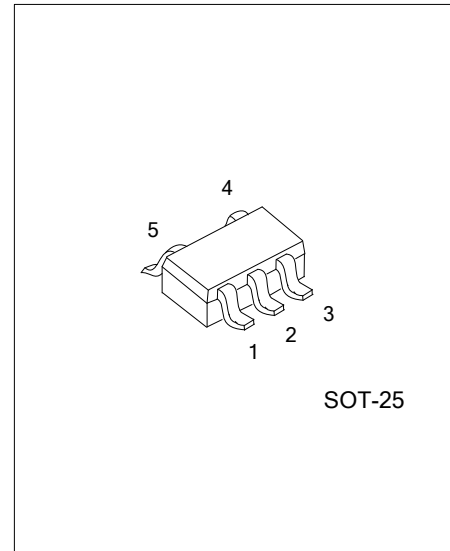




## UC3550

CMOS IC

### PWM CONTROLLED, PWM/PFM SWITCHABLE STEP-UP DC-DC CONTROLLER



#### DESCRIPTION

The UTC **UC3550** series is a compact, high efficiency, step-up DC/DC controllers includes an error amplifier, oscillator, PWM comparator, skip cycle comparator, voltage reference, soft-start, and high speed lower ON-resistance driver for driving external power devices (NMOS or NPN) ,Additionally, a CE (chip enable) function that reduces power consumption during shut-down mode.

That typically operated from a single-or dual-cell battery packs. It have a driver pin ,ext pin, for connecting to an external transistor(NMOS or NPN). a lower ON-resistance external transistor can obtain larger output current. With only external components, this series allow a simple means to accommodate high output current applications.

The UTC **UC3550** series goes automatically into skip switching cycles under light load condition to maintain high efficiency.

#### FEATURES

- \* Input Voltage Range: 0.9~8V
- \* Output Voltage Range: 1.8~6V Programmable in 0.1V with High Accuracy  $\pm 2.5\%$
- \* High Efficiency 88% (Typ.)
- \* Low Start-up Voltage of 0.9V Typical at  $I_{OUT} = 1.0mA$
- \* Oscillator Frequency: 300kHz.( $\pm 20\%$ )
- \* Chip Enable Pin with Pull-up Current Source
- \* High Output Current up to 1000mA ( $V_{IN} = 2.0V, V_{OUT} = 3.3V$ )

#### ORDERING INFORMATION

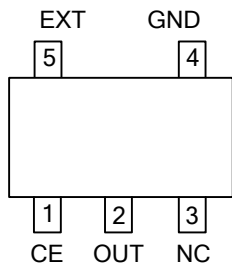
Ordering Number		Package	Packing
Lead Free	Halogen Free		
UC3550L-xx-AF5-R	UC3550G-xx-AF5-R	SOT-25	Tape Reel

<p>UC3550L-xx-AF5-R</p> <p>(1)Packing Type (2)Package Type (3)Voltage Code (4)Lead Free</p>	<p>(1) R: Tape Reel (2) AF5: SOT-25 (3) xx: reference to Marking Information (4) G: Halogen Free, L: Lead Free</p>
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MARKING INFORMATION

PACKAGE	VOLTAGE CODE	MARKING
SOT-25	33:3.3V 36:3.6V 37:3.7V 50:5.0V	

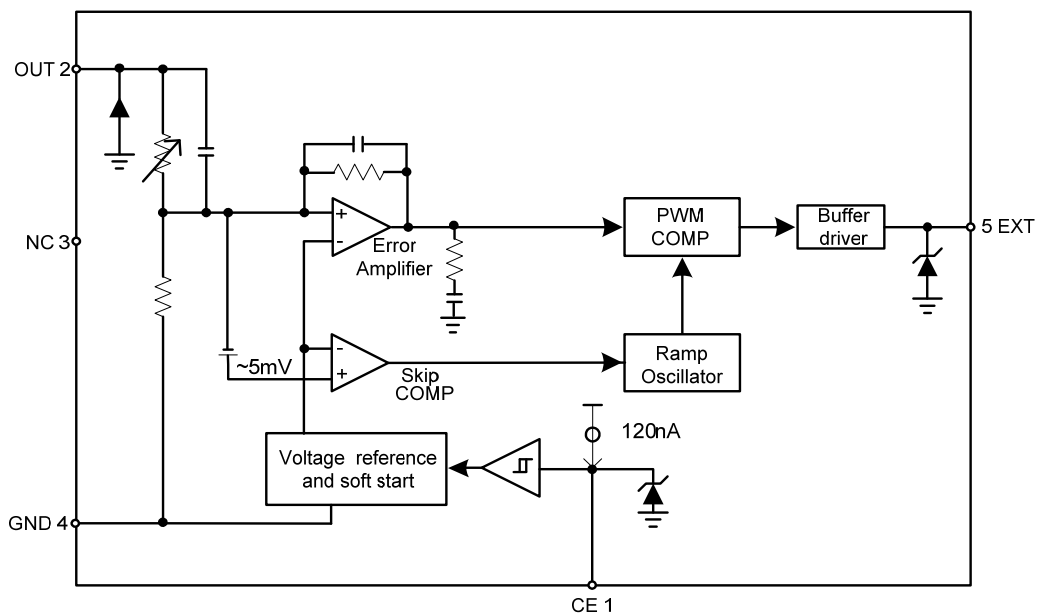
PIN CONFIGURATION



PIN DESCRIPTION

PIN NO	PIN NAME	DESCRIPTION
1	CE	Chip Enable: The chip is enabled if a voltage equal to or greater than 1.0V or left floating is applied. The chip is disabled if a voltage less than 0.3V is applied.
2	OUT	Output voltage monitor, IC internal power supply
3	NC	No connection
4	GND	Ground
5	EXT	External transistor drive

BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	$V_{OUT}$	-0.3~8	V
EXT Voltage	$V_{EXT}$	-0.3 ~ 8	V
EXT Sink/Source Current	$I_{EXT}$	-150 ~ +150	mA
CE Input Voltage Range	$V_{CE}$	-0.3 ~ 12.0	V
CE Input Current Range	$I_{CE}$	-155 ~ 155	mA
Power Dissipation ( $T_a=25^{\circ}C$ )	$P_D$	500	mW
Junction Temperature	$T_J$	+150	$^{\circ}C$
Operating Temperature	$T_{OPR}$	-40 ~ +85	$^{\circ}C$
Storage Temperature	$T_{STG}$	-55 ~ +150	$^{\circ}C$

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	$\theta_{JA}$	250	$^{\circ}C/W$

## ■ ELECTRICAL CHARACTERISTICS ( $T_A=25^{\circ}C$ , $f_{OSC}=300kHz$ , unless otherwise specified)

### UC3550-3.3V

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>OSCILLATOR</b>							
Frequency	$f_{OSC}$	$V_{OUT}=V_{SET}\times 0.96$	240	300	360	kHz	
Frequency Temperature Coefficient	$\Delta f$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		0.10		%/ $^{\circ}C$	
Maximum PWM Duty Cycle	$D_{MAX}$	$V_{OUT}=V_{SET}\times 0.96$	70	80	90	%	
Minimum Start-up Voltage	$V_{START1}$	$I_{OUT}=0mA$		800	900	mV	
Minimum Start-up Voltage	$V_{START2}$	$I_{OUT}=1mA$		900	1000	mV	
Minimum Start-up Voltage Temperature Coefficient	$\Delta V_{START}$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		-1.6		mV/ $^{\circ}C$	
Minimum Operation Hold Voltage	$V_{OPR}$	$I_{OUT}=0mA$		600	700	mV	
Soft-Start Time	$t_{SS}$	$V_{OUT}=V_{SET}$		60	250	ms	
<b>CE (PIN 1)</b>							
CE Input Voltage :							
High State, Device Enabled	$V_{CEH}$	$V_{OUT}=V_{SET}\times 0.96$	900			mV	
Low State, Device Disabled	$V_{CEL}$				680	mV	
CE Input Current :							
High State, Device Enabled	$I_{CEH}$	$V_{OUT}=V_{CE}=5.0V$	-0.5	0	0.5	$\mu A$	
Low State, Device Disabled	$I_{CEL}$	$V_{OUT}=5.0V, V_{CE}=0V$	0	0.15	0.5	$\mu A$	
<b>EXT (PIN 5)</b>							
ON Resistance	EXT "H"	$R_{EXTH}$	$V_{EXT}=V_{OUT}-0.4V$		11	15	$\Omega$
	EXT "L"	$R_{EXTL}$	$V_{EXT}=0.4V$		8	12	$\Omega$
<b>TOTAL DEVICE</b>							
Output Voltage	$V_{OUT}$		3.218	3.3	3.383	V	
Output Voltage temperature coefficient	$\Delta V_{OUT}$	$T_A=-40 \sim 85^{\circ}C$		150		ppm/ $^{\circ}C$	
Operating Current	$I_{DD}$	$V_{OUT}=V_{CE}=V_{SET}\times 0.96$		103	160	$\mu A$	
Stand-by Current	$I_{STN-BY}$	$V_{OUT}=V_{CE}=V_{SET}+0.5V$		15	38	$\mu A$	
Off-State Current	$I_{OFF}$	$V_{OUT}=5.0V, V_{CE}=0V, T_A=-40 \sim +85^{\circ}C$		0.6	1.5	$\mu A$	
Efficiency	$\eta$	$I_{OUT} = 200mA, V_{IN} = 2.0V$	80	88		%	

■ ELECTRICAL CHARACTERISTICS (Cont.)

**UC3550-3.6V**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>OSCILLATOR</b>							
Frequency	$f_{OSC}$	$V_{OUT}=V_{SET}\times 0.96$	240	300	360	kHz	
Frequency Temperature Coefficient	$\Delta f$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		0.10		%/ $^{\circ}C$	
Maximum PWM Duty Cycle	$D_{MAX}$	$V_{OUT}=V_{SET}\times 0.96$	70	80	90	%	
Minimum Start-up Voltage	$V_{START1}$	$I_{OUT}=0mA$		800	900	mV	
Minimum Start-up Voltage	$V_{START2}$	$I_{OUT}=1mA$		900	1000	mV	
Minimum Start-up Voltage Temperature Coefficient	$\Delta V_{START}$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		-1.6		mV/ $^{\circ}C$	
Minimum Operation Hold Voltage	$V_{OPR}$	$I_{OUT}=0mA$		600	700	mV	
Soft-Start Time	$t_{SS}$	$V_{OUT}=V_{SET}$		60	250	ms	
<b>CE (PIN 1)</b>							
CE Input Voltage :							
High State, Device Enabled	$V_{CEH}$	$V_{OUT}=V_{SET}\times 0.96$	900			mV	
Low State, Device Disabled	$V_{CEL}$				680	mV	
CE Input Current :							
High State, Device Enabled	$I_{CEH}$	$V_{OUT}=V_{CE}=5.0V$	-0.5	0	0.5	$\mu A$	
Low State, Device Disabled	$I_{CEL}$	$V_{OUT}=5.0V, V_{CE}=0V$	0	0.15	0.5	$\mu A$	
<b>EXT (PIN 5)</b>							
ON Resistance	EXT "H"	$R_{EXTH}$	$V_{EXT}=V_{OUT}-0.4V$		11	15	$\Omega$
	EXT "L"	$R_{EXTL}$	$V_{EXT}=0.4V$		8	12	$\Omega$
<b>TOTAL DEVICE</b>							
Output Voltage	$V_{OUT}$		3.51	3.6	3.69	V	
Output Voltage temperature coefficient	$\Delta V_{OUT}$	$T_A=-40 \sim 85^{\circ}C$		150		ppm/ $^{\circ}C$	
Operating Current	$I_{DD}$	$V_{OUT}=V_{CE}=V_{SET}\times 0.96$		103	160	$\mu A$	
Stand-by Current	$I_{STN-BY}$	$V_{OUT}=V_{CE}=V_{SET}+0.5V$		15	38	$\mu A$	
Off-State Current	$I_{OFF}$	$V_{OUT}=5.0V, V_{CE}=0V, T_A=-40 \sim +85^{\circ}C$		0.6	1.5	$\mu A$	
Efficiency	$\eta$	$I_{OUT} = 200mA, V_{IN} = 2.0V$	80	88		%	

■ ELECTRICAL CHARACTERISTICS (Cont.)

**UC3550-3.7V**

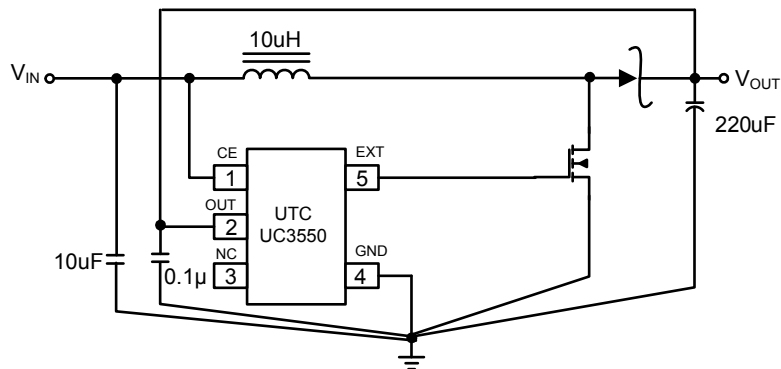
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>OSCILLATOR</b>							
Frequency	$f_{OSC}$	$V_{OUT}=V_{SET}\times 0.96$	240	300	360	kHz	
Frequency Temperature Coefficient	$\Delta f$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		0.10		%/ $^{\circ}C$	
Maximum PWM Duty Cycle	$D_{MAX}$	$V_{OUT}=V_{SET}\times 0.96$	70	80	90	%	
Minimum Start-up Voltage	$V_{START1}$	$I_{OUT}=0mA$		800	900	mV	
Minimum Start-up Voltage	$V_{START2}$	$I_{OUT}=1mA$		900	1000	mV	
Minimum Start-up Voltage Temperature Coefficient	$\Delta V_{START}$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		-1.6		mV/ $^{\circ}C$	
Minimum Operation Hold Voltage	$V_{OPR}$	$I_{OUT}=0mA$		600	700	mV	
Soft-Start Time	$t_{SS}$	$V_{OUT}=V_{SET}$		60	250	ms	
<b>CE (PIN 1)</b>							
CE Input Voltage :							
High State, Device Enabled	$V_{CEH}$	$V_{OUT}=V_{SET}\times 0.96$	900			mV	
Low State, Device Disabled	$V_{CEL}$				680	mV	
CE Input Current :							
High State, Device Enabled	$I_{CEH}$	$V_{OUT}=V_{CE}=5.0V$	-0.5	0	0.5	$\mu A$	
Low State, Device Disabled	$I_{CEL}$	$V_{OUT}=5.0V, V_{CE}=0V$	0	0.15	0.5	$\mu A$	
<b>EXT (PIN 5)</b>							
ON Resistance	EXT "H"	$R_{EXTH}$	$V_{EXT}=V_{OUT}-0.4V$		11	15	$\Omega$
	EXT "L"	$R_{EXTL}$	$V_{EXT}=0.4V$		8	12	$\Omega$
<b>TOTAL DEVICE</b>							
Output Voltage	$V_{OUT}$		3.608	3.7	3.793	V	
Output Voltage temperature coefficient	$\Delta V_{OUT}$	$T_A=-40 \sim 85^{\circ}C$		150		ppm/ $^{\circ}C$	
Operating Current	$I_{DD}$	$V_{OUT}=V_{CE}=V_{SET}\times 0.96$		103	160	$\mu A$	
Stand-by Current	$I_{STN-BY}$	$V_{OUT}=V_{CE}=V_{SET}+0.5V$		15	38	$\mu A$	
Off-State Current	$I_{OFF}$	$V_{OUT}=5.0V, V_{CE}=0V, T_A=-40 \sim +85^{\circ}C$		0.6	1.5	$\mu A$	
Efficiency	$\eta$	$I_{OUT} = 200mA, V_{IN} = 2.0V$	80	88		%	

## ■ ELECTRICAL CHARACTERISTICS (Cont.)

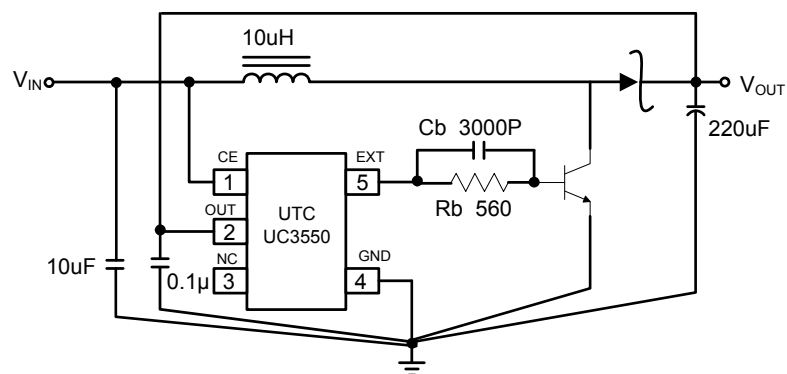
### UC3550-5.0V

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>OSCILLATOR</b>							
Frequency	$f_{OSC}$	$V_{OUT}=V_{SET}\times 0.96$	240	300	360	kHz	
Frequency Temperature Coefficient	$\Delta f$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		0.1		%/ $^{\circ}C$	
Maximum PWM Duty Cycle	$D_{MAX}$	$V_{OUT}=V_{SET}\times 0.96$	70	80	90	%	
Minimum Start-up Voltage	$V_{START1}$	$I_{OUT}=0mA$		800	900	mV	
Minimum Start-up Voltage	$V_{START2}$	$I_{OUT}=1mA$		900	1000	mV	
Minimum Start-up Voltage Temperature Coefficient	$\Delta V_{START}$	$T_A=-40^{\circ}C \sim 85^{\circ}C$		-1.6		mV/ $^{\circ}C$	
Minimum Operation Hold Voltage	$V_{OPR}$	$I_{OUT}=0mA$		600	700	mV	
Soft-Start Time	$t_{SS}$	$V_{OUT}=V_{SET}$		60	200	ms	
<b>CE (PIN 1)</b>							
CE Input Voltage :							
High State, Device Enabled	$V_{CEH}$	$V_{OUT}=V_{SET}\times 0.96$	900			mV	
Low State, Device Disabled	$V_{CEL}$				680	mV	
CE Input Current :							
High State, Device Enabled	$I_{CEH}$	$V_{OUT}=V_{CE}=5.0V$	-0.5	0	0.5	$\mu A$	
Low State, Device Disabled	$I_{CEL}$	$V_{OUT}=5.0V, V_{CE}=0V$	0	0.15	0.5	$\mu A$	
<b>EXT (PIN 5)</b>							
ON Resistance	EXT "H"	$R_{EXTH}$	$V_{EXT}=V_{OUT}-0.4V$		6	10	$\Omega$
	EXT "L"	$R_{EXTL}$	$V_{EXT}=0.4V$		6	10	$\Omega$
<b>TOTAL DEVICE</b>							
Output Voltage	$V_{OUT}$		4.875	5	5.125	V	
Output Voltage temperature coefficient	$\Delta V_{OUT}$	$T_A=-40 \sim 85^{\circ}C$		150		ppm/ $^{\circ}C$	
Operating Current	$I_{DD}$	$V_{OUT}=V_{CE}=V_{SET}\times 0.96$		136	220	$\mu A$	
Stand-by Current	$I_{STN-BY}$	$V_{OUT}=V_{CE}=V_{SET}+0.5V$		15	38	$\mu A$	
Off-State Current	$I_{OFF}$	$V_{OUT}=5.0V, V_{CE}=0V, T_A=-40 \sim +85^{\circ}C$		0.6	1.5	$\mu A$	
Efficiency	$\eta$	$I_{OUT} = 200mA, V_{IN} = 3.0V$	80	88		%	

## ■ TYPICAL STEP-UP CONVERTER APPLICATION



Step-up Converter using external MOSFET



Step-up Converter using external NPN

### Recommended components

Nmos  $t_R$  : XP161A0390PR/ (Torex) or NTGS3446T1(ON SEMI)

L : 10uH(Sunida CD54  $f_{OSC}=300kHz$ )

SD : MA737, or MBRM110L

$C_{IN}$  : 10V 10uF (tantalum)

$C_L$  : 16V220uF (tantalum)

### NPN $t_R$ type

$t_R$  : 2SD1628(Sanyo), MMJT9410

$R_B$  : 500~1000 $\Omega$ (Adjust according to load and  $T_r$ ,  $h_{FE}$  levels)

$C_B$  : 3000p(ceramic type)

## ■ EXTERNAL COMPONENT SELECTION

### Inductor Selection

An inductor value of 10 $\mu$ H performs well in most application. The UC3550 series also work with inductors in the 4.7 $\mu$ H to 12 $\mu$ H range. An inductor with higher peak inductor current tends a higher output voltage ripple( $I_{PEAK} \times$  output filter capacitor ESR). The inductor's DC resistance significantly affects efficiency.

### Output Capacitor Selection

The output ripple voltage( $I_{PEAK} \times$  output filter capacitor ESR) is the product of the peak inductor current and the output capacitor Equivalent Series Resistance (ESR). Best performances are obtained with good high frequency characteristics capacitors and low ESR. The best compromise for the value of the Output Capacitance is 220F Tantalum Capacitor. The output capacitor as close as possible to the device pins.

### Input Capacitor Selection

The Input Capacitor is required to compensate, if present, the series impedance between the Supply Voltage Source and the Input Voltage of the Application. A value of 10 F is enough to guarantee stability for distances less than 2". In any case we suggest to connect both capacitors, The input capacitor as close as possible to the device pins.

### Diode Selection

The Schottky diode with an high switching speed and a very low Forward Voltage (VF) is needed. Higher VF may cause lost power as heat in the diode, with a decrease of the Efficiency. Moreover, since the Output Voltage pin is also used as the device Supply Voltage, the Start-up Voltage (see related plots) is strictly due to the diode Forward Voltage at the rated Forward Current.

### External Component Selection

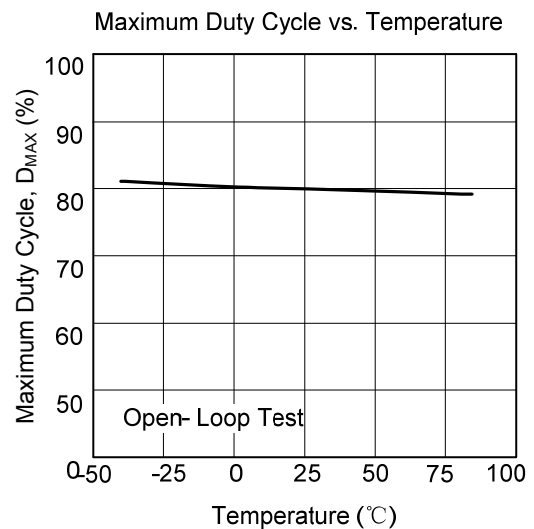
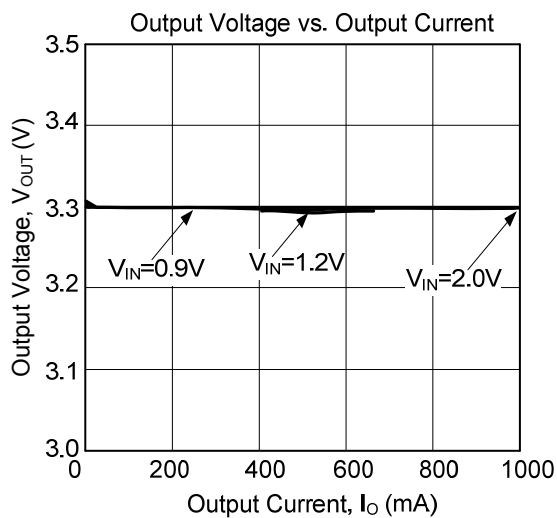
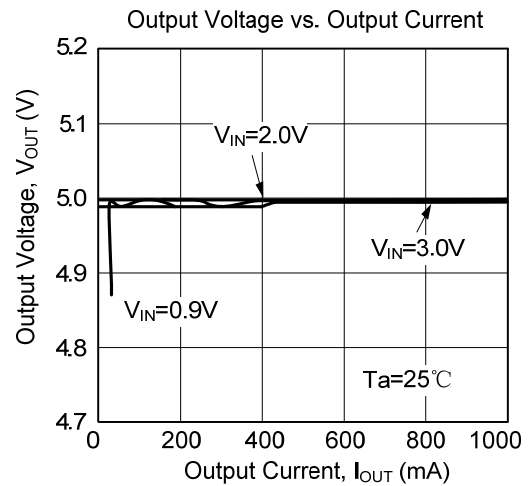
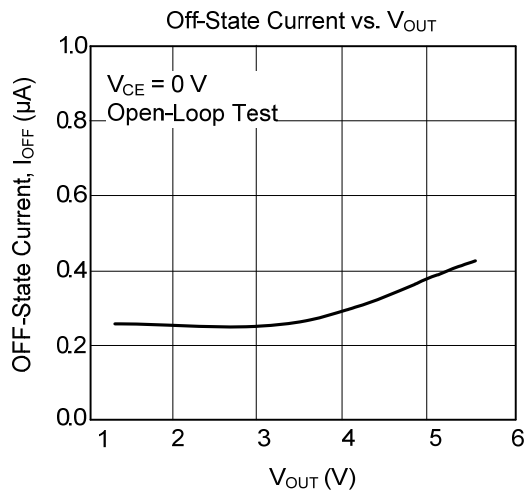
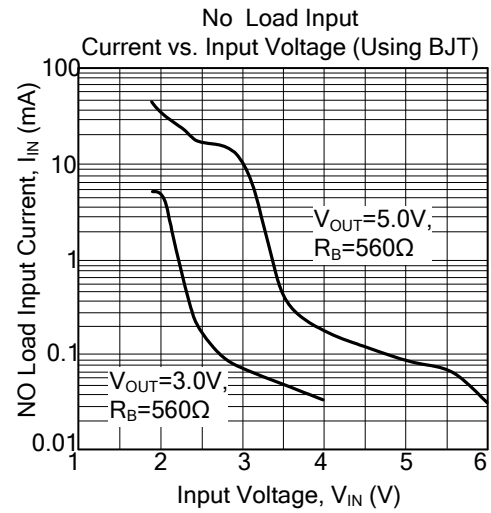
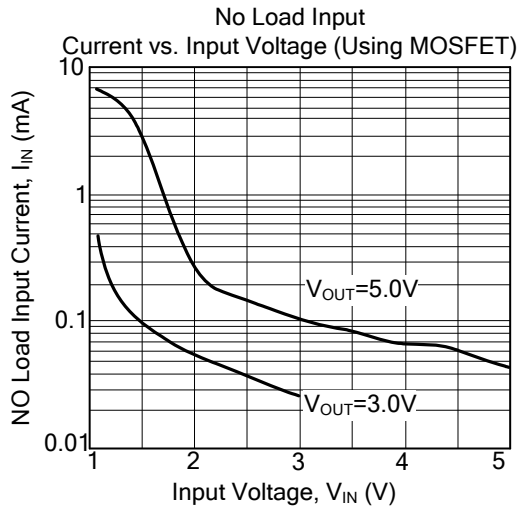
An enhancement N-channel MOSFET or a bipolar NPN transistor can be used as the external switch transistor. since enhancement N-channel MOSFET is a voltage driven device, it is a more efficient switch than a BJT transistor. However, he MOSFET requires a higher voltage to turn on as compared with BJT transistor

For enhancement N-channel MOSFET ( it is especially importance for  $R_{DS(ON)}$ , typically < 0.1 $\Omega$ , threshold voltage,  $V_{GS(TH)}$  must be <  $V_{OUT}$ , typically < 1.5V.

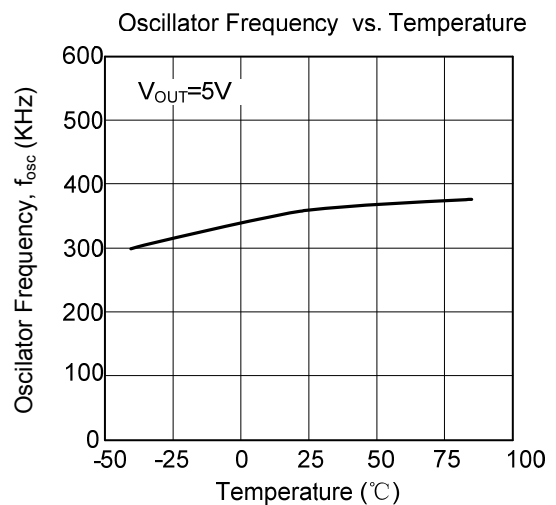
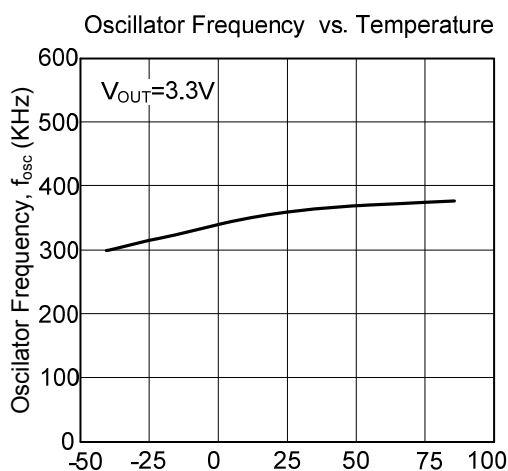
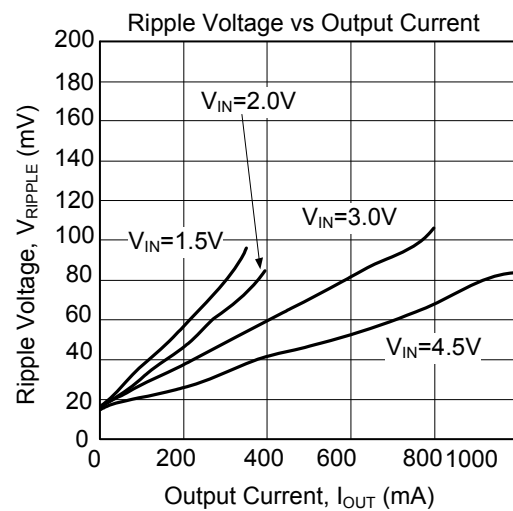
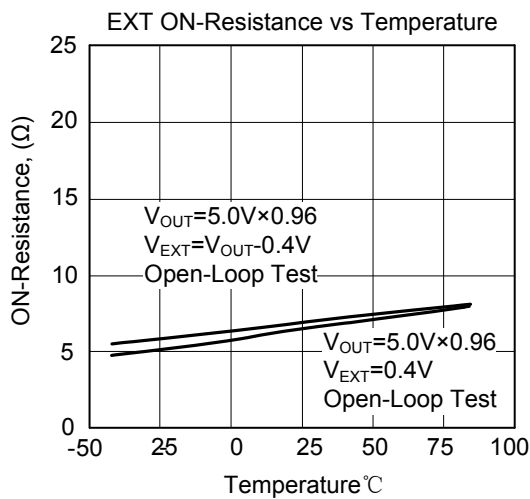
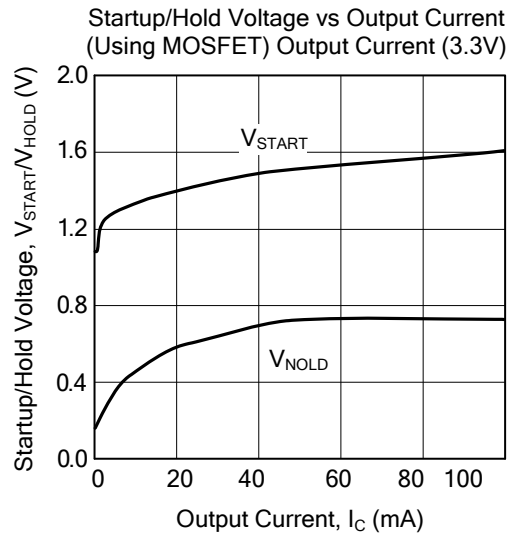
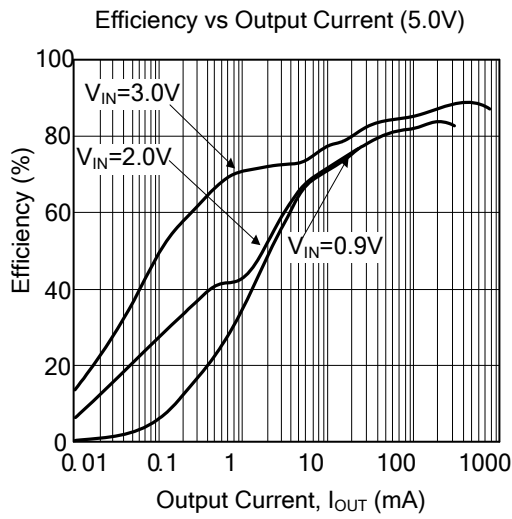
For bipolar NPN transistor, continuous collector current typically 1A to 4A and  $V_{CE(SAT)}$  < 0.2V. the driving capability is determined by the DC current gain,  $H_{FE}$ , of the transistor and the base resistor,  $R_B$ . Moreover, a speed-up capacitor,  $C_B$  should be connected in paralld with  $R_B$  to reduce switch loss and improve efficiency.



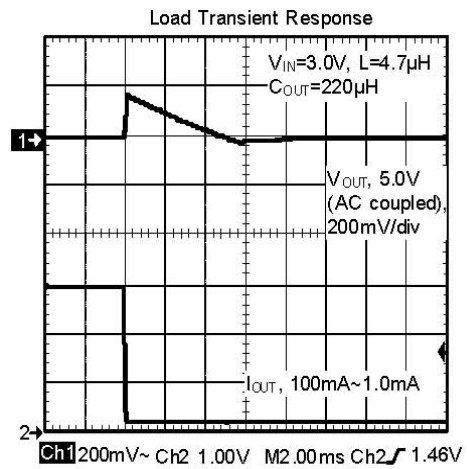
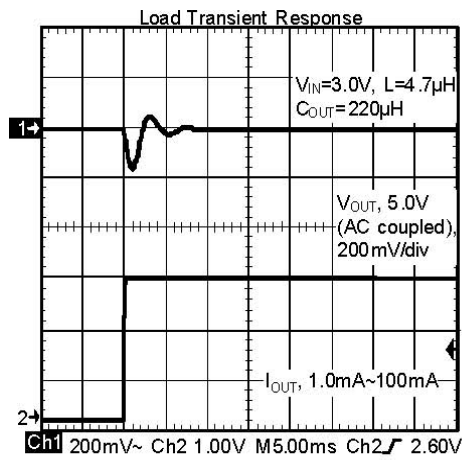
## TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS(Cont.)



■ TYPICAL CHARACTERISTICS(Cont.)



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