT-89, 89-5	Pd	500	mW
	USP-6B		100	
VDD Input Voltage		VDD	12	V
Operating Temperature Range		Topr	-30~＋80	℃
Storage Temperature Range		Tstg	-40~＋125	℃

■ELECTRICAL CHARACTERISTICS

XC6371/72A501PR V_{OUT}=5.0V, FOSC=100kHZ 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	-	-	V
Operation Start Voltage	V_{ST1}	External Components Connected, I_{OUT}=1mA	-	-	0.90	V
Oscillation Start Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} Lx : 10kΩ pull-up to 5V	-	-	0.80	V
No Load Input Current	I_{IN}	V_{IN}=V_{OUT}×0.8, I_{OUT}=0mA (*1)	-	12.8	25.7	μA
Supply Current 1	I_{DD1}	Same as V_{ST2}, Apply output voltage×0.95 to V_{OUT}	-	80.2	133.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2}, Apply output voltage×1.1 to V_{OUT}	-	8.2	16.5	μA
Lx Switch-On Resistance	R_{SWON}	Same as I_{DD1}, V_{LX}=0.4V	-	1.4	2.4	Ω
Lx Leak Current	I_{LXL}	No external components. V_{OUT}=V_{LX}=10V	-	-	1.0	μA
Oscillation Frequency	FOSC	Same as I_{DD1}. Measuring of Lx waveform	85	100	115	kHz
Maximum Duty Ratio	MAXDTY	Same as I_{DD1}. Measuring of Lx waveform	80	87	92	%
PFM Duty Ratio (*4)	PFMDTY	Same as I_{DD1}. Measuring of Lx waveform	10	17	25	%
Lx Limit Voltage	V_{LXLMT}	Same as I_{DD1}. Apply output voltage to Lx, Voltage required to produce FOSC×2	0.7	-	1.3	V
Efficiency	EFFI		-	85	-	%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	mS

NOTE: Unless otherwise stated, V_{IN}=V_{OUT}×0.6, I_{OUT}=50mA. See Typical Application Circuits, Circuit1

*1: The Schottky diode (SD) must be type MA735, with reverse current (I_R)<1.0μA at reverse voltage (V_R)=10.0V.(XC6372A)
*2: "Supply Current 1" is the supply current while the oscillator is continuously oscillating. In actual operation the oscillator periodically operates which results in less average power consumption. The current actually provided by an external V_{IN} source is represented by "No Load Input Current (I_{IN})".
*3: When PWM operates at PWM Mode.
*4: When PFM operates at PFM Mode.(XC6372A)

■ELECTRICAL CHARACTERISTICS (Continued)

XC6371/72C501PR VOUT=5.0V, FOSC=100kHz Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Output Voltage	VOUT		4.875	5.000	5.125	V
Maximum Input Voltage	VIN		10	-	-	V
Operation Start Voltage	VST1	External Components Connected, IOUT=1mA	-	-	0.90	V
Operation Start Voltage	VST2	No external components. Apply voltage to VOUT, Lx : 10kΩ pull-up to 5V	-	-	0.80	V
No Load Input Current	IIN	VIN=VOUT×0.8, IOUT=0mA (*1)	-	12.8	25.7	μA
Supply Current 1	IDD1	Same as VST2, Apply output voltage×0.95 to VOUT	-	80.2	133.8	μA
Supply Current 2	IDD2	Same as VST2, Apply output voltage×1.1 to VOUT	-	8.2	16.5	μA
Lx Switch-On Resistance	RSWON	Same as IDD1, VLx=0.4V	-	1.4	2.4	Ω
Lx Leak Current	ILXL	No external components, VOUT =VLX=10V	-	-	1.0	μA
Oscillation Frequency	FOSC	Same as IDD1, Measuring of Lx waveform	85	100	115	kHZ
Maximum Duty Ratio	MAXDTY	Same as IDD1, Measuring of Lx waveform	80	87	92	%
PFM Duty Ratio (*4)	PFMDTY	Same as IDD1, Measuring of Lx waveform	10	17	25	%
Stand-by Current	ISTB	Same as IDD1	-	-	0.5	μA
CE "High" Voltage	VCEH	Same as IDD1, Lx Oscillation start	0.75	-	-	V
CE "Low" Voltage	VCEL	Same as IDD1, Lx Oscillation stop	-	-	0.20	V
CE "High" Current	ICEH	Same as IDD1, VCE=VOUT×0.95	-	-	0.25	μA
CE "Low" Current	ICEL	Same as IDD1, VCE=0V	-	-	-0.25	μA
Lx Limit Voltage	VLxLMT	Same as IDD1, Apply output voltage to Lx, Voltage required to produce FOSC×2	0.7	-	1.3	V
Efficiency	EFFI		-	85	-	%
Slow-Start Time	TSS		4.0	10.0	20.0	ms

NOTE: Unless otherwise stated, connect CE to VOUT, VIN=VOUT×0.6, IOUT=50mA. See Typical Application Circuits, Circuit 2.

*1: The Schottky diode (SD) must be type MA735, with reverse current (IR)<1.0μA at reverse voltage (VR)=10.0V.(XC6372C)

*2: "Supply Current 1" is the supply current while the oscillator is continuously oscillating. In actual operation the oscillator periodically operates which results in less average power consumption. The current actually provided by an external VIN source is represented by "No Load Input Current (IIN)".

*3: When PWM operates at PWM Mode.

*4: When PFM operates at PFM Mode.(XC6372C)

■ELECTRICAL CHARACTERISTICS (Continued)

XC6371/72E501PR VOUT=5.0V, FOSC=100kHz Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Output Voltage	VOUT		4.875	5.000	5.125	V
Maximum Input Voltage	VIN		10	-	-	V
Operation Start Voltage	VST1	External Components Connected, IOUT=1mA	-	-	0.90	V
Oscillation Start Voltage	VST2	No external components, Apply voltage to VOUT, Lx:10kΩ pull-up to 5V	-	-	0.80	V
No Load Input Voltage	IIN	VIN=VOUT×0.8, IOUT=0mA(*1)	-	12.8	25.7	μA
Supply Current 1	IDD1	Same as VST2, Apply output voltage×0.95 to VOUT	-	80.2	133.8	μA
Supply Current 2	IDD2	Same as VST2, Apply output voltage×1.1 to VOUT	-	8.2	16.5	μA
Lx Switch-On Resistance	RSWON	Same as IDD1, VLX=0.4V	-	1.4	2.4	Ω
Lx Leak Current	ILXL	No external components, VOUT =VLX=10V	-	-	1.0	μA
Oscillation Frequency	FOSC	Same as IDD1, Measuring of Lx waveform	85	100	115	kHZ
Maximum Duty Ratio	MAXDTY	Same as IDD1, Measuring of Lx waveform	80	87	92	%
PFM Duty Ratio (*4)	PFMDTY	Same as IDD1, Measuring of Lx waveform	10	17	25	%
Lx Limit Voltage	VLxLMT	Same as IDD1, Apply output voltage to Lx, Voltage required to produce FOSC×2	0.7	-	1.3	V
Efficiency	EFFI		-	85	-	%
Slow-Start Time	TSS		4.0	10.0	20.0	ms

NOTE: Unless otherwise stated, connect VDD to VOUT, VIN=VOUT×0.6, IOUT=50mA. See Typical Application Circuits, Circuit 3.

*1: The Schottky diode (SD) must be type MA2Q735, with reverse current (IR)<1.0μA at reverse voltage (VR)=10.0V.(XC6372E)

*2: "Supply current 1" is the supply current while the oscillator is continuously oscillating. In actual operation the oscillator periodically operates which results in less average power consumption. The current actually provided by external VIN source is represented by "No Load Input Current (IIN)".

*3: When PWM operates at PWM Mode.

*4: When PFM operates at PFM Mode.(XC6372E)

*5: When the VDD and VOUT pins are independently used, the voltage range at the VDD pin should be 2.2V to 10V. The IC operates from VDD=0.8V. However, output voltage and oscillation frequency are properly stabilized when VDD=2.2V or higher.

■ELECTRICAL CHARACTERISTICS (Continued)

XC6373A300PR V_{OUT}=3.0V, FOSC=30kHz

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	-	-	V
Operation Start Voltage	V_{ST1}	External Components Connected, I_{OUT}=1mA	-	-	0.90	V
Oscillation Start Voltage	V_{ST2}	No external components, Apply voltage to V_{OUT}, LX :10kΩ pull-up to 5V	-	-	0.80	V
Supply Current 1	I_{DD1}	Same as V_{ST2}. Apply output voltage × 0.95 to V_{OUT}	-	13.1	21.9	μA
Supply Current 2	I_{DD2}	Same as V_{ST2}, Apply output voltage × 1.1 to V_{OUT}	-	3.9	7.9	μA
Lx Switch-On Resistance	R_{SWON}	Same as I_{DD1}, V_{LX}=0.4V	-	3.4	5.7	Ω
Lx Leak Current	I_{LXL}	No external components, V_{OUT} =V_{LX}=10V	-	-	1.0	μA
Oscillation Frequency	FOSC	Same as I_{DD1}, Measuring of Lx waveform	24	30	36	kHZ
Maximum Duty Ratio	MAXDTY	Same as I_{DD1}, Measuring of Lx waveform	80	87	92	%
Efficiency	EFFI		-	77	-	%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	mS

NOTE: Unless otherwise stated, V_{IN}=V_{OUT} × 0.6, I_{OUT}=15mA. See Typical Application Circuits, Circuit 1.

XC6373A330PR V_{OUT}=3.3V, FOSC=30kHz

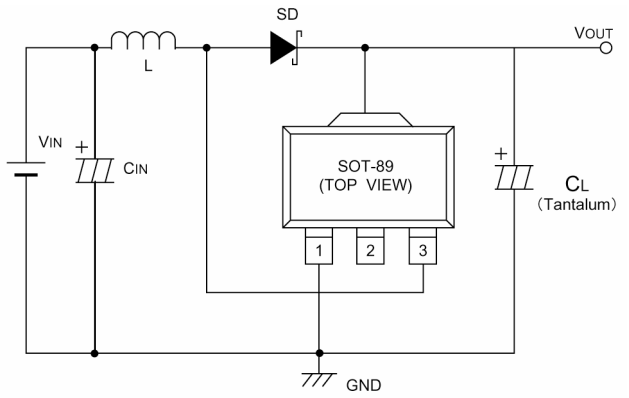
Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Output Voltage	V_{OUT}		3.128	3.300	3.383	V
Maximum Input Voltage	V_{IN}		10	-	-	V
Operation Start Voltage	V_{ST1}	External Components Connected, I_{OUT}=1mA	-	-	0.90	V
Oscillation Start Voltage	V_{ST2}	No external components, Apply voltage to V_{OUT}, LX :10kΩ pull-up to 5V	-	-	0.80	V
Supply Current 1	I_{DD1}	Same as V_{ST2}, Apply output voltage × 0.95 to V_{OUT}	-	14.1	23.5	μA
Supply Current 2	I_{DD2}	Same as V_{ST2}, Apply output voltage × 1.1 to V_{OUT}	-	4.0	8.1	μA
Lx Switch-On Resistance	R_{SWON}	Same as I_{DD1}. V_{LX}=0.4V	-	3.4	5.7	Ω
Lx Leak Current	I_{LXL}	No external components, V_{OUT} =V_{LX}=10V	-	-	1.0	μA
Oscillation Frequency	FOSC	Same as I_{DD1}, Measuring of Lx waveform	24	30	36	kHZ
Maximum Duty Ratio	MAXDTY	Same as I_{DD1}, Measuring of Lx waveform	80	87	92	%
Efficiency	EFFI		-	77	-	%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	mS

NOTE: Unless otherwise stated, V_{IN}=VOUT × 0.6, IOUT=16.5mA. See Typical Application Circuits, Circuit 1.

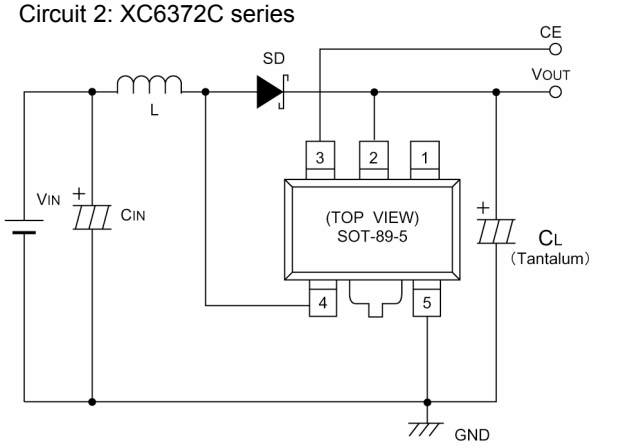
■TYPICAL APPRICATION CIRCUITS

Circuit 1: XC6372A series



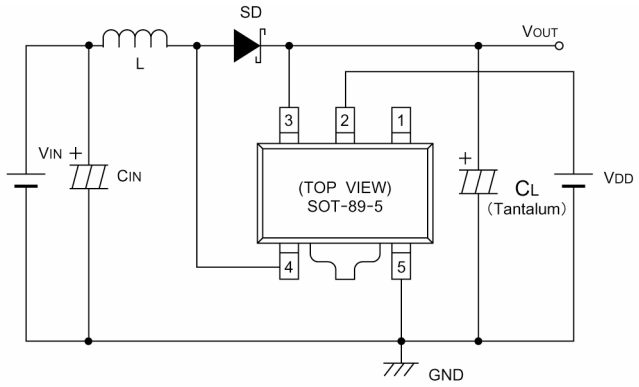
L : 100μH (SUMIDA, CR54)
SD : MA2Q735 (Schottky diode; MATSUSHITA)
CL : 16V 47μF (Tantalum capacitor, NICHICHEMI MCE)
CIN : 16V 220μF (Aluminium Electrolytic Capacitor)

Circuit 2: XC6372C series



L : 100μH (CR54, SUMIDA)
SD : MA2Q735 (Schottky Diode; MATUSHITA)
CL : 16V 47μF (Tantalum Capacitor, NICHICHEMI MCE)
CIN : 16V 220μF (Aluminium Electrolytic Capacitor)

Circuit 3: XC6372E series

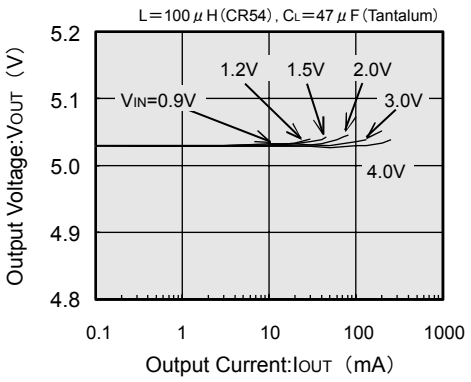


L : 100μH (CR54, SUMIDA)
SD : MA2Q735 (Schottky Diode; MATUSHITA)
CL : 16V 47μF (Tantalum Capacitor; NICHICHEMI MCE)
CIN : 16V 220μF (Aluminium Electrolytic Capacitor)

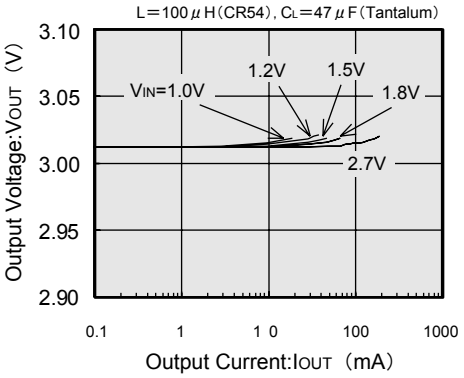
■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

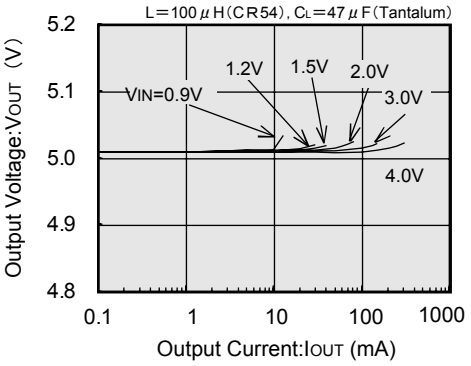
XC6371A501PR



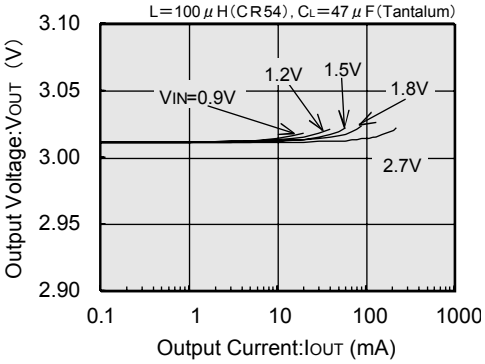
XC6371A301PR



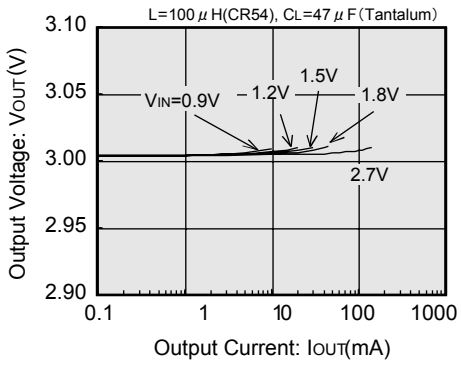
XC6372A501PR



XC6372A301PR



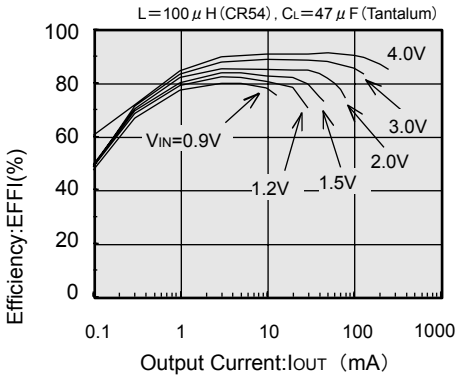
XC6373A300PR



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Efficiency vs. Output Current

XC6371A501PR



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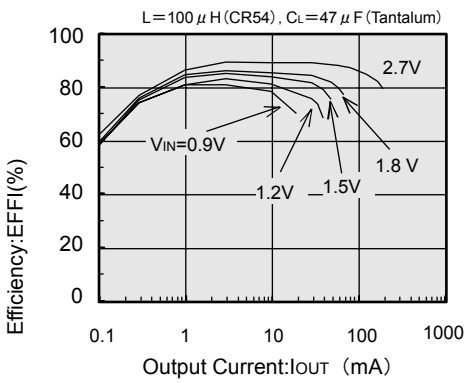

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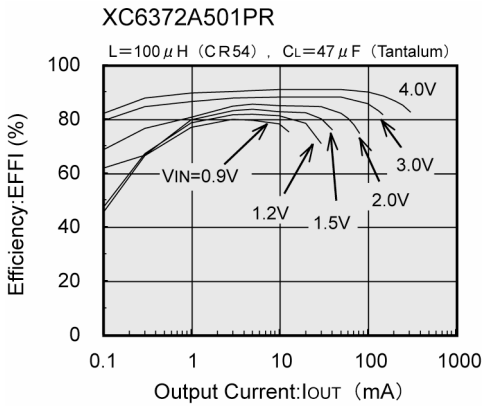

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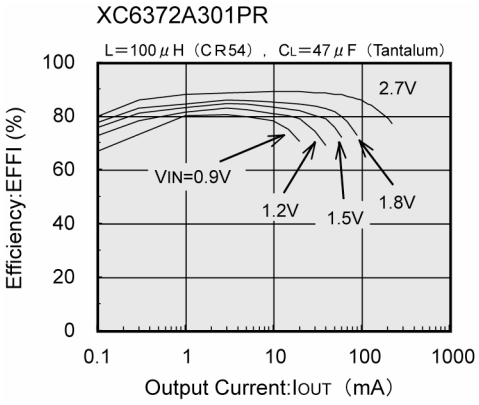

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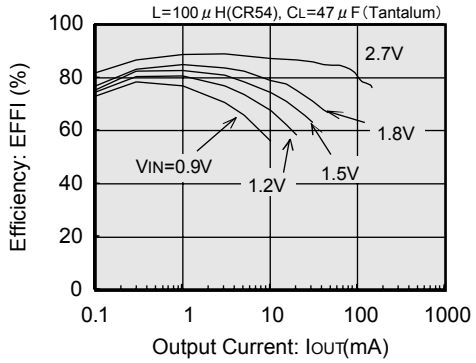
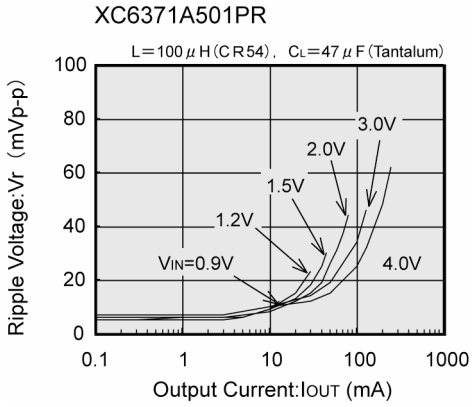


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Ripple Voltage vs. Output Current

XC6371A501PR



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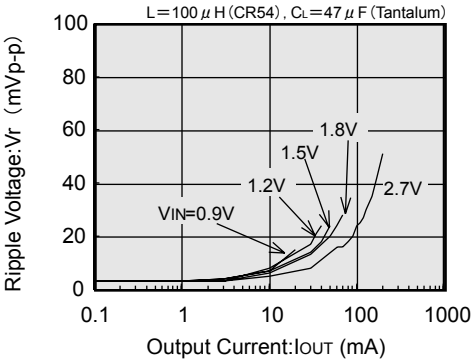

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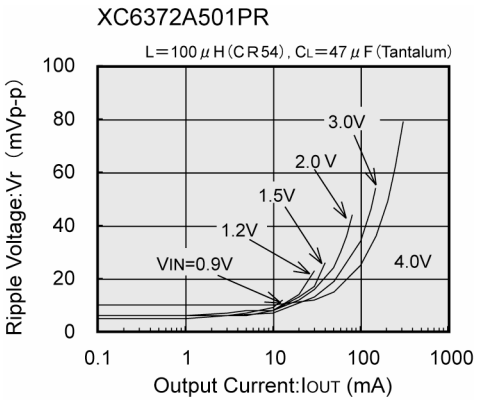

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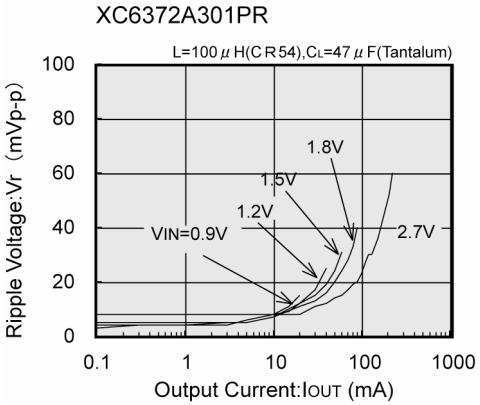

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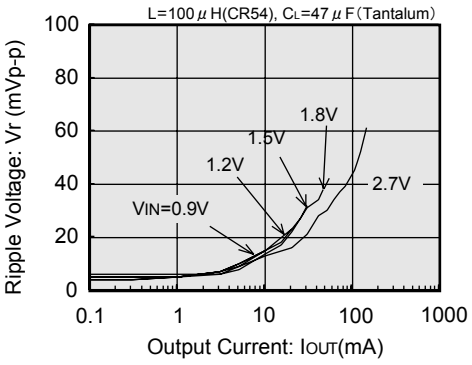
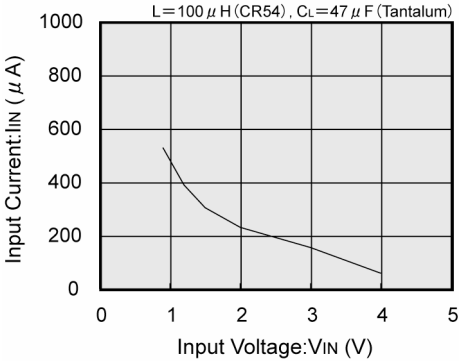


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(4) No Load Input Current vs. Input Voltage

XC6371A501PR



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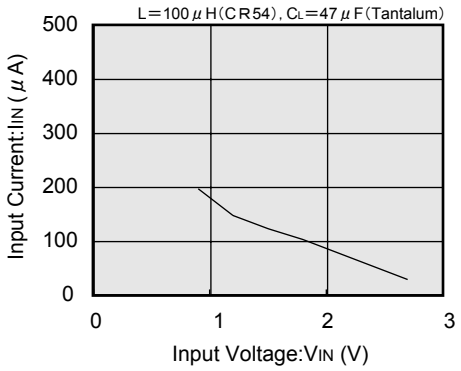

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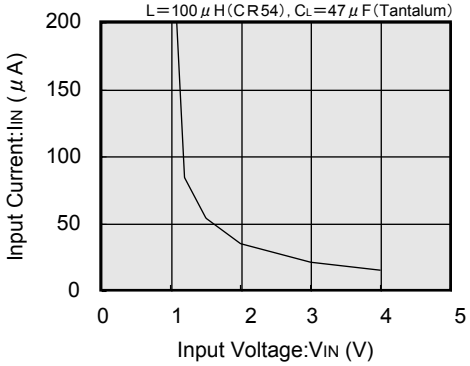

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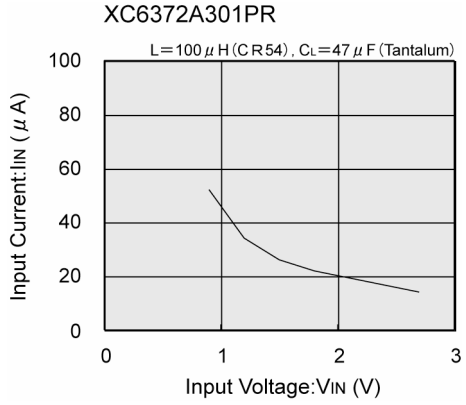

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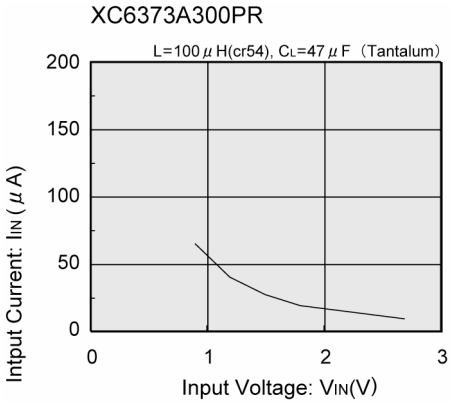
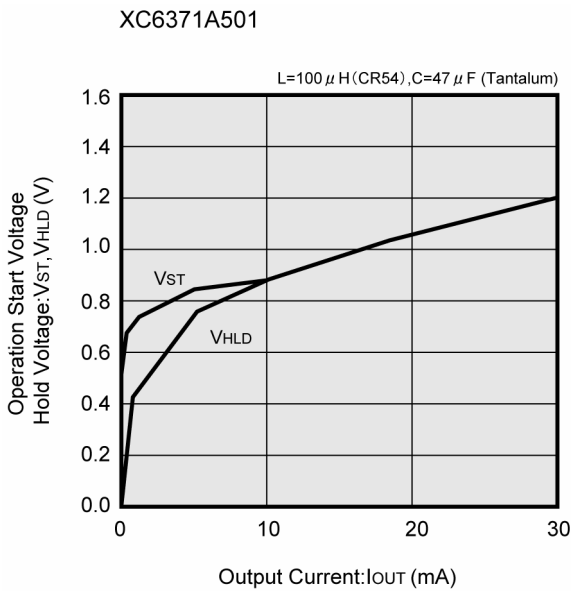
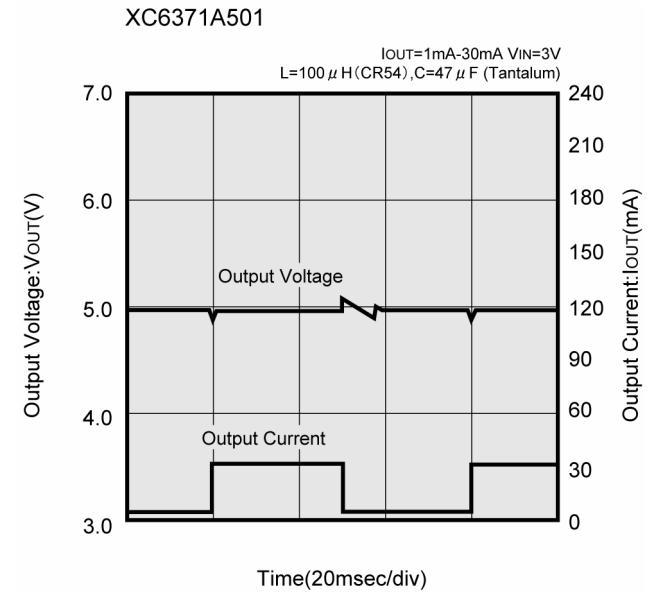


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5) Operation Start Voltage / Hold Voltage vs. Output Current

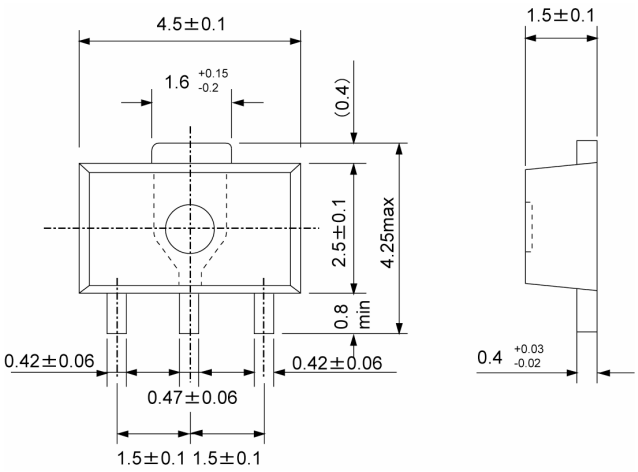


(6) Load Transient Response

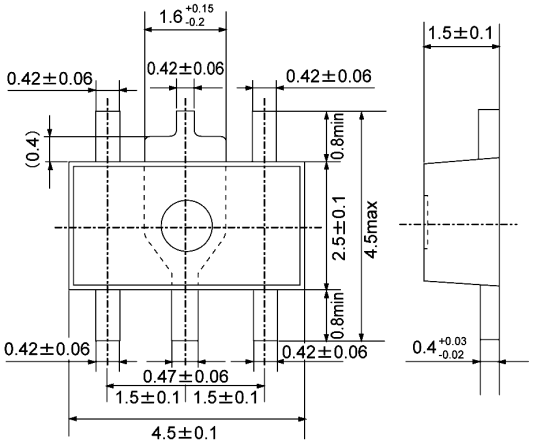


■PACKAGING INFORMATION

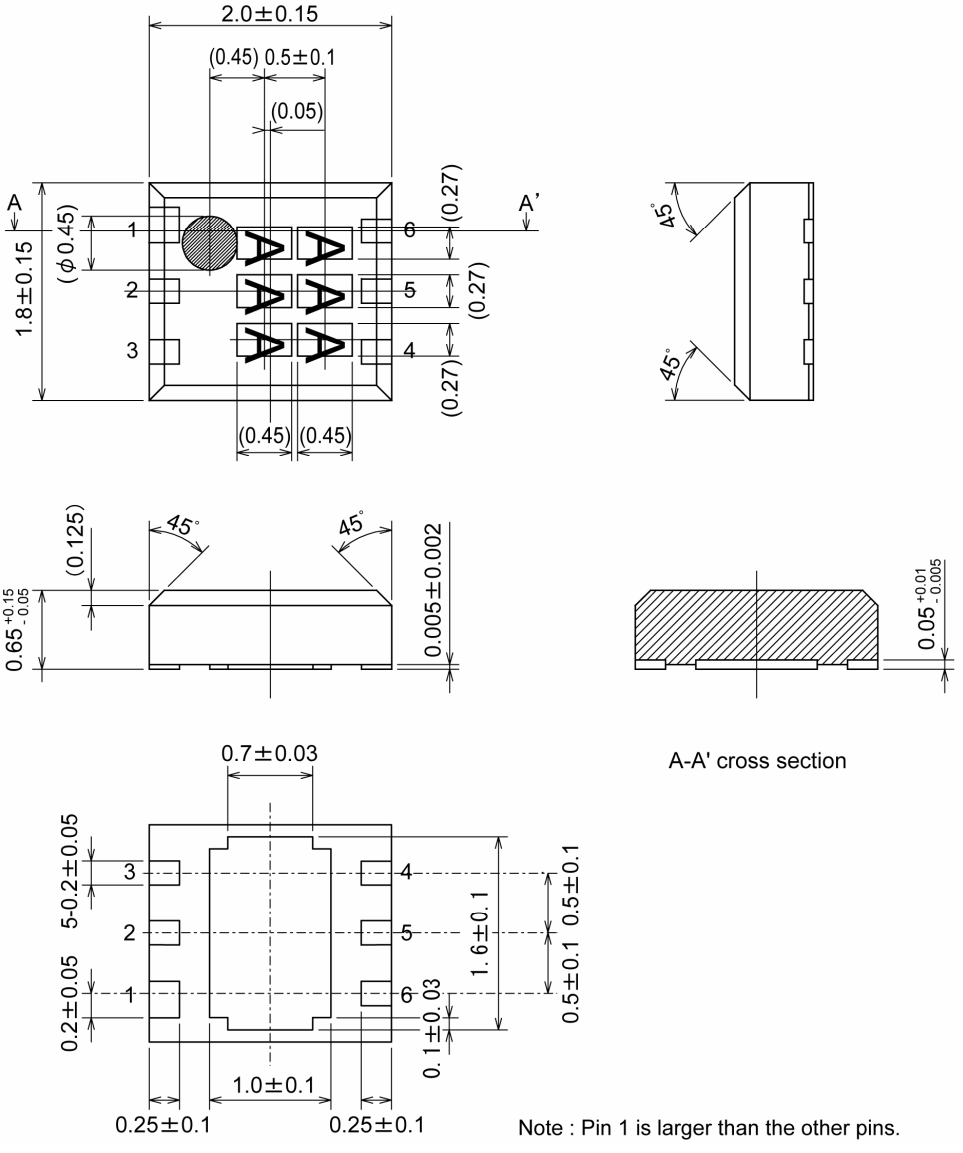
●SOT-89



●SOT-89-5



●USP-6B

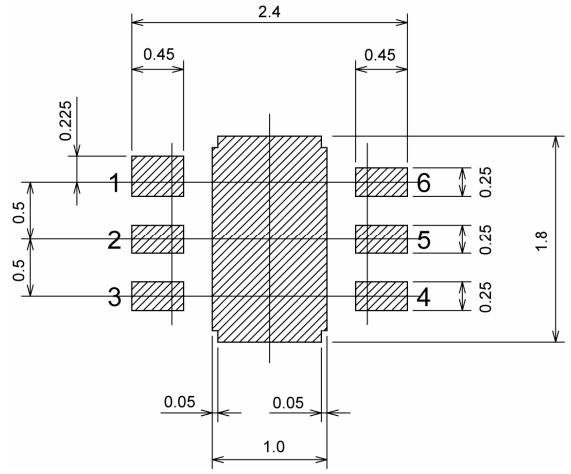


A-A' cross section

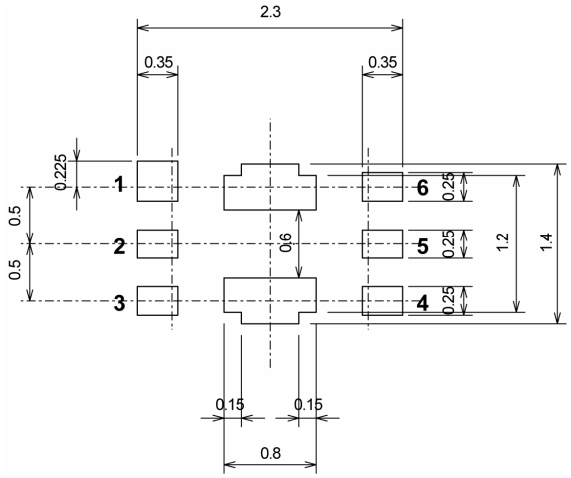
Note : Pin 1 is larger than the other pins.

■PACKAGING INFORMATION (Continued)

●USP-6B Recommended Pattern Layout



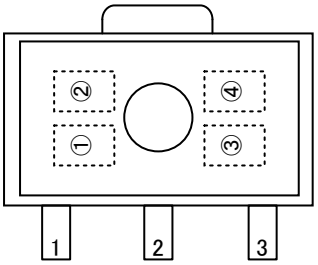
●USP-6B Recommended Metal Mask Design



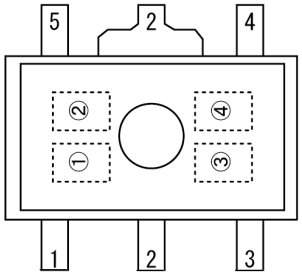
■MARKING RULE

[XC6371/72]

●SOT-89, SOT-89-5



SOT-89
(TOP VIEW)



SOT-89-5
(TOP VIEW)

① Represents product series

MARK	PRODUCT SERIES
$\overline{A}$	XC6371A
$\overline{A}$	XC6371C
$\overline{S}$	XC6371E

MARK	PRODUCT SERIES
$\overline{1}$	XC6372A
$\overline{1}$	XC6372C
$\overline{3}$	XC6372E

② Represents integer of output voltage and oscillation frequency

OUTPUT VOLTAGE (V)	OSCILLATION FREQUENCY		
	50kHz	100kHz	180kHz
1.x	B	1	1
2.x	C	2	2
3.x	F	3	3
4.x	E	4	4
5.x	F	5	5
6.x	H	6	6
7.x	K	7	7

③ Represents decimal number of output voltage and oscillation frequency

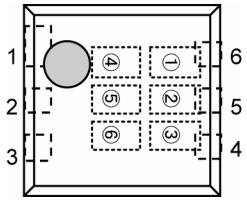
OUTPUT VOLTAGE (V)	OSCILLATION FREQUENCY		
	50kHz	100kHz	180kHz
x.0	0	0	A
x.1	1	1	B
x.2	2	2	C
x.3	3	3	D
x.4	4	4	E
x.5	5	5	F
x.6	6	6	H
x.7	7	7	K
x.8	8	8	L
x.9	9	9	M

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

■MARKING RULE (Continued)

[XC6371/72] (Continued)

●USP-6B



USP-6B
(TOP VIEW)

① Represents product series

MARK	PRODUCT SERIES
5	XC6371xxxxDx
2	XC6372xxxxDx

② Represents product classification

MARK	PRODUCT SERIES
A	XC6371A
C	XC6371C
E	XC6371E

③④ Represents output voltage (ex.)

MARK		OUTPUT VOLTAGE (V)
③	④	
3	3	3.3
5	0	5.0

⑤ Represents oscillation frequency

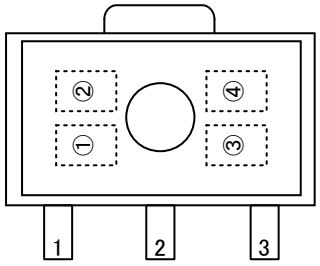
MARK	OSCILLATION FREQUENCY (kHz)
0	50
1	100
2	180

⑥ Represents production lot number
0 to 9, A to Z repeated (G, I, J, O, Q, W excepted)
Note: No character inversion used.

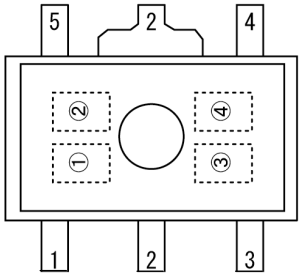
■MARKING RULE (Continued)

〔XC6373〕

●SOT-89,SOT-89-5



SOT-89
(TOP VIEW)



SOT-89-5
(TOP VIEW)

① Represents product series

MARK	FUNCTION		PRODUCT SERIES
A	-	Built-in Transistor	XC6372AxxxPx
A	CE	Built-in Transistor	XC6372CxxxPx
S	Separated V_{DD} and V_{OUT}	Built-in Transistor	XC6372ExxxPx

② Represents integer of output voltage and oscillation frequency

OUTPUT VOLTAGE (V)	OSCILLATION FREQUENCY (PRODUCT SERIES)
	30kHz (XC6373xxx0Px)
1.x	B
2.x	C
3.x	F
4.x	E
5.x	F
6.x	H
7.x	K

③ Represents decimal number of output voltage and oscillation frequency

OUTPUT VOLTAGE (V)	OSCILLATION FREQUENCY (PRODUCT SERIES)
	30kHz (XC6373xxx0Px)
x.0	0
x.1	1
x.2	2
x.3	3
x.4	4
x.5	5
x.6	6
x.7	7
x.8	8
x.9	9

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

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