BYD Microelectronics Co., Ltd.

BF1502-B

Offline Primary-side PWM + PFM Power Switch Controller

General Description

BF1502-B is a high performance offline PWM + PFM power switch controller, which operating in primary side sensing and regulation. It is used in low power AC/DC chargers and adaptor applications and etc. The BF1502-B operates in PFM in CC mode. In CV mode, in order to achieve high efficiency, it operates in PFM at large load condition and in PWM+PFM at light/medium load condition. In addition, the BF1502-B has a built-in DC output cable drop compensation, so it is easy to achieve the constant output voltage in universal AC input.

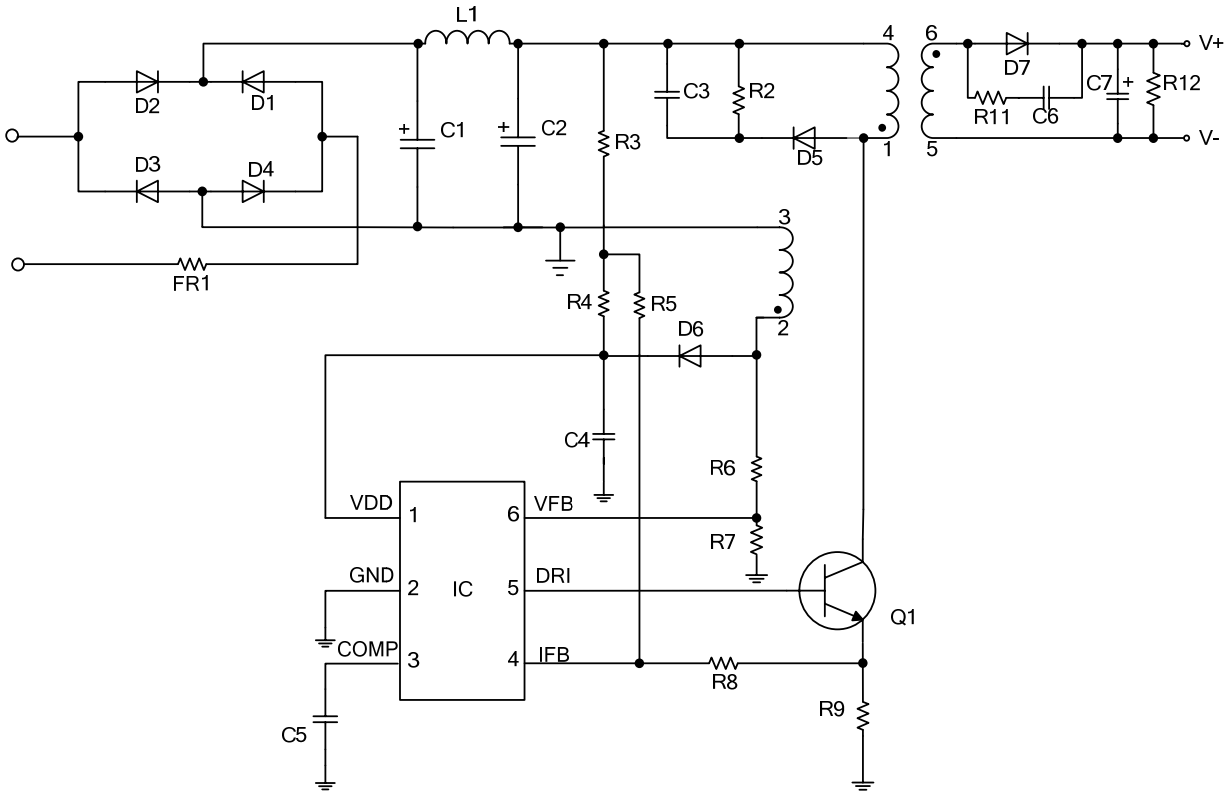
Applications

- Cell Phone Charger
- Low Power Adaptor
- Auxiliary Power for PC, TV etc.
- LED Driver

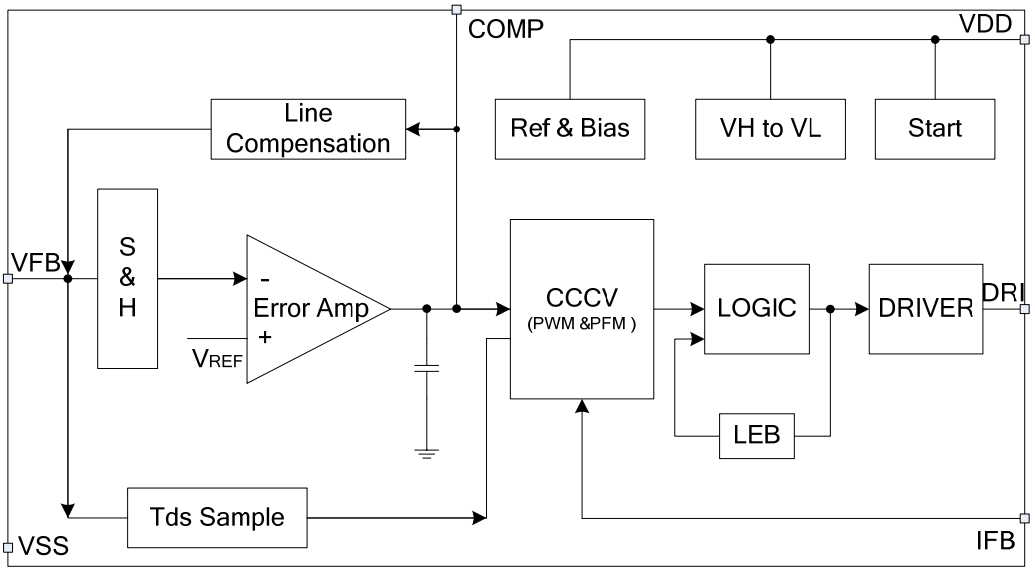
Features

- Multi-mode Operation for Highest Overall Efficiency
- ±5% Constant Voltage/Current Regulation at Universal AC Input
- Built-in Soft-Start Circuit
- Programmable Cable Drop Compensation
- Built-in Output Constant-current and Constant-voltage Control with Primary-side Feedback
- No Opto-coupler and TL431 Required
- Low Start-up Current (Max.5uA)
- Built-in Short Circuit Protection, VOUT Over Voltage Protection
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- SOT23-6 Package

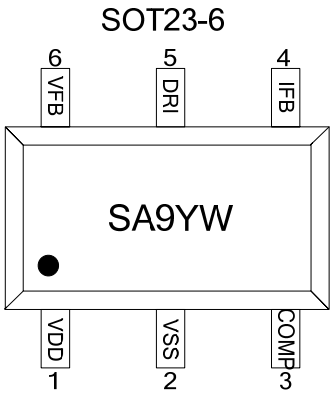
Typical application



Block Diagram



Package Type and marking information



SA9: Internal Code
Y: Year Code
W: Week Code

Pin Description

Pin Num	Pin Name	Description
1	VDD	Power Supply
2	GND	Ground
3	COMP	for the output cable voltage drop compensation
4	IFB	Primary current sense input. Used for cycle-by-cycle peak current control and limit
5	DRI	Base drive for the external power BJT switch
6	VFB	Voltage sense input from the auxiliary winding

Electrical Characteristic

(T_A = 25°C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Supply voltage						
Start-up Current	$I_{DD\ ST}$	VCC=13.5V		2.5	5	μA
Operation Current	$I_{DD\ op}$			180	230	μA
Operation Voltage	$V_{DD\ op}$			17.5		V
Turn-on Threshold Voltage	UVLO(ON)	VCCON	14	16.5	19.5	V
Turn-off Threshold Voltage	UVLO(OFF)	VCCOFF	6	7	8.2	V
Oscillator						
Maximum Operating Frequency	$f_{SW\ MAX}$			55		KHz
Minimum Operating Frequency	$f_{SW\ MIN}$		1.2	1.8	2.2	KHz
Current Sensing						
Leading Edge Blanking	T_{LEB}		400	450	500	ns
Maximum Current Sense Detection Voltage	$V_{OCP\ MAX}$	VCC=20V	0.861	0.875	0.891	V
Minimum Current Sense Detection Voltage	$V_{OCP\ MIN}$	VCC=20V		0.275		V
Voltage Sensing						
Reference Voltage for EA	V_{REF_EA}	VCC=20V	1.901	1.94	1.969	V
Else						
Output Delay Time	T_{DELAY}			150		ns
Output Driver Current	I_{DRIVER}		15	20	25	mA
Reference Voltage for Over Voltage Protection	V_{REF_OV}			2.5		V
Soft Start Time	T_{SS}			1		ms

Absolute Maximum Ratings

Parameter	Symbol	Value	Unite
VDD pin input voltage	VDD	40	V
Power Dissipation	P_D	400	mW
Sense pin input voltage	V_{VFB} V_{IFB}	7	V
Lead temperature	T_L	260	℃
Operating Junction Temperature	T_J	-40 to +125	℃
Storage Temperature Range	T_{STJ}	-55 to +150	℃

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.

Operation Description

● CC/CV Operation

The BF1502-B uses PFM control mode in CC mode while PWM+PFM mode in CV mode. In charger applications, a discharged battery starts charging in the CC mode, the IC switches to CV mode until the battery is nearly full charged. In order to achieve constant output current and voltage, the working frequency and primary-side peak current will be changed with the feedback voltage of VFB pin. The output voltage and current is given by:

$$V_{OUT} = 2 \cdot \frac{R_6 + R_7}{R_7} \cdot \frac{N_S}{N_A} - V_D \quad (1)$$

Where V_D indicates the drop voltage of output Diode, N_S/N_A indicates the transformer secondary-auxiliary turns ratio.

$$I_{OUT} = \frac{1}{2} \cdot \frac{3}{7} \cdot \frac{N_P}{N_S} \cdot I_P \quad (2)$$

Where I_P indicates the maximum peak current of primary winding, N_P/N_S indicates the primary-secondary turns ratio.

●Cycle-by-Cycle Current Limiting

The primary-side current flow through the sense-resistor and make the voltage on IFB pin ramp up. When the voltage exceeds the internal threshold voltage value, the power BJT will be turned off immediately. The threshold voltage is changing gradually in CV mode while constant in CC mode.

●Soft Start

A built-in soft start circuit is applied at start-up state. Once the VDD reaches UVLO(ON), the primary-side peak current voltage threshold will ramp up from 0.275V to 0.9V gradually because of the soft start circuit.

●Voltage Protection Function

The BF1502-B includes such a function that protect against output over-voltage and under-voltage, which could be monitored by VFB pin and VDD pin. If the voltage at VFB pin exceeds the over-voltage threshold, the external power BJT will be turned off immediately and the controller will restart. Once VDD drops below the UVLO(OFF) threshold, the controller will reset itself and go into a new start cycle. The controller will continue the start cycle until the error condition is removed.

●Output Cable Drop Compensation

The BF1502-B includes programmable output cable compensation to achieve good load regulation. The cable drop compensation is programmable by changing the value of the resistance R6. The maximum compensation voltage V_{COMP} is given by:

$$V_{COMP} = I_{COMP} \cdot R_6 \cdot \frac{N_S}{N_A} \quad (3)$$

Where $I_{COMP} = 55uA$ is the maximum compensation current which generated by an internal current source.

Test Circuits

(1) Current consumption in start up period (Test circuit 1)

Test Condition:

Connect IFB and COMP pin to ground, R1=20Kohm, make the DRI pin floating and set V2=1±0.03V.

Test Method:

Set V1=5±0.03V with 1ms delay time.

Keep V2 powered, increase V1 to 13.5±0.03V, the current A1 flowing into VDD is the current consumption.

(2) Hysteresis start-up (Test circuit 1)

Test Condition:

Connect IFB and COMP pin to ground, R1=20Kohm, make the DRI pin floating and set V2=1±0.03V.

Test Method:

Set V1=5±0.03V with 1ms delay time.

When V1 increases over Vx1, the IC starts to work normally, and only when V1 decreases under Vx2, the IC stops working and moves into standby mode.

Vx1 is the voltage V1 when the output (the DRI pin) frequency changes from 0 to (13±4KHz).

Vx2 is the voltage V1 when the output (the DRI pin) frequency changes from (13±4KHz) to 0.

(3) EA reference voltage (Test circuit 2)

Test Condition:

Connect IFB and COMP pin to ground, R1=20Kohm, make the DRI pin floating and set V1=5±0.03V, Set V2=1±0.03V.

Test Method:

Set V1=20±0.03V with 5ms delay time.

The EA reference voltage is the voltage V2 when the output (the DRI pin) frequency changes from (13±4KHz) to 0.

(4) Over current protection detection voltage (Test circuit 3)

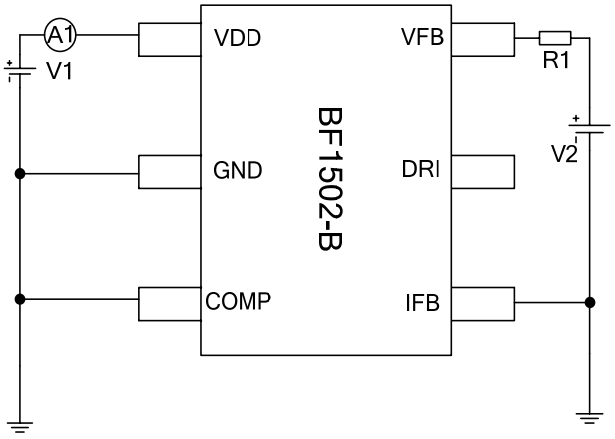
Test Condition:

Connect COMP pin to ground, R1=20Kohm, make the DRI pin floating and set V1=5±0.03V, V2=1±0.03V, Set V3=0±0.03V.

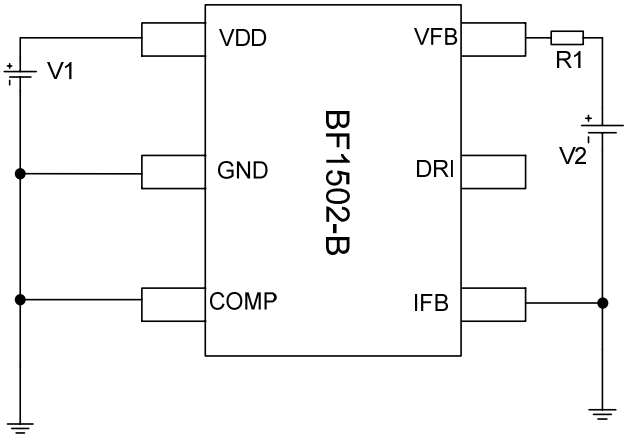
Test Method:

Set V1=20±0.03V with 5ms delay time.

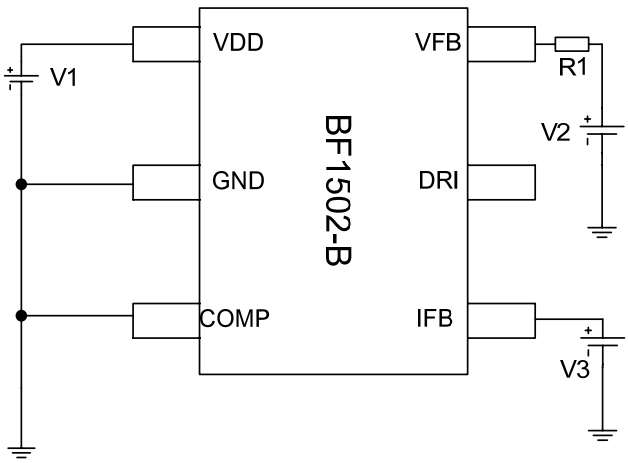
The over current protection detection voltage is the voltage V3 when the output (the DRI pin) frequency changes from (13±4KHz) to 0.



Circuit1: For testing current consumption, hysteresis start-up



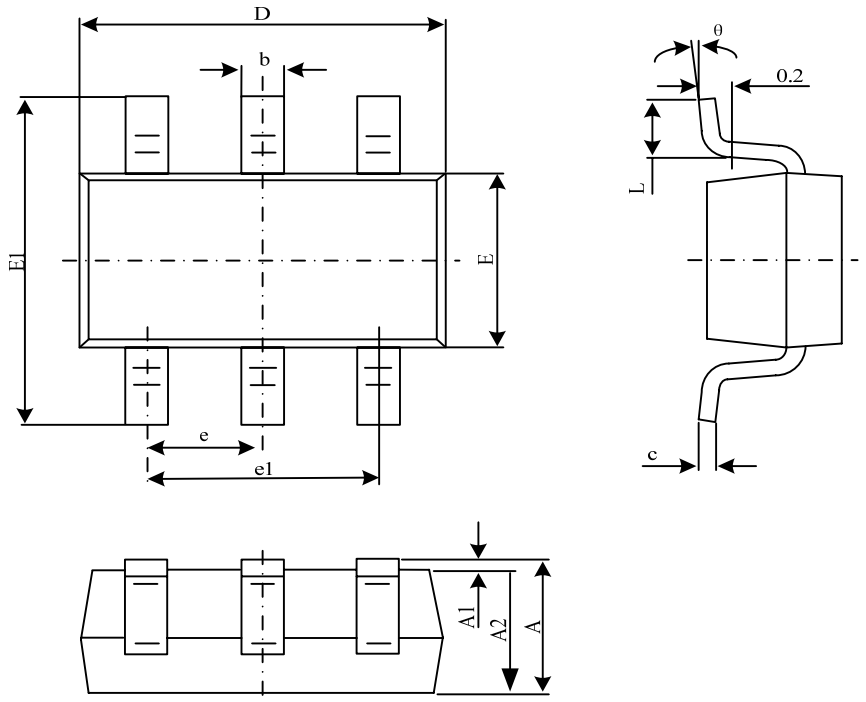
Circuit2: For testing EA reference voltage



Circuit3: For testing Over current protection detection voltage

Package Outline

SOT23-6



Symbol	Dimensions In Millimetres		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

RESTRICTIONS ON PRODUCT USE

- The information contained herein is subject to change without notice.

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