



BYD Microelectronics Co., Ltd.

# BF1501 Series

## Off Line AC/DC Switcher IC

### General Description

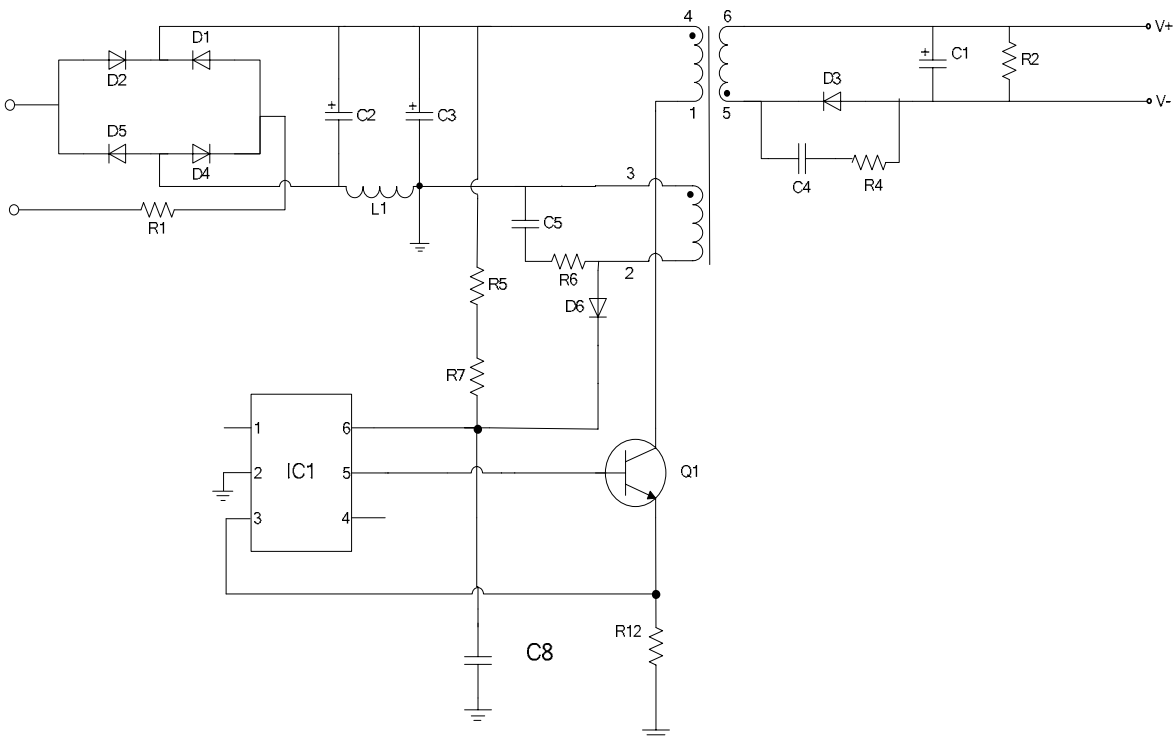
The BF1501 series switcher ICs cost effectively replace all power supplies up to 5W output power based on unregulated isolated linear transformer (50/60HZ). Unlike conventional PWM (pulse width modulation) controllers, they regulate the output voltage in a new method of off-time modulation control. The controller consists of a VCO (voltage control oscillator), Sense and logic circuit, VDD pin, under-voltage lockout circuit, protection for over-voltage, current limited circuit, leading edge blanking, over load protection and fault condition auto-restart. They are ideal low power AC/DC adapter/charger solution for portable devices.

### Applications

- AC/DC adapter/charger for cell/cordless phones, digital cameras, MP3/portable audio devices etc
- LED Lighting
- Replacements for linear transformers and RCC SMTPS

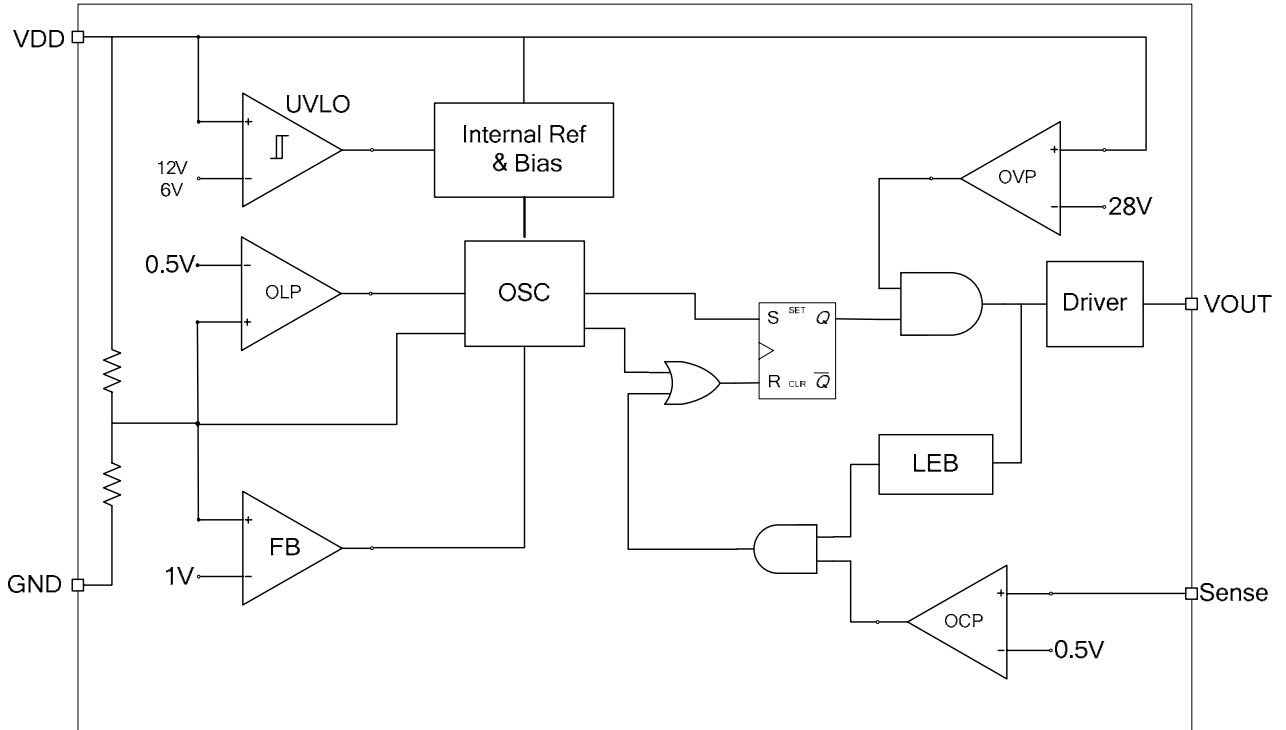
### Features

- **Low start-up current**
  - Typ.15  $\mu$ A
  - Max.25  $\mu$ A
- **Low operating current**
  - Typ.2 mA
  - Max.5 mA
- **UVLO(under voltage lockout)**
  - Typ.12V start-up
  - Typ.6V shut-down
- **LEB(leading edge blanking)**
  - Typ.300ns
- **OVP(over voltage protection)**
  - Typ.28 V
- **Operation Frequency**
  - Typ.50KHZ(VDD=21V)
- **Output Driver Ability**
  - Typ.15 mA
- **OLP(over load protection)**
- **Universal AC input range**
- **Constant voltage and constant current**
- **Small SOT-23-6 Package**





### Block Diagram



## Selection Guide

- **Type Number**

**BF1501-XX**

Symbol	Meaning	Description
XX	The maximum operate frequency	Assigned from AA to WW

- **Type Number Option**

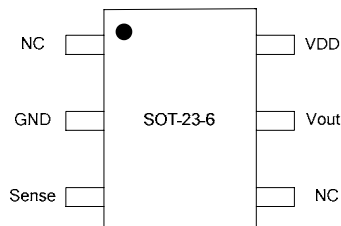
Through choosing the "XX", the maximum operate frequency is determined.

**Table 1. Operate frequency & Marking**

( @ 25 )

Type Number	Operate frequency	Mark
BF1501-CA	50K	BCX
BF1501-LA	45K	BLX

## Package Type



## Pin Description

Pin number	Pin name	Description
1	NC	Not connected
2	GND	Ground
3	Sense	Current sensor, it senses the voltage via a sensed resistor
4	NC	Not connected
5	V <sub>out</sub>	Gate drive output for the external power BJT switch
6	VDD	Power Supply

## Function Description

### 1. Under Voltage Lockout

The turn-on and turn-off thresholds of the BF1501 are fixed internally at 12V/6V. During start-up, the hold-up capacitor must be charged to 12V through the start-up resistor, so that the BF1501 can be enabled. The hold-up capacitor will continue to supply VDD until power can be delivered from the auxiliary winding of the main transformer. When VDD drops below 6V, IC will be shut-down, and have to start-up again. This UVLO hysteretic window ensures that BF1501 can start-up very well.

### 2. Leading Edge Blanking

When the power BJT is switched on, a voltage spike will inevitably occur at the sense pin. To avoid premature termination of the switching pulse, a 300 ns leading-edge blanking time is built in BF1501. Conventional RC filtering can be omitted. During this blanking period, the current-limit comparator is disabled and it cannot switch off the gate driver.

### 3. Voltage Control Oscillator

The sense circuit of BF1501 series will sense the voltage of VDD pin (also the power pin of BF1501) and then control the frequency of the oscillator. The max frequency of BF1501 series is set to the rated output power point, for example BF1501-CA is set to 50 KHZ. Two signals are generated from the oscillator: the maximum duty cycle signal (DC max) and the clock signal that indicates the beginning of each switching cycle.

### 4. Sense Circuit

A resistor voltage divided circuit is connected between the VDD pin and GND pin in order to sample the feedback voltage at VDD pin. When the voltage of VDD pin exceeds 21V, IC will come into constant voltage control mode, shut-down the output pin and start a bypass circuit. This bypass circuit is linearly controlled by the feedback voltage. When the voltage of VDD pin falls below 21V, the off-time linearly increases in order to have a constant current output.

### 5. Gate Output

Unlike other chips, BF1501 used a constant current circuit to drive the output BJT. The output current is fixed at 15mA, select the appropriate HFE of BJT could have a different output power.

### 6. Fault Condition Auto-restart

In the event of a fault condition such as output over-load or short circuit, BF1501 series enter into auto-restart operation. It is using the turn-on and turn-off threshold again. BF1501 series are working in start mode to protect the system from damage caused by the fault condition.

### 7. Current Limit

The current through the power BJT is detected by the current limit circuit. Then the current flows through the sense-resistor and makes the voltage on Sense pin ramp up. And when this voltage exceeds the internal threshold ( $V_{limit}$ ), the power BJT is turned off immediately.

**Electrical Characteristic**

Item	Conditions	Min.	Typ.	Max.	Unit	
<b>Supply voltage</b>						
Start-up Current	$V_{DD} = V_{DD\ ON} - 0.1$		15	25	$\mu A$	
Operation voltage	25		21		V	
Turn-on Threshold Voltage	$V_{DD\ ON}$	11	12	13	V	
Turn-off Threshold Voltage	$V_{DD\ OFF}$	5.5	6	6.5	V	
Over-voltage Threshold	$V_{OVP}$		28	30	V	
<b>Oscillator</b>						
Operate Frequency	25	BF1501-CA	45	50	55	KHz
		BF1501-LA	40	45	50	
Duty Cycle	$V_{SENSE} = 0$			70%		
Green Mode Frequency	25	16	20	24	KHz	
<b>Current Sensing</b>						
Leading Edge Blanking	25	250	300	350	ns	
Current Sense Detection Voltage	$V_{DD} = 15V$	0.45	0.5	0.55	V	
<b>Else</b>						
Output Delay Time	25		150		ns	
Output Driver Current	25	12	15	18	mA	

**Absolute Maximum Ratings**

Item	Symbol	Value	Unit
VDD pin input voltage	$V_{DD}$	40	V
SENSE pin input voltage	$V_{SENSE}$	7	V
Power Dissipation	$P_D$	400	mW
Operating Junction Temperature	$T_J$	-40 to +125	
Storage Temperature Range	$T_{STJ}$	-55 to +150	
Lead temperature	$T_L$	260	

**Attention:** Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## Test Circuits

### (1) Current consumption in start up period

#### Test circuit 1

Close the S1, connect Sense pin to ground and make the VOUT pin floating.

Set  $V1=5\pm0.03V$  with 1ms delay time.

Keep V1 powered, increase V1 to  $11\pm0.03V$ , the current A1 flowing into VDD is the current consumption.

### (2) Hysteresis start-up

#### Test circuit 1

When V1 increases over  $Vx1$ (the first threshold voltage) from 0V, the IC starts to work normally, and only when V1 decreases under  $Vx2$ (the second threshold voltage), the IC stops working and moves into standby mode.

Set  $V1=5\pm0.03V$  with 1ms delay time.

Close the S1, connect Sense pin to ground and make the OUT pin floating.

$Vx1$  is the voltage V1 when the output (the VOUT pin) frequency changes from  $(0\pm1KHZ)$  to  $(25\pm10KHZ)$ .

$Vx2$  is the voltage V1 when the output (the VOUT pin) frequency changes from  $(25\pm10KHZ)$  to  $(0\pm1KHZ)$ .

### (3) CC/CV mode transforming voltage

#### Test circuit 1

When the voltage increases to a certain value, IC will change from CC mode to CV mode.

Set  $V1=5\pm0.03V$  with 1ms delay time.

Close the S1, connect Sense pin to ground and make the VOUT pin floating.

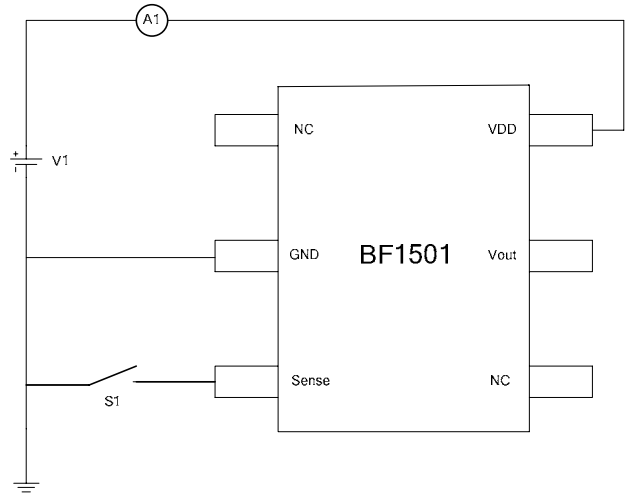
The CC/CV mode transforming voltage is the voltage V1 when the output (the VOUT pin) frequency changes from  $(50\pm10KHZ)$  to  $(0\pm1KHZ)$ .

### (4) Over current protection detection voltage

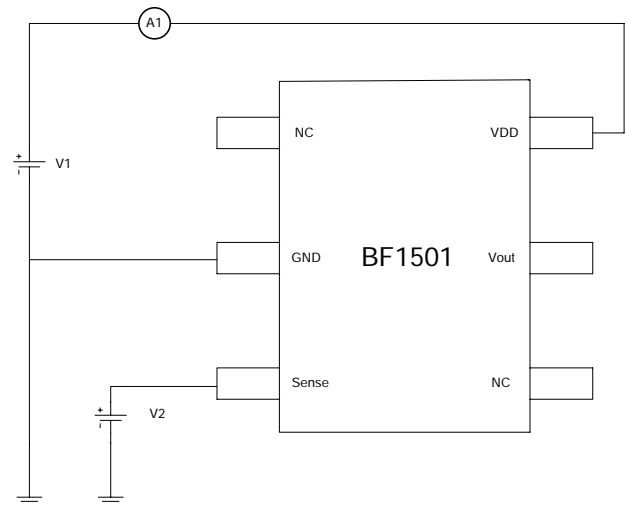
#### Test circuit 2

Set  $V1=15\pm0.03V$ ,  $V2=0\pm0.03V$ , make the VOUT pin floating.

The over current protection detection voltage is the voltage V2 when the output (the VOUT pin) frequency changes from  $(35\pm10KHZ)$  to  $(0\pm1KHZ)$ .



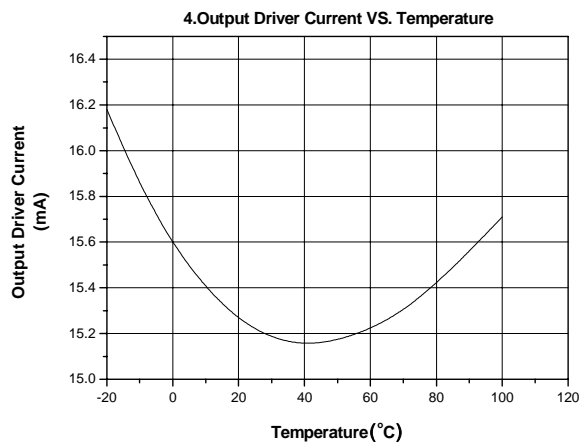
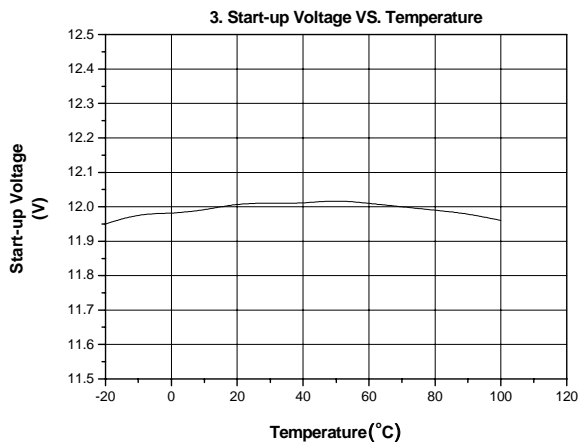
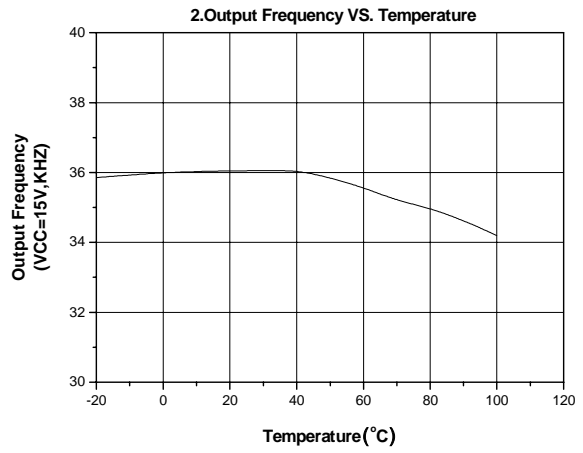
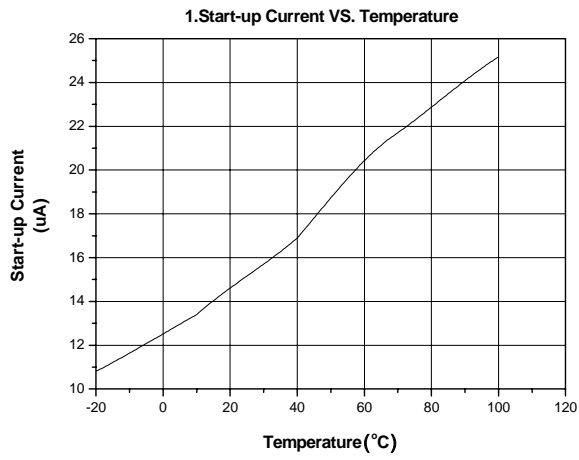
Circuit1: For testing current consumption、CC/CV mode transforming voltage、Hysteresis start-up



Circuit2: For testing Over current protection detection voltage

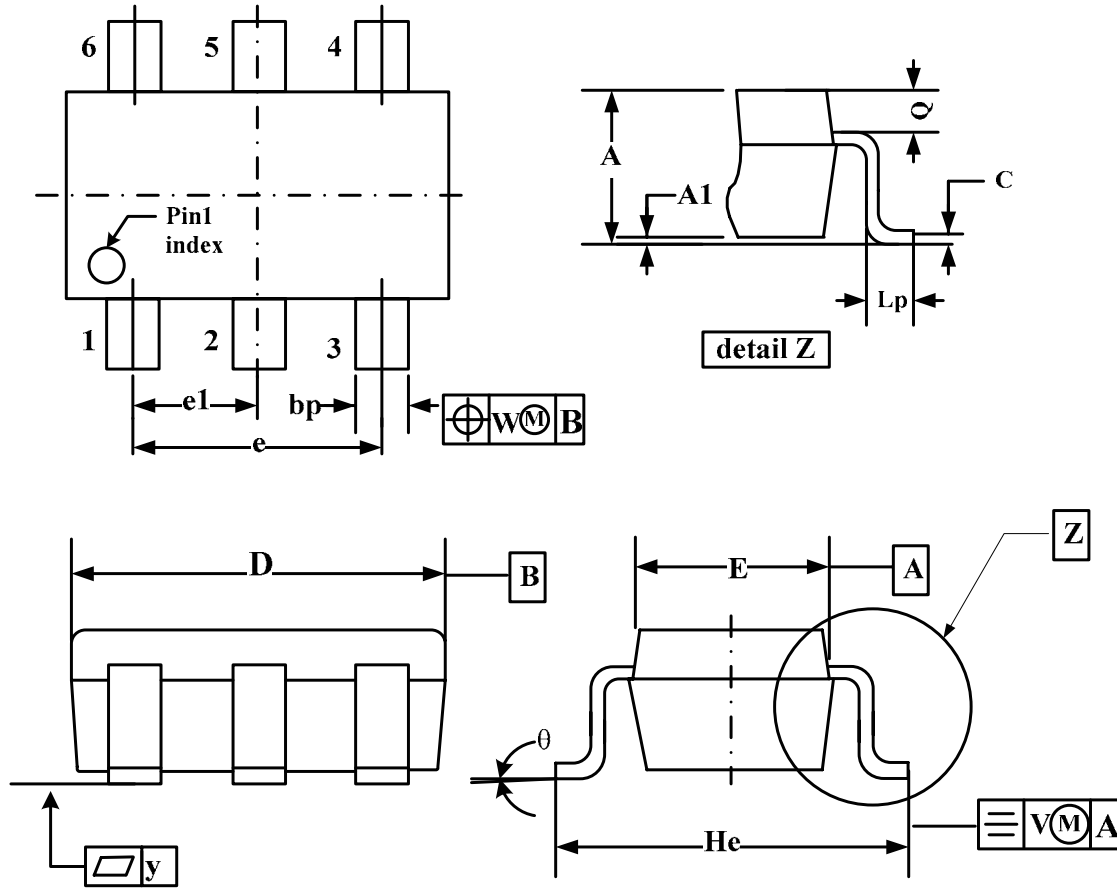


### Typical Characteristic Charts



Package outline

SOT-23-6



Dimensions (mm)

A	A1	bp	c	D	E	e	e1	He	Lp	Q	v	w	y	θ
1.3	0.15	0.50	0.20	3.1	1.7	1.9	0.95	3.0	0.6	0.33	0.2	0.2	0.1	0°
1.0	0.03	0.35	0.10	2.7	1.3	1.9	0.95	2.5	0.2	0.23	0.2	0.2	0.1	10°

BYD Microelectronics Co. Ltd. reserves the right to modify the specifications without prior notification.