



## UC3500

CMOS IC

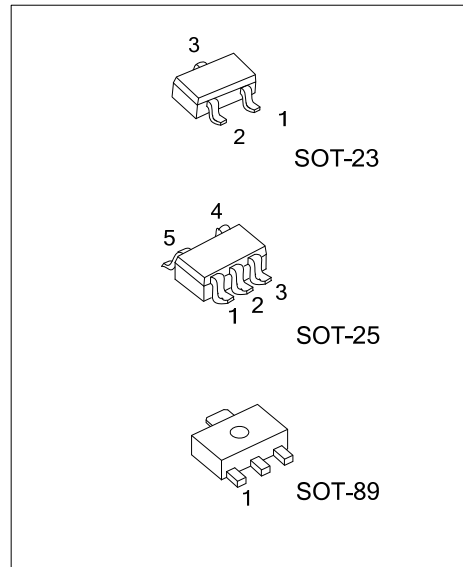
### HIGH EFFICIENCY VFM CONTROLLED STEP-UP DC/DC CONVERTER

#### DESCRIPTION

The UTC **UC3500** Step-up DC/DC converters are optimized for applications that prioritize high efficiency and high frequency. The efficiency is greatly improved by utilizing an internal VFM controlled scheme that switches with fixed frequency and is adjustable up to more than 150 KHz depending on the load.

The UTC **UC3500** requires only three external components to realize the conversion from the battery voltage to the selected output voltage in the range of 2.5V ~ 5.5V.

The start-up voltage of UTC **UC3500** is guaranteed at 0.8V and the device is operating down to 0.5V. The Output current is guaranteed up to 150mA, while quiescent current is only 18µA.



#### FEATURES

- \* 0.8V start-up voltage
- \* 0.5V hold-on voltage
- \* Output current up to 150mA
- \* Low supply current of 18µA
- \* Wide output voltage range of 2.5V~5.5V
- \* High efficiency up to 88%
- \* Low profile and minimum external components

#### ORDERING INFORMATION

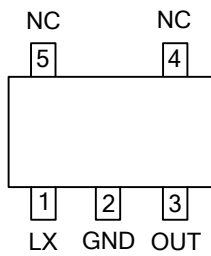
Ordering Number	Package	Packing
UC3500G-xx-AB3-R	SOT-89	Tape Reel
UC3500G-xx-AE3-R	SOT-23	Tape Reel
UC3500G-xx-AF5-R	SOT-25	Tape Reel

<p>UC3500L-xx-AB3-R</p> <p>(1)Packing Type</p> <p>(2)Package Type</p> <p>(3)Voltage Code</p> <p>(4)Green Package</p>	<p>(1) R: Tape Reel</p> <p>(2) AB3:SOT-89, AE3:SOT-23, AF5:SOT-25</p> <p>(3) xx: reference to Marking Information</p> <p>(4) G: Halogen Free and Lead Free</p>
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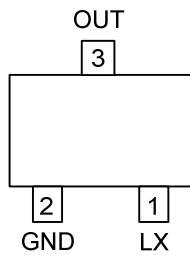
MARKING INFORMATION

PACKAGE	VOLTAGE CODE	MARKING
SOT-25	25:2.5V 27:2.7V 28:2.8V 30:3.0V 33:3.3V 36:3.6V 40:4.0V 50:5.0V	
SOT-23		
SOT-89		

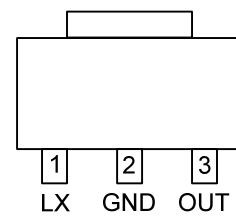
PIN CONFIGURATION



SOT-25

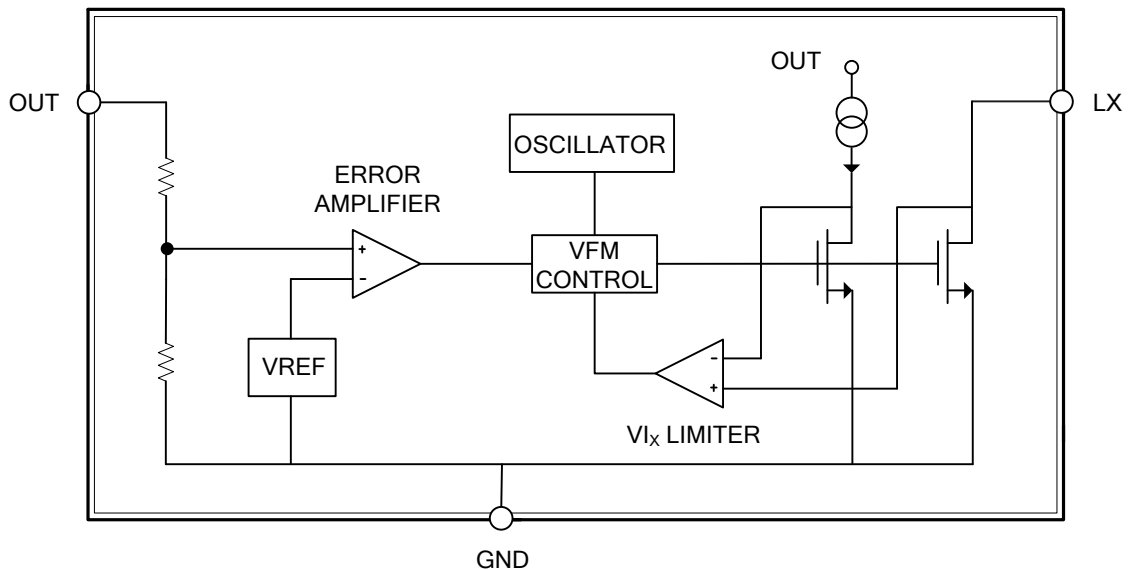


SOT-23



SOT-89

BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATING

PARAMETER		SYMBOL	RATINGS	UNIT
Output Voltage		$V_{OUT}$	7	V
Input Voltage		$V_{IN}$	7	V
LX Pin Voltage		$V_{LX}$	7	V
LX Pin Output Current		$I_{LX}$	Internally limited	
Power Dissipation at 25°C	SOT-23/SOT-25	$P_D$	160	mW
	SOT-89		500	
Derating Rate $T_A > 25^\circ\text{C}$	SOT-23/SOT-25		1.6	°C/mW
	SOT-89		5	
Operating Temperature		$T_{OPR}$	-25 ~ +85	°C
Storage Temperature		$T_{STG}$	-65 ~ +150	°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.

## ■ ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise specified.)

### UC3500-2.5V ( $V_{IN} = 1.4\text{V}$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10\text{mA}$	2.4	2.5	2.6	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1\text{mA}$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1\text{mA}$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu\text{A}$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100\text{mA}$		760		$\text{m}\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4\text{V}, V_{OUT} = 2.8\text{V}$		0.1	0.3	$\mu\text{A}$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10\text{mA}$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10\text{mA}$		81		%
		$I_{OUT} = 50\text{mA}$		83		%
		$I_{OUT} = 100\text{mA}$		82		%

### UC3500-2.7V ( $V_{IN} = 1.6\text{V}$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10\text{mA}$	2.6	2.7	2.8	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1\text{mA}$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1\text{mA}$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu\text{A}$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100\text{mA}$		760		$\text{m}\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4\text{V}, V_{OUT} = 3.0\text{V}$		0.1	0.3	$\mu\text{A}$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10\text{mA}$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10\text{mA}$		82		%
		$I_{OUT} = 50\text{mA}$		83		%
		$I_{OUT} = 100\text{mA}$		82		%

■ ELECTRICAL CHARACTERISTICS(Cont.)

**UC3500-2.8V** ( $V_{IN} = 1.7V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	2.7	2.8	2.9	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		760		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 3.1V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		82		%
		$I_{OUT} = 50mA$		83		%
		$I_{OUT} = 100mA$		82		%

**UC3500-3.0V** ( $V_{IN} = 1.8V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	2.9	3	3.1	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		750		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 3.3V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		82		%
		$I_{OUT} = 50mA$		84		%
		$I_{OUT} = 100mA$		82		%

**UC3500-3.3V** ( $V_{IN} = 2.0V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	3.2	3.3	3.4	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		750		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 3.6V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		83		%
		$I_{OUT} = 50mA$		85		%
		$I_{OUT} = 100mA$		84		%

## ■ ELECTRICAL CHARACTERISTICS(Cont.)

### UC3500-3.6V ( $V_{IN} = 2.2V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	3.49	3.6	3.71	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		18		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		750		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 3.9V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		84		%
		$I_{OUT} = 50mA$		86		%
		$I_{OUT} = 100mA$		85		%

### UC3500-4.0V ( $V_{IN} = 2.4V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	3.88	4.0	4.12	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		19		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		740		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 4.3V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		85		%
		$I_{OUT} = 50mA$		87		%
		$I_{OUT} = 100mA$		85		%

### UC3500-5.0V ( $V_{IN} = 3.0V$ )

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Voltage	$V_{OUT}$	$I_{OUT} = 10mA$	4.85	5.0	5.15	V
Start-up Voltage ( $V_{IN}-V_F$ ) (Note)	$V_{START}$	$I_{OUT} = 0$		0.7	1.1	V
		$I_{OUT} = 1mA$		0.8	1.2	V
Hold-on Voltage	$V_{HOLD}$	$I_{OUT} = 0$	0.4	0.6		V
		$I_{OUT} = 1mA$	0.25	0.5		V
Supply Current	$I_{SUPPLY}$	$I_{OUT} = 0$		19		$\mu A$
Internal Switch $R_{DS(ON)}$	$R_{LX}$	$I_{LX} = 100mA$		730		m $\Omega$
Internal Leakage Current	$I_{LX(LEAK)}$	$V_{LX} = 4V, V_{OUT} = 5.3V$		0.1	0.3	$\mu A$
Maximum Oscillator Frequency	$f_{OSC}$	$I_{OUT} = 10mA$		150		KHz
Oscillator Duty Cycle	$D_{ty}$	to be measure on LX pin		75		%
Efficiency	$\eta$	$I_{OUT} = 10mA$		86		%
		$I_{OUT} = 50mA$		88		%
		$I_{OUT} = 100mA$		85		%

Note:  $V_F$  references to the forward voltage of the diode.

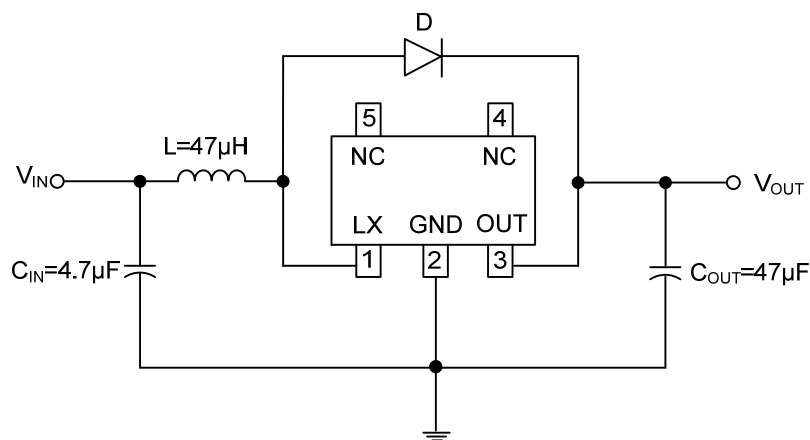
## ■ PRINCIPLE OF OPERATION

The UTC **UC3500** consists of a Band-Gap reference voltage source, error amplifier, VFM control logic core, oscillator,  $V_{LX}$  limiter amplifier, N-channel MOSFET switching transistor and output voltage divider network.

The device compares the Band-Gap reference voltage with the feedback voltage from the output through divider network. In  $T_{ON}$  phase, the energy is transferred from the battery to the inductor. The switch is turned off after a maximum on time set to  $2.5\mu s$ . In  $T_{OFF}$  phase, the energy stored in the inductor is transferred to the load. This process is continuously performed to ensure stable output voltage. Until the output voltage reaches the expected value.

Therefore, in case of light load, the device works in PFM mode. In heavy load condition, the device works in continuous mode, the frequency range up to a maximum 150 KHz set by the built in oscillator. In over current conditions, the  $T_{on}$  time is shorted; the switching frequency will be higher than 150 KHz.

## ■ TYPICAL APPLICATION CIRCUIT

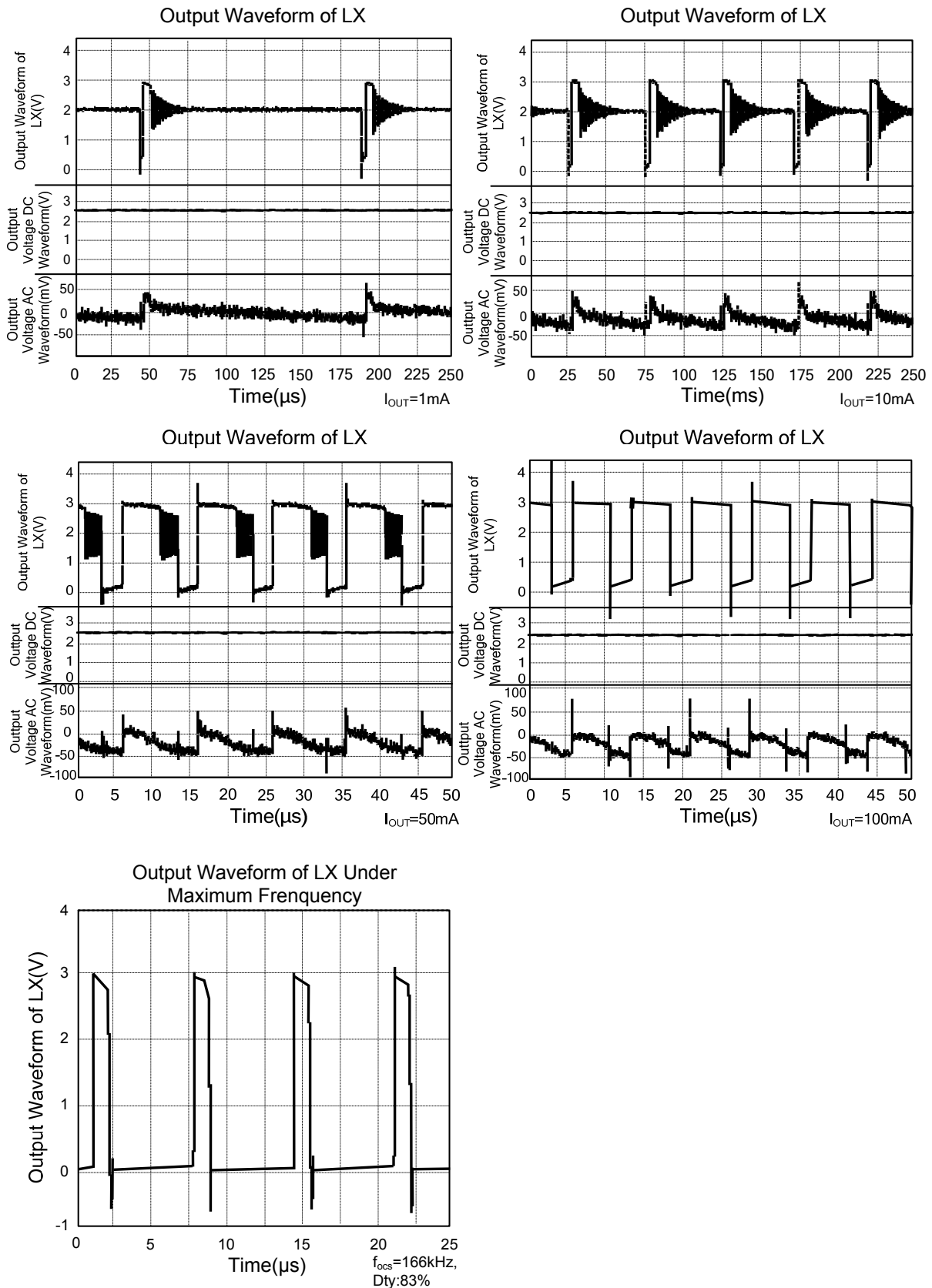


## ■ RECOMMENDED COMPONENTS

- L : 47µH (Sunida CD54 Fosc=500kHz)
- D : MA737, or MBRM110L
- $C_{IN}$  : 10V 4.7µF (Tantalum)
- $C_{OUT}$  : 16V 47µF (Tantalum)

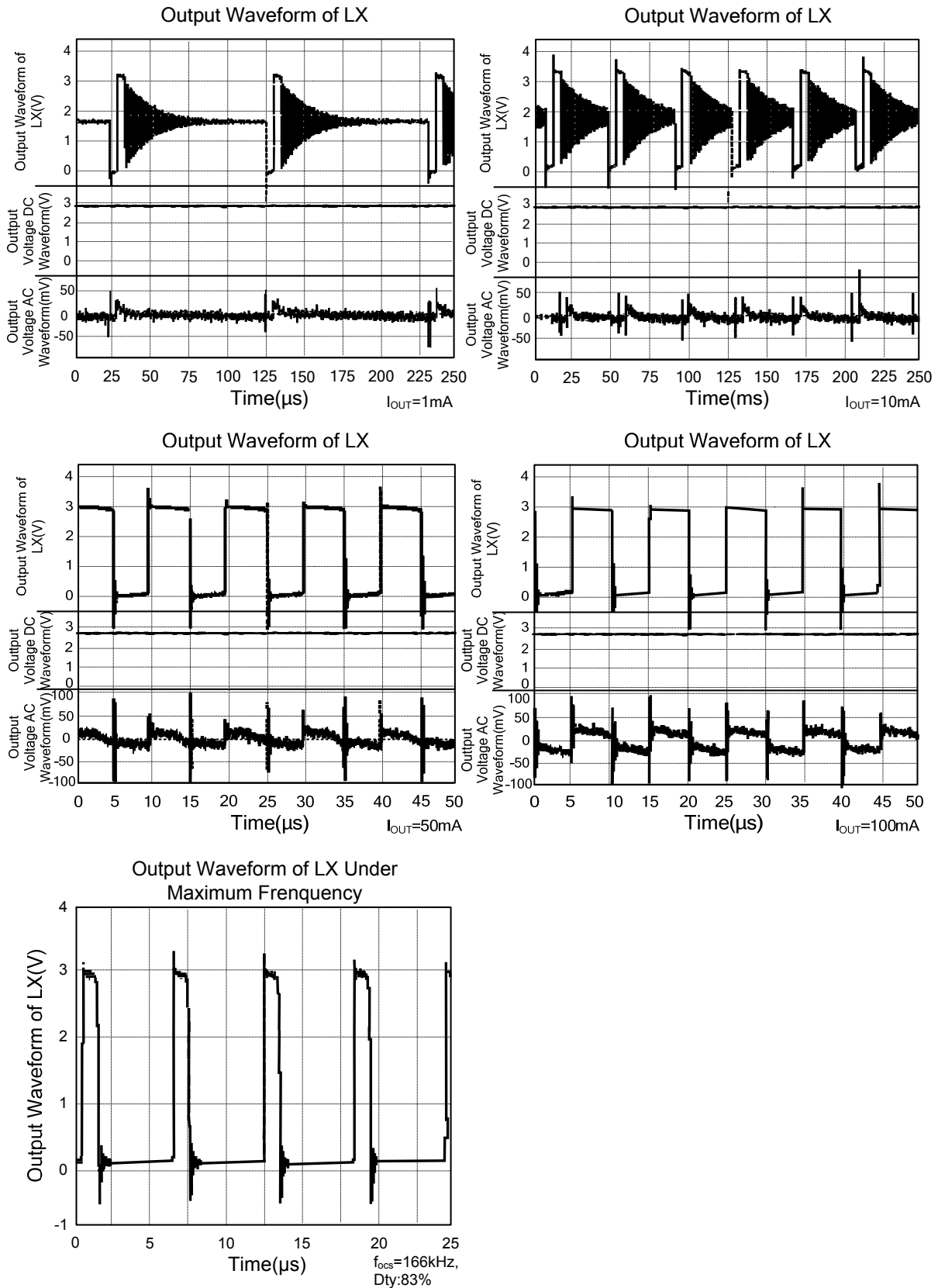
■ TYPICAL CHARACTERISTICS

UC3500-2.5V



■ TYPICAL CHARACTERISTICS(Cont.)

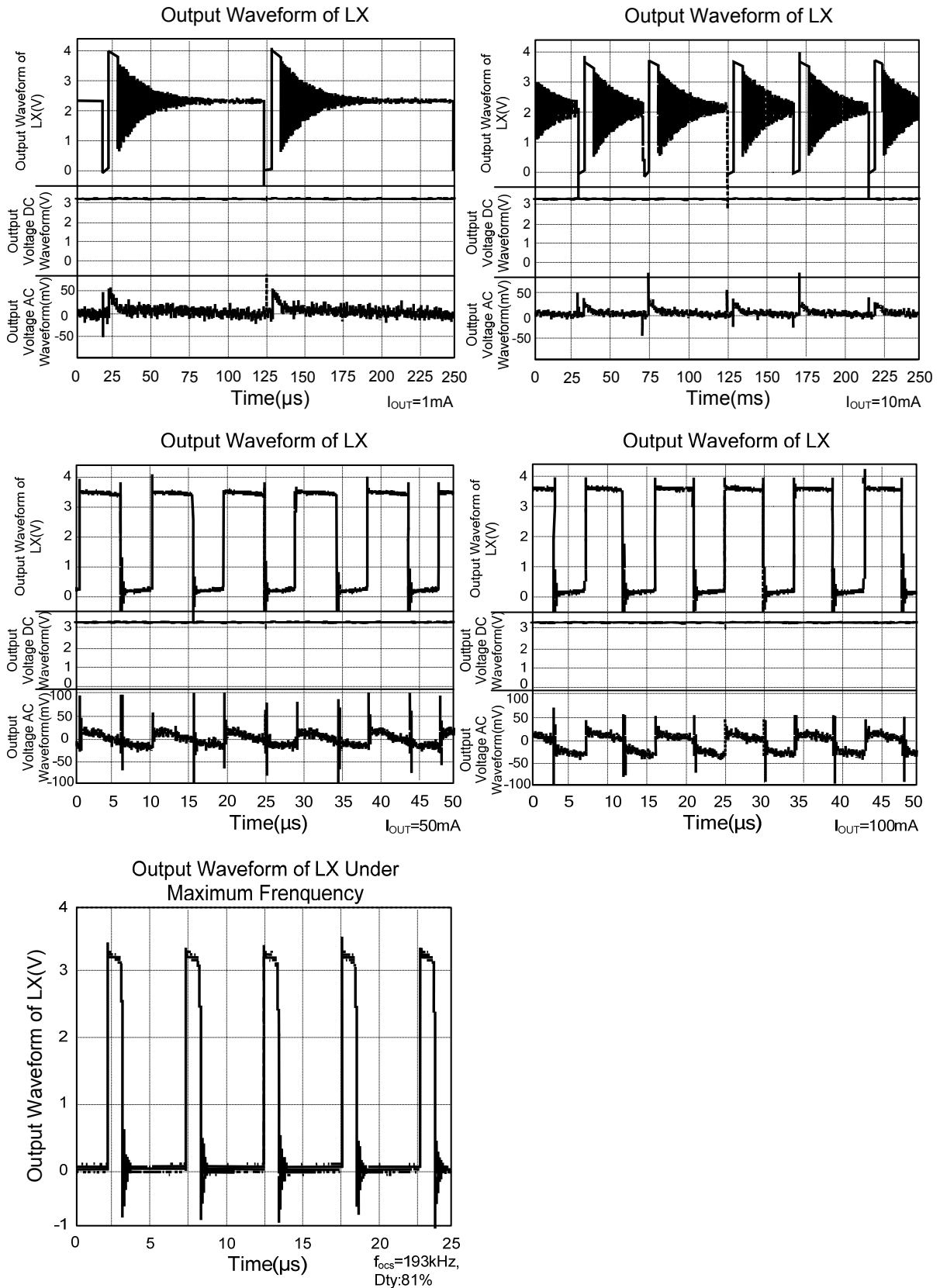
UC3500-2.7V





## ■ TYPICAL CHARACTERISTICS(Cont.)

### UC3500-3.3V



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