

- ◆ **CMOS Low Power Consumption**
- ◆ **Operating Voltage: 0.9V~10.0V**
- ◆ **Output Voltage Range: 2.0V~7.0V**
- ◆ **Output Voltage Accuracy: $\pm 2.5\%$**
- ◆ **Selectable Oscillator Frequency:
(50kHz, 100kHz, 180kHz)**

■ Applications

- Cellular phones, pagers
- Palmtops
- Cameras, video recorders
- Portable equipment

■ General Description

The XC6372 series, unlike the conventional PWM controlled converters, are a group of step-up DC/DC converters that automatically change their operation modes into PFM modes while loads are light, such as when the duty ratios are less than 10%.

When loads are light, as in the stand-by mode, the XC6372 changes to PFM control so as to decrease oscillator frequencies, resulting in reduced supply current.

Therefore, the XC6372 is suitable for use with portable equipment that requires the PWM controlled performance of low ripple and high output current, and a supply current that varies between low and high. Built-in proprietary phase compensation and slow start-up circuits ensure excellent transient response and improved performance.

Output voltage can be selected from 2.0V to 7.0V in 0.1V increments (accuracy: $\pm 2.5\%$). Oscillator frequency is also selectable from three frequencies; 50, 100, and 180kHz (accuracy: $\pm 15\%$).

Every built-in switching transistor type enables a step-up circuit to be configured using only three external components; a coil, a diode, and a capacitor. External transistor versions are available to accommodate high output current applications.

SOT-89 small package.

■ Features

Operating (start-up) voltage range: 0.9V~10V

Output voltage range: 2.0V~7.0V in 0.1V increments

Highly accurate: Set-up voltage $\pm 2.5\%$

Oscillator frequency: 50kHz, 100kHz, 180kHz ($\pm 15\%$) selectable

Maximum output currents (Tr built-in): Typ.100mA

at $V_{IN}=3.0, V_{OUT}=5.0V$Note(1)

Highly efficient (Tr built-in): Typ.85%

at $V_{IN}=3.0V, V_{OUT}=5.0V$Note(1)

Both switching transistor built-in and external Tr types are available.

Five-lead packaged units offer either Chip Enable or independent Vout pin option.

Phase compensation and slow startup circuits included.

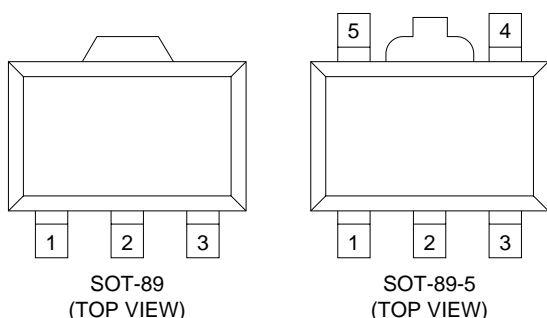
Small package: SOT-89 mini-power mold (3-pin, 5-pin)

Note(1): Performance depends on external components and PCB layout.

■ Selection Guide

PART TYPE	OPERATION MODE	PACKAGE	SWITCHING RELATED	ADDITIONAL FUNCTION	FEATURES
XC6372A	PWM/PFM	SOT-89-3	Built-in Transistor "Lx"lead	-----	<ul style="list-style-type: none"> • Switching transistor incorporated standard type. • PFM operation during light loads.
XC6372B	PWM/PFM	SOT-89-3	External Transistor "EXT"lead	-----	<ul style="list-style-type: none"> • External switching transistor standard type. • Adding external transistor can improve the output capability up to several hundred mA.
XC6372C	PWM/PFM	SOT-89-5	Built-in Transistor "Lx"lead	Chip Enable(CE)	<ul style="list-style-type: none"> • Stand-by (CE) function added version to the XC6372A • Stand-by current: 0.5μA max.
XC6372D	PWM/PFM	SOT-89-5	External Transistor "EXT"lead	Chip Enable(CE)	<ul style="list-style-type: none"> • Stand-by (CE) function added version to the XC6372B • Stand-by current: 0.5μA max.
XC6372E	PWM/PFM	SOT-89-5	Built-in Transistor "Lx"lead	Separated "VDD"and"Vout"leads	<ul style="list-style-type: none"> • Individual power supply and set-up voltage sensing leads are available
XC6372F	PWM/PFM	SOT-89-5	External Transistor "EXT"lead	Separated "VDD"and"Vout"leads	<ul style="list-style-type: none"> • Individual power supply and set-up voltage sensing leads are available.

Pin Configuration



3

Pin Assignment

(XC6372A, C6372B)

PIN NUMBER		PIN NAME	FUNCTION
XC6372A	XC6372B		
1	1	V _{SS}	Ground
2	2	V _{OUT}	Output voltage monitor / IC internal power supply
3	–	L _x	Switch
–	3	EXT	External switch transistor drive

(XC6372C, C6372D)

PIN NUMBER		PIN NAME	FUNCTION
XC6372C	XC6372D		
5	5	V _{SS}	Ground
2	2	V _{OUT}	Output voltage monitor / IC internal power supply
4	–	L _x	Switch
–	4	EXT	External switch transistor drive
3	3	CE	Chip Enable
1	1	NC	No Connection

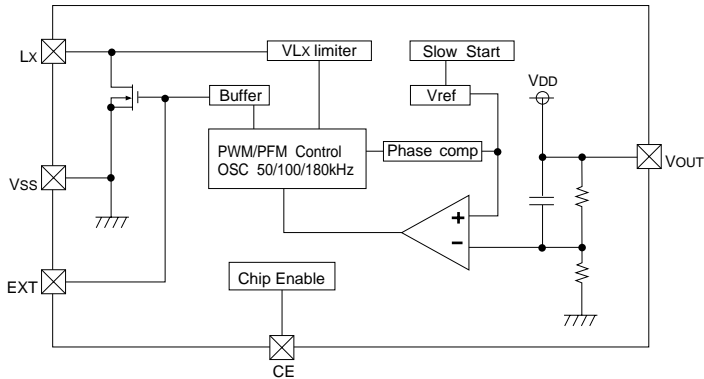
(XC6372E, C6372F)

PIN NUMBER		PIN NAME	FUNCTION
XC6372E	XC6372F		
5	5	V _{SS}	Ground
2	2	V _{DD}	IC internal power supply
4	–	L _x	Switch
–	4	EXT	External switch transistor drive
3	3	V _{OUT}	Output voltage monitor
1	1	NC	No Connection

Block Diagram

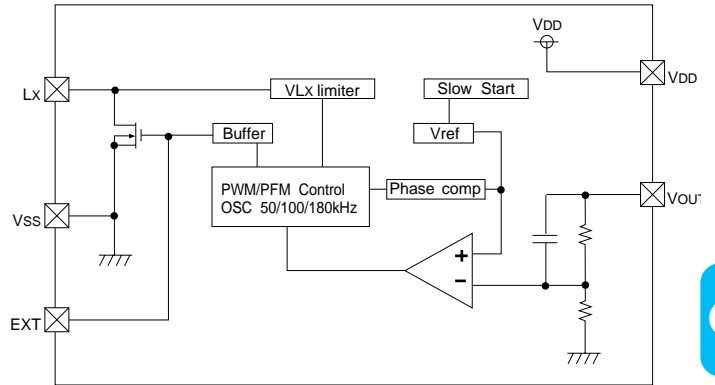
XC6372A~XC6372D

(V_{OUT} pin serves also as V_{DD}.)



- Note: 1. Built-in transistor type units use the Lx pin.
External transistor type units use the EXT pin.
2. The CE pin is only used with the XC6372C and XC6372D.

XC6372E and XC6372F



- Note: 1. The V_{DD} pin is only used with the XC6372E and XC6372F.
2. Built-in transistor type units use the Lx pin.
External transistor type units use the EXT pin.

3

Absolute Maximum Ratings

T_a=25°C

PARAMETER	SYMBOL	RATINGS	UNITS
V _{OUT} Input Voltage	V _{OUT}	12	V
Lx pin Voltage	V _{LX}	12	V
Lx pin Current	I _{LX}	400	mA
EXT pin Voltage	V _{EXT}	V _{SS} -0.3~V _{OUT} +0.3	V
EXT pin Current	I _{EXT}	±50	mA
CE Input Voltage	V _{CE}	12	V
V _{DD} Input Voltage	V _{DD}	12	V
Continuous Total Power Dissipation	P _d	500	mW
Operating Ambient Temperature	T _{opr}	-30~+80	°C
Storage Temperature	T _{stg}	-40~+125	°C

Electrical Characteristics

XC6372A501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		4.875	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected. $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
		$L_x:10k\Omega$ pull-up to 5V.				
No Load Input Current	I_{IN}	$V_{IN}=V_{OUT}\times 0.8, I_{OUT}=0mA$ (Note1)		12.8	25.7	μA
Supply Current 1 (Note2)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		80.2	133.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ to V_{OUT} .		8.2	16.5	μA
L_x Switch-On Resistance	R_{SWON}	Same as I_{DD1} . $V_{Lx}=0.4V$.		1.4	2.4	Ω
L_x Leakage Current	I_{LXL}	No external components. $V_{OUT}=V_{Lx}=10V$.			1.0	μA
Oscillator Frequency(Note 3)	F_{OSC}	Same as I_{DD1} . Measuring of L_x waveform.	85	100	115	kHz
Maximum Duty Ratio	MAXDTY	Same as I_{DD1} . Measuring of L_x waveform.	80	87	92	%
PFM Duty Ratio(Note 4)	PFMDTY	Same as I_{DD1} . Measuring of L_x waveform.	10	17	25	%
L_x Limit Voltage	V_{LxLMT}	Same as I_{DD1} . Apply output voltage to L_x .	0.7		1.3	V
		Voltage required to produce $F_{OSC} \times 2$.				
Efficiency	EFFI			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, $V_{IN}=V_{OUT}\times 0.6, I_{OUT}=50mA$. See Typical Application Circuits, Fig.1.

Note: 1. The Schottky diode (SD) must be type MA735, with reverse current (I_R) $<1.0\mu A$ at reverse voltage (V_R)=10.0V

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.

4. When PFM operates.

XC6372B501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		4.875	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected. $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
Supply Current 1 (Note1)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		40.0	66.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ to V_{OUT} .		8.2	16.5	μA
EXT "High" On Resistance	R_{EXTH}	Same as I_{DD1} . $V_{EXT}=-0.4V$.		37.5	62.5	Ω
EXT "Low" On Resistance	R_{EXTL}	Same as I_{DD1} . $V_{EXT}=0.4V$.		30	50	Ω
Oscillator Frequency (Note 2)	F_{OSC}	Same as I_{DD1} . Measuring of EXT waveform.	85	100	115	kHz
Maximum Duty Ratio	MAXDTY	Same as I_{DD1} . Measuring of EXT waveform.	80	87	92	%
PFM Duty Ratio (Note 3)	PFMDTY	Same as I_{DD1} . Measuring of EXT waveform.	10	17	25	%
Efficiency	EFFI			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, $V_{IN}=V_{OUT}\times 0.6, I_{OUT}=50mA$. See Typical Application Circuits, Fig.2.

Note: 1. "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.

2. When PWM operates.

3. When PFM operates.

Electrical Characteristics

XC6372C501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		4.875	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected. $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
		Lx: 10k Ω pull-up to 5V.				
No Load Input Current	I_{IN}	$V_{IN}=V_{OUT} \times 0.8, I_{OUT}=0mA$ (Note1)		12.8	25.7	μA
Supply Current 1 (Note2)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		80.2	133.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ 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 Leakage Current	I_{LXL}	No external components. $V_{OUT}=V_{Lx}=10V$.			1.0	μA
Oscillator Frequency(Note 3)	F_{OSC}	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(Note 4)	$PFMDTY$	Same as I_{DD1} . Measuring of Lx waveform.	10	17	25	%
Stand-by Current	I_{STB}	Same as I_{DD1} .			0.5	μA
CE"High" Voltage	V_{CEH}	Same as I_{DD1} .	0.75			V
CE"Low" Voltage	V_{CEL}	Same as I_{DD1} .			0.20	V
CE"High" Current	I_{CEH}	Same as I_{DD1} . $V_{CE}=V_{OUT} \times 0.95$			0.25	μA
CE"Low" Current	I_{CEL}	Same as I_{DD1} . $V_{CE}=0V$.			-0.25	μA
Lx Limit Voltage	V_{LxLMT}	Same as I_{DD1} . Apply output voltage to Lx.	0.7		1.3	V
		Voltage required to produce $F_{OSC} \times 2$.				
Efficiency	$EFFI$			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, connect CE to V_{OUT} , $V_{IN}=V_{OUT} \times 0.6$, $I_{OUT}=50mA$. See Typical Application Circuits, Fig.3.

Note: 1. The Schottky diode (SD) must be type MA735, with reverse current (I_R) < 1.0 μA at reverse voltage (V_R) =10.0V

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.

4. When PFM operates.

Electrical Characteristics

XC6372D501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		4.875	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected. $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
Supply Current 1 (Note1)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		40.0	66.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ to V_{OUT} .		8.2	16.5	μA
EXT"High" On Resistance	R_{EXTH}	Same as I_{DD1} . $V_{EXT}=-0.4V$		37.5	62.5	Ω
EXT"Low" On Resistance	R_{EXTL}	Same as I_{DD1} . $V_{EXT}=0.4V$		30	50	Ω
Oscillator Frequency (Note2)	F_{OSC}	Same as I_{DD1} . Measuring of EXT waveform.	85	100	115	kHz
Maximum Duty Ratio	$MAXDTY$	Same as I_{DD1} . Measuring of EXT waveform.	80	87	92	%
PFM Duty Ratio (Note3)	$PFMDTY$	Same as I_{DD1} . Measuring of EXT waveform.	10	17	25	%
Stand-by Current	I_{STB}	Same as I_{DD1} .			0.5	μA
CE"High" Voltage	V_{CEH}	Same as I_{DD1} .	0.75			V
CE"Low" Voltage	V_{CEL}	Same as I_{DD1} .			0.20	V
CE"High" Current	I_{CEH}	Same as I_{DD1} . $V_{CE}=V_{OUT}\times 0.95$.			0.25	μA
CE"Low" Current	I_{CEL}	Same as I_{DD1} . $V_{CE}=0V$.			-0.25	μA
Efficiency	$EFFI$			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, connect CE to V_{OUT} , $V_{IN}=V_{OUT}\times 0.6$, $I_{OUT}=50mA$ See Typical Application Circuits, Fig.4.

Note: 1. "Supply Current 1" is the current while the oscillator is continuously oscillating. In an actual operation the oscillator periodically operates which results in less average power consumption.

2. When PWM operates.

3. When PFM operates.

Electrical Characteristics

XC6372E501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		48.75	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected, $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
No Load Input Voltage	I_{IN}	$V_{IN}=V_{OUT} \times 0.8, I_{OUT}=0mA$ (Note1)		12.8	25.7	μA
Supply Current 1(Note2)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		80.2	133.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ to V_{OUT} .		8.2	16.5	μA
Lx Switch-On Resistance	R_{SWON}	Same as I_{DD1} . $V_{OUT}=V_{LX}=0.4V$.		1.4	2.4	Ω
Lx Leakage Current	I_{LXL}	No external components. $V_{OUT}=V_{LX}=10V$.			1.0	μA
Oscillator Frequency(Note 3)	F_{OSC}	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(Note 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.	0.7		1.3	V
		Voltage required to produce $F_{OSC} \times 2$.				
Efficiency	$EFFI$			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, connect V_{DD} to V_{OUT} . $V_{IN}=V_{OUT} \times 0.6$, $I_{OUT}=50mA$. See Typical Application Circuits, Fig.5.

Note: 1. The Schottky diode (SD) must be type MA735, with reverse current (I_R) $<1.0\mu A$ at reverse voltage (V_R)=10.0V

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 V_{IN} source is represented by "No-Load Input Current (I_{IN})".

3. When PWM operates.

4. When PFM operates.

※When the V_{DD} and V_{OUT} pins are independently used, the voltage range at the V_{DD} pin should be 2.2V to 10V.

The IC operates from $V_{DD}=0.8V$. However, output voltage and oscillator frequency are properly stabilized when $V_{DD}=2.2V$ or higher.

XC6372F501PR $V_{OUT}=5.0V, F_{OSC}=100kHz$

$T_a=25^{\circ}C$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}		48.75	5.000	5.125	V
Maximum Input Voltage	V_{IN}		10			V
Operation Start-up Voltage	V_{ST1}	External Components Connected. $I_{OUT}=1mA$.			0.90	V
Oscillation Start-up Voltage	V_{ST2}	No external components. Apply voltage to V_{OUT} .			0.80	V
Supply Current 1(Note1)	I_{DD1}	Same as V_{ST2} . Apply output voltage $\times 0.95$ to V_{OUT} .		40.0	66.8	μA
Supply Current 2	I_{DD2}	Same as V_{ST2} . Apply output voltage $\times 1.1$ to V_{OUT} .		8.2	16.5	μA
EXT "High" On Resistance	R_{EXTH}	Same as I_{DD1} . $V_{EXT}=V_{OUT}-0.4V$		37.5	62.5	Ω
EXT "Low" On Resistance	R_{EXTL}	Same as I_{DD1} . $V_{EXT}=0.4V$		30	50	Ω
Oscillator Frequency(Note2)	F_{OSC}	Same as I_{DD1} . Measuring of EXT waveform.	85	100	115	kHz
Maximum Duty Ratio	$MAXDTY$	Same as I_{DD1} . Measuring of EXT waveform.	80	87	92	%
PFM Duty Ratio(Note3)	$PFMDTY$	Same as I_{DD1} . Measuring of EXT waveform.	10	17	25	%
Efficiency	$EFFI$			85		%
Slow-Start Time	T_{SS}		4.0	10.0	20.0	ms

Measuring conditions: Unless otherwise specified, connect V_{DD} to V_{OUT} . $V_{IN}=V_{OUT} \times 0.6$, $I_{OUT}=50mA$. See Typical Application Circuits, Fig.6.

Note: 1. "Supply Current 1" is the supply current while the oscillator is continuously oscillating. In an actual operation the oscillator periodically operates which results in less average power consumption.

2. When PWM operates.

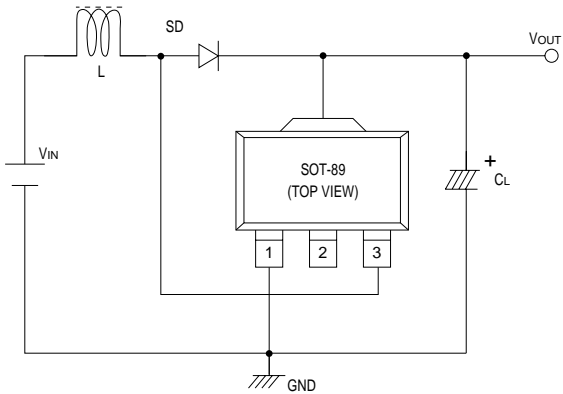
3. When PFM operates.

※When the V_{DD} and V_{OUT} pins are independently used, the voltage range at the V_{DD} pin should be 2.2V to 10V.

The IC operates from $V_{DD}=0.8V$. However, output voltage and oscillator frequency are properly stabilized when $V_{DD}=2.2V$ or higher.

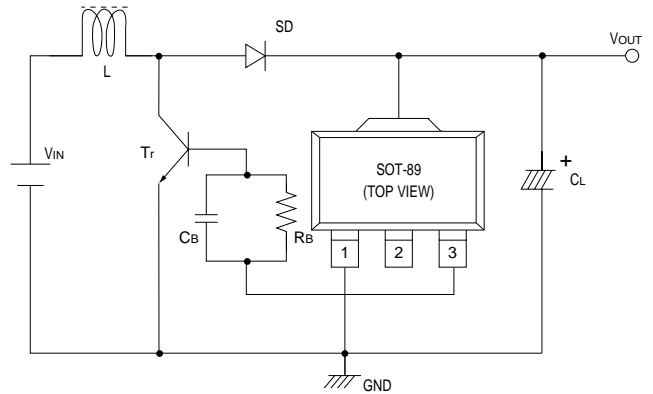
Typical Application Circuits

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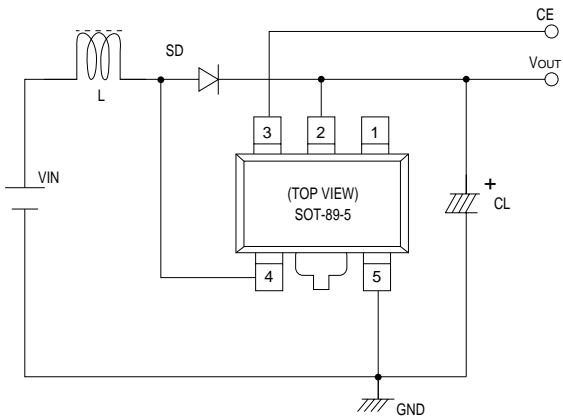
- L: 100 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)

[Fig-1] XC6372A Application



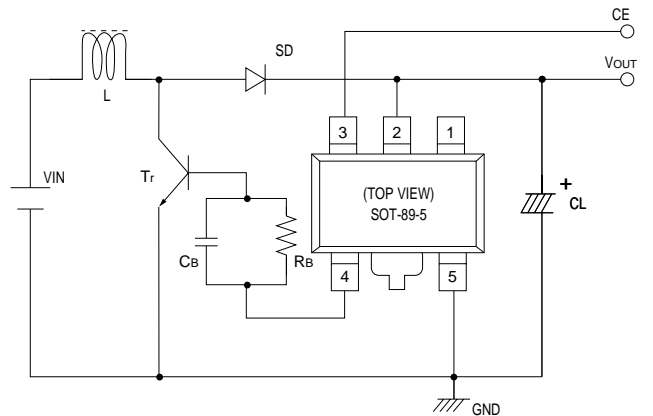
- L: 47 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)
- RB: 1k Ω , CB:3300pF (Fosc=100kHz)
- Tr: 2SC3279, 2SD1628G

[Fig-2] XC6372B Application



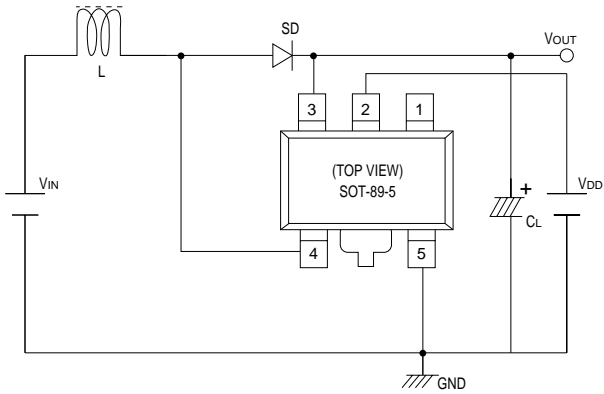
- L: 100 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)

[Fig-3] XC6372C Application



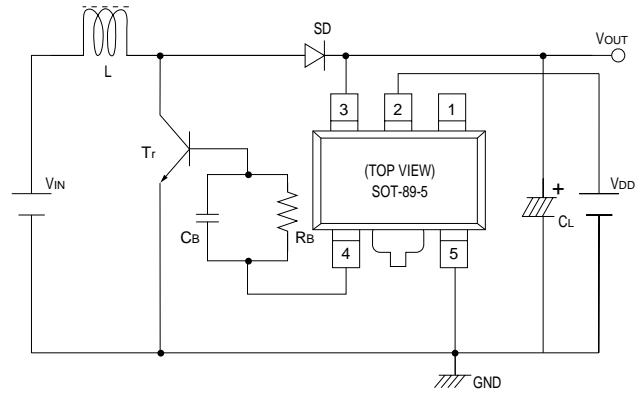
- L: 47 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)
- RB: 1k Ω , CB:3300pF (Fosc=100kHz)
- Tr: 2SC3279, 2SD1628G

[Fig-4] XC6372D Application



- L: 100 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)

[Fig-5] XC6372E Application

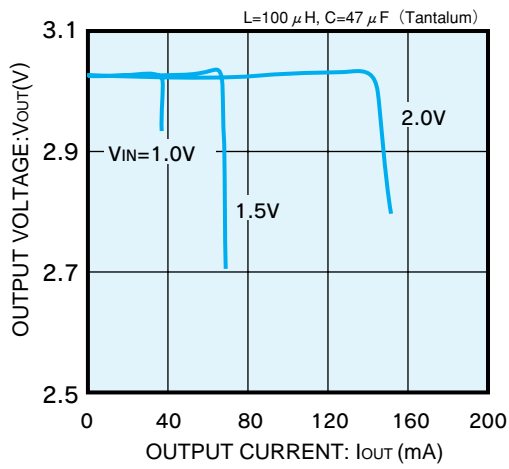


- L: 47 μ H (SUMIDA, CD-54)
- SD: MA735 (Schottky diode; MATSUSHITA)
- CL: 16V 47 μ F (Tantalum capacitor, NICHICON, F93)
- R: 1k Ω , CB:3300pF ($F_{osc}=100$ kHz)
- Tr: 2SC3279, 2SD1628G

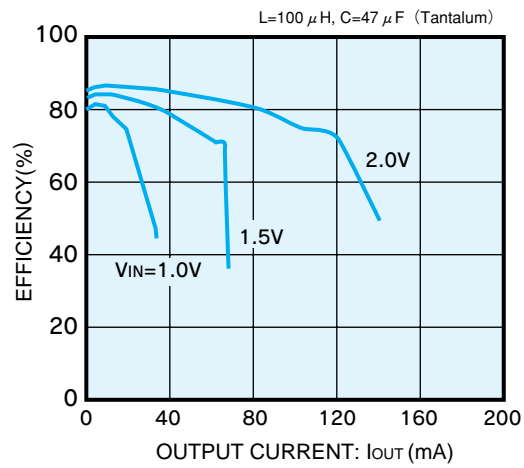
[Fig-6] XC6372F Application

Electrical Characteristics

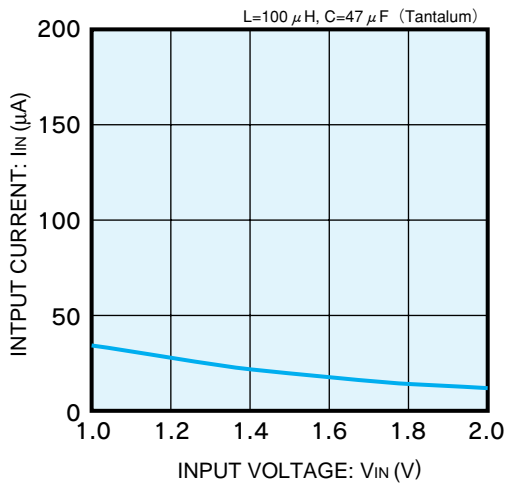
XC6372A301



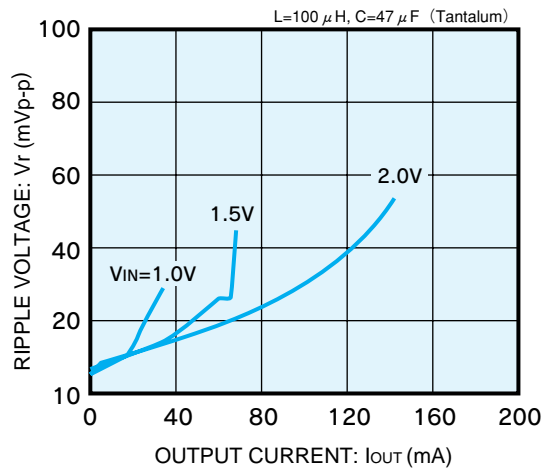
XC6372A301



XC6372A301



XC6372A301



Note: Please refer to the XC6371 series application notes for more detailed information and data (www.torex.co.jp)