QUASI RESONANT CURRENT MODE SWITCH FOR FLYBACK SWITCHING MODE POWER SUPPLY

1. Description

The iP7517 is a Switched Mode Power Supply switch IC with advanced energy features to meet stringent global energy efficiency requirements.
iP7517 combines a true current mode modulator and a zero current detector to ensure full borderline/critical conduction mode in any load/line conditions and minimum drain voltage switching (Quasi-Resonant operation).
Quasi-Resonant operation is achieved by means of a transformer zero current sensing input ZCD that triggers MOSFET on.
The iP7517 integrates built-in advanced energy saving features with high level protection features to provide cost effective and reliable solutions for energy efficient power supplies.
The iP7517 also features an efficient protective circuitry which, in presence of an over-current condition, disables the output pulses and enters a safe mode, trying to restart. Once the fault has gone the device auto-recovers.
The switcher includes, Under-Voltage Lockout (UVLO), Leading Edge Blanking (LEB), and self-protection circuitry. Compared with discrete MOSFET and PWM controller solution, the iP7517 can reduce total cost, component count, size and weight; while simultaneously increasing efficiency, productivity, and system reliability. This device provides a basic platform that suits for cost-effective designs of quasi-resonant switching fly back converters.
The device includes a high voltage power switch and a circuit for start-up directly from the rectified mains voltage.

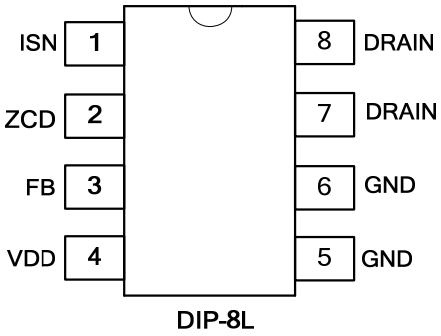
2. Features

- Single-end, pulse by pulse peak current mode PWM
- Quasi resonant for high efficiency and low EMI
- UVLO with high voltage start-up input for fast start-up and low standby current
- Wide operation voltage with OVP latched at 28 V on VDD
- Leading-Edge Blanking (LEB)
- Primary current limit, overload and open feedback protection latched
- Auto-recovery on through UVLO crossover
- Reduced current PFM at light load for ultimate power saving
- DIP-8L packaging, with few external components needed
- Internal over temperature protection (OTP)
- Direct opt coupler connection
- Internal minimum off time
- Integrated power switch: 6 Ω and 700 V
- Operates from universal AC mains supplies: 90~264 V

3. Applications

- Standby SMPS (LCD、TV、etc.)
- Offline battery chargers (cell phone etc.)
- LED driver (AC - DC LED Lighting.)

4. Pin Assignments



DIP-8L

5. Marking Information

Product Name	Marking
iP7517	iP7517 XXXXX X : Date Code

6. Ordering Code

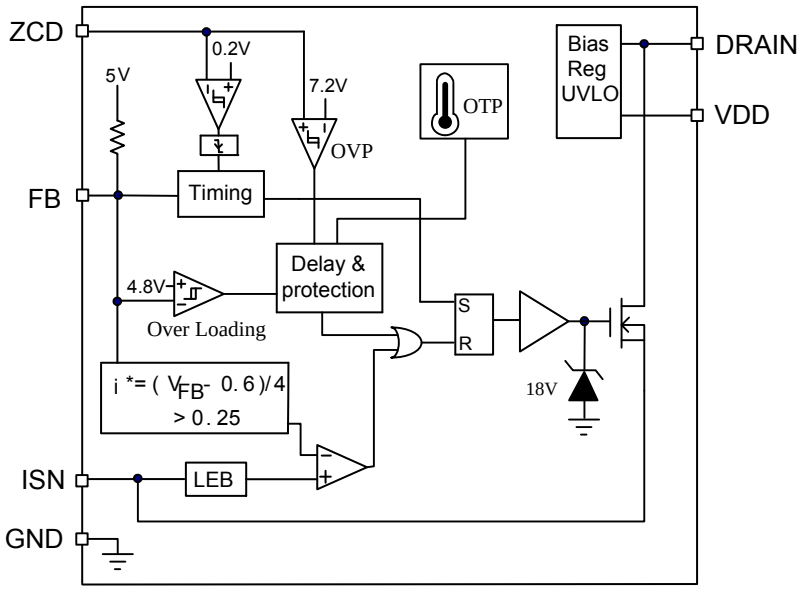
iP7517 □ └── Assembly Material	Assembly Material G: Halogen and Lead Free Device

Note: inergy defines “Green” as lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900 ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500 ppm by weight ; Follow IEC 61249-2-21 and IPC / JEDEC J-STD-020C)

7. Pin Definitions

Pin	Name	Description
1	ISN	Current sense / Power MOSFET source
2	ZCD	Zero current detect and secondary over voltage protect
3	FB	Feedback in
4	VDD	Supply power
5,6	GND	Ground
7,8	DRAIN	High voltage start-up power / Power MOSFET drain

8. Block Diagram



9. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply voltage	VDD	30	V
Maximum voltage on FB, ISN	-	- 0.3 ~ 6	V
Maximum voltage on Drain	-	700	V
Maximum junction temperature	TJ_{MAX}	150	℃
Storage temperature range	-	- 60 to + 150	℃
Operating junction temperature	T_J	- 40 to + 125	℃
ESD capability, HBM model	-	2.0	kV
ESD capability, MM model	-	200	V
Maximum voltage on ZCD	-	VDD + 0.3 ~ VDD - 50	V

10. Electrical Characteristics

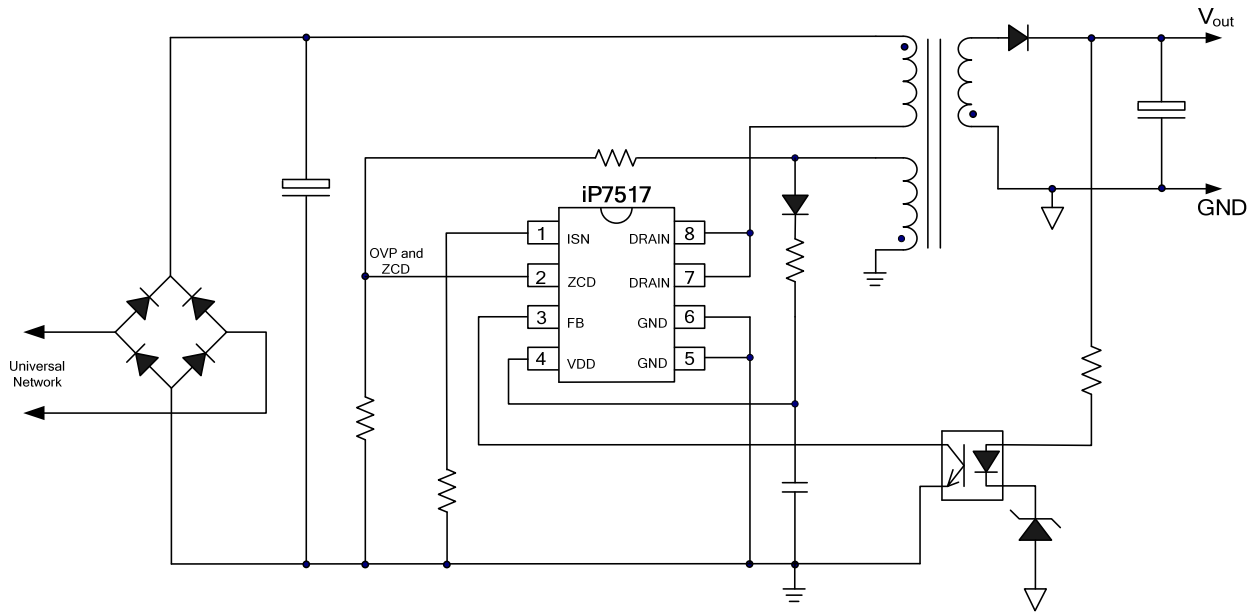
(For typical values T_J = 25 ℃, for min/max values T_J = - 40 ℃/ 120 ℃, VDD = 15 V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage section						
Start up current	IDD_{st}		-	20	30	uA
Turn on threshold	VDD_{on}		13	14	15	V
Operating current	IDD_{op}	f = 20kHz	-	1	1.8	mA
Output off threshold	VDD_{off}		8	9	10	V
On/off hysterisis	Hys		4	5	6	V
Latched off current	I_{latch}		-	200	-	uA
Latched off clear	VDD_{latch}		-	6	-	V
Drain start-up supply section						
supply current	IH_{on}	V_{Drain} = 50 V, VDD = VDD_{off}	-	2	-	mA
standby current	IH_{stb}		-	4	-	uA
Zero Current detect section						
Zero current detect	V_{TH}	Negative slope	-	0.2	-	V
Zero current detect hysteretic	V_h		-	0.05	-	V
ZCD input impedance	R_{int}	< 0 V or > 1 V	-	100	-	kΩ
		0 V < V_{ZCD}< 1	-	1	-	MΩ
Delay to turn on	t_{ZCD}		-	300	-	ns
Input capacitance	C_{par}	V_{ZCD} = 1.0 V	-	10	-	pF
Minimum off time	t_{OFF}		-	4	-	us
Secondary OVP threshold	V_{ovth}		-	7.2	-	V
Secondary OVP LEB	t_{sample}		-	2	-	us
Feedback section						
Pull up resistor	R_{up}		-	20	-	kΩ
V_{FB} / I_{SENSE}	I_{ratio}	(FB - 0.6) / 4	-	4	-	
FB for PFM onset	V_{PFM}		-	2.6	-	V
Isense section						
Delay to turn off	t_{delay}		-	100	-	ns
LEB	t_{LEB}		-	300		ns
High current limit	V_{ilimit}		-	1.1	-	V
low current limit	$V_{illimit}$	PFM mode	-	0.25	-	V
Source current	I_s	Pin open protect	-	1	-	uA
Power switch section						
Turn-on R_{DS}	R_{DSon}	VDD =15 V, ID = 0.5 A	-	5.5	6.5	Ω

10. Electrical Characteristics (cont.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Protection section						
Over current limit	V_{oc}		-	1.1	-	V
Overload on	V_{ol}		4.5	4.8	5.1	V
Overload delay	t_{od}		-	60	-	ms
Over voltage	V_{ov}	latch	-	28	-	V
Over Temp on	T_{ot}		-	130	-	℃

11. Application Circuit



12. Typical Characteristics

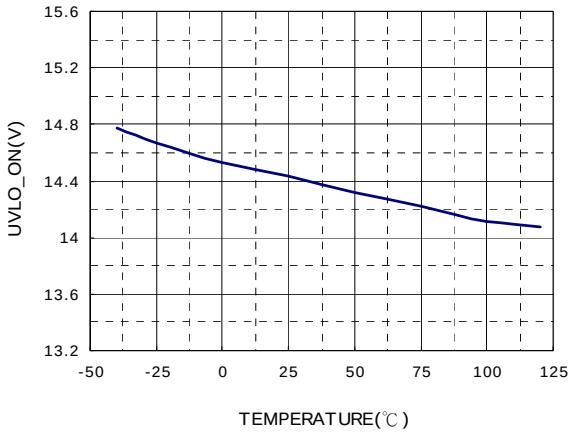


Figure 1. UVLO_ON vs Temperature

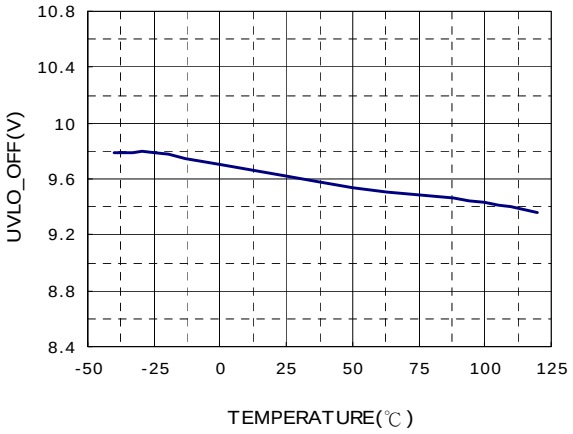


Figure 2. UVLO_OFF vs Temperature

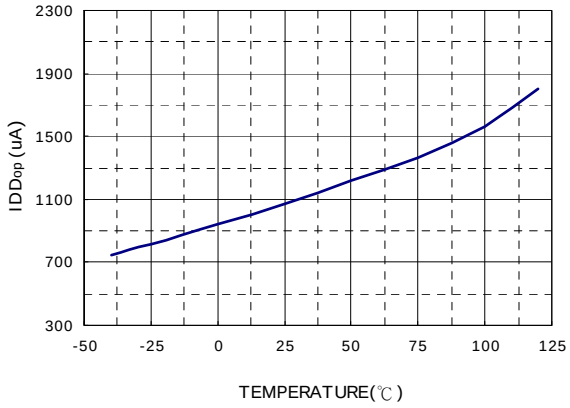


Figure 3. IDD operation current vs Temperature

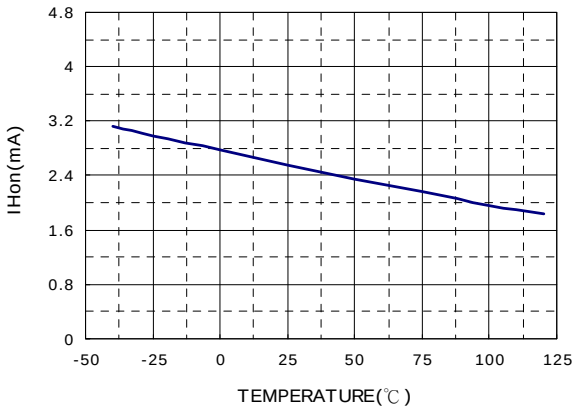


Figure 4. Drain start-up supply current vs Temperature

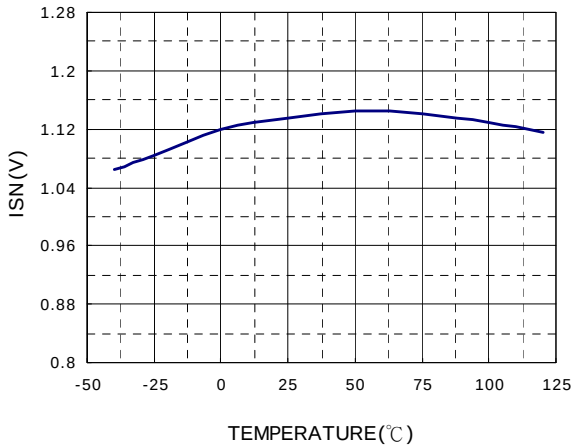


Figure 5. ISN vs Temperature

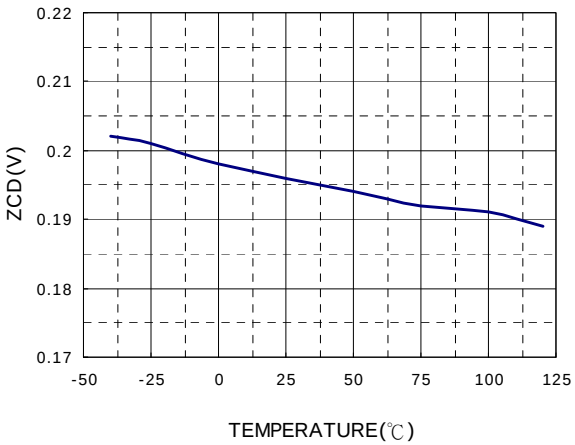


Figure 6. ZCD vs Temperature

12. Typical Characteristics (cont.)

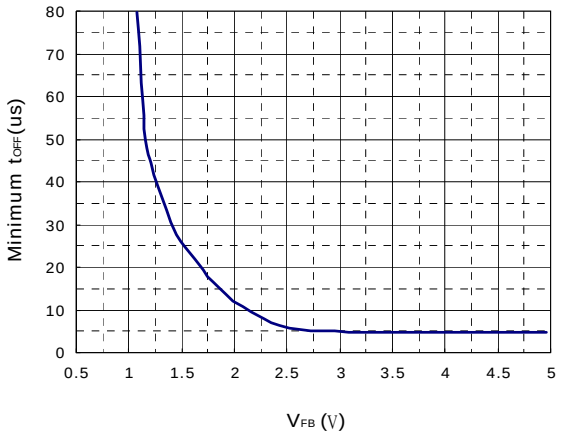


Figure 7. Minimum t_{OFF} vs V_{FB} (25℃)

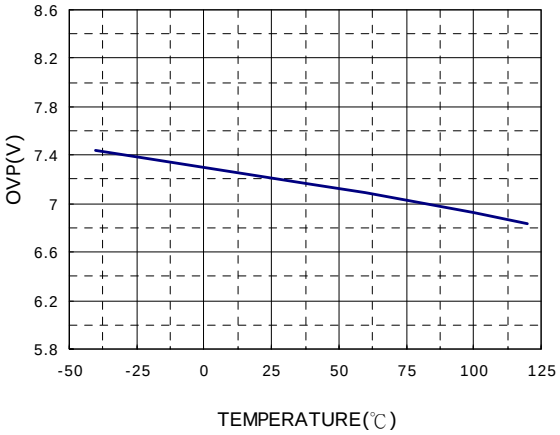


Figure 8. OVP (VDD = 15V, Rfb = 47kohm)

13. Functional Description

iP7517 is a quasi resonant switch for single-end fly back converter. It is designed for AC/DC converter using only minimal external component.

a. Under voltage lock out

The power is supplied between VDD (pin 4) and GND (Pin 5, 6). Below UVLO's on voltage, controller is in UVLO state it takes very small current ,as low as 20 uA to detect external voltage and protection Pin 6 is supposed to be connected to power in. When VDD below 6 V, an internal HV transistor is turned-on so supply current flows from pin 6 to VDD. When voltage rises above UVLO's on voltage (14V), the controller starts to operate and the HV transistor is turned off. The start-up current is about 4 uA. In the operation mode, controller consumes about 1mA. It would continue to operate unless the voltage drops below UVLO off voltage (9V) However, the HV transistor would not return on unless VDD voltage drops below 6 V. Between this period, IC consumes 200 uA so VDD would eventually decreases to 6 V and HV transistor would be re-turned-on

b. Feed back

At UVLO situation , FB pin sinks low with 1 mA current. Once the UVLO is released, V_{FB} is pull up to internal 5 V through a 20 kΩ resistor.
V_{FB} minus 0.6 V and divided by 4 is equal to the reference turn-off current, i*. So V_{FB} equals to 5 V and corresponds to the maxima shunt voltage of current of 1.1 V.
Above half load, VFB of 2.6 V, switching frequency is limited through a 5 us minimum off-time. Below half-load point, V_{FB} = 2.6 V, switching frequency is reduced by increasing the minimum off-time. At quarter-load point, V_{FB} =1.6 V, the minimum off-time is 50uSec, corresponds to audible limit 20 kHz. At this load-range, both turn-off peak current and minimum off-time vary.
Below this point, as the load degreases further, V_{FB} is even further down and minimum off time further increases, however, the shunt voltage of turn-off peak current is limited at 0.25 V. Therefore, at light load, V_{FB} controls the output power through the re-turn-on time or minimum off time, resulting to a pure PFM.
Virtually at V_{FB} = 0.6 V will correspond to infinite minimum off-time.
If the feedback voltage is higher than 4.9 V for more than 60 ms, PWM would be stopped and latched, which is defined as overload protect. It stays latched till it enters UVLO state.

c. Zero Current detect

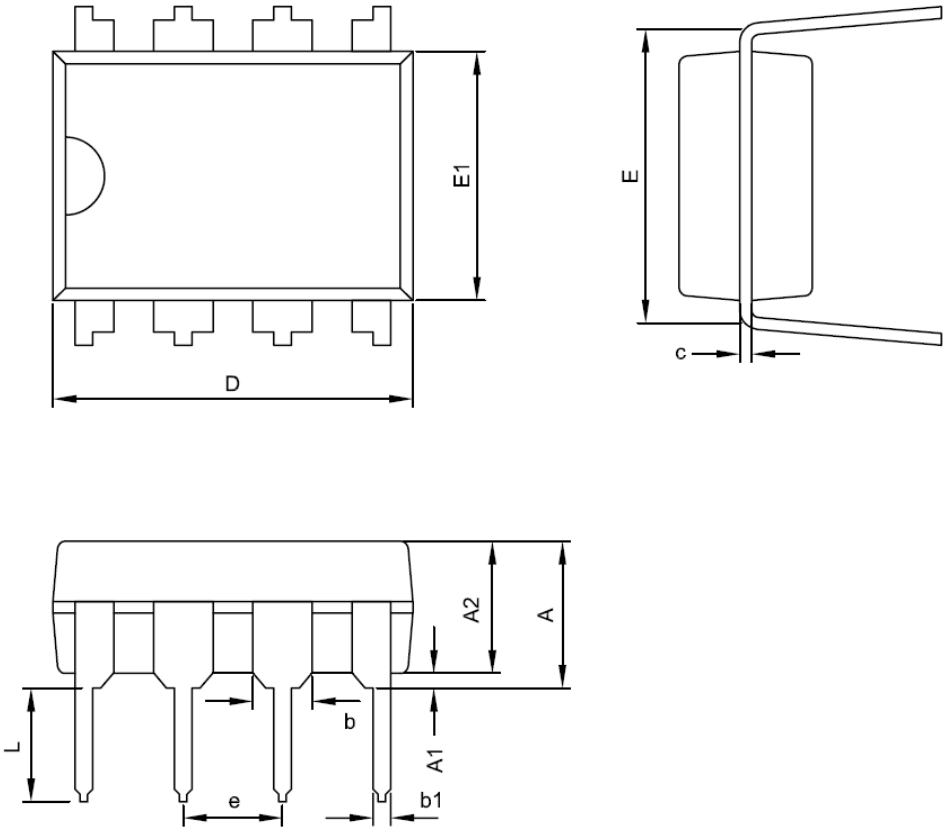
The ZCD signal is sensed through an internal resistor of 100 kΩ, and the sensing end is clamped between 0 and 1 V. This voltage is compared with 0.2 V reference, and the falling edge of the comparator's output is used as a set signal for PWM-on. However, the set signal is inhibited for minimum off-time, which is predetermined by feedback voltage.
At full load, PWM will turn-on 300 ns after falling edge of the ZCD signal, which should correspond to the 1st valley of MOSFET's drain voltage. A small capacitor may be connected between ZCD and ground to delay the turn-on time to match the valley's minima. As the load decreases, the MOSFET's drain voltage falling edge comes sooner. At some point, the 1st falling edge comes sooner than minimum off-time, so set signal is masked and turn-on is not initiated, then drain voltage will continue to oscillate, but with decreasing amplitude. The next falling edge which comes after minimum off-time will generate turn-on signal to trigger on PWM.

d. Current sense

ZCD signal triggers PWM to turn-on main MOSFET, and current through transformer primary winding and MOSFET starts to increase. This current is monitored through ISN pin, which senses the voltage across the shunt resistor. When the current reaches reference turn-off current, i*, the MOSFET is turn-off.
Usually , even though it is not prominent at quasi-resonant converter, at MOSFET turn-on is a current spike caused by the discharge of parasitic capacitance of MOSFET and diode, So here a 300 ns mask for not to detect the current sensing (Leading edge blanking / LEB) is included to prevent premature turn-off.

13. Package Dimensions

DIP- 8L



Symbol	Dimensions In Millimeters	
	MIN.	MAX.
A	3.71	5.33
A1	0.38	--
A2	3.20	3.61
D	9.02	10.16
E	7.62 BSC	
E1	6.20	6.60
c	0.20	0.36
b	1.52 BSC	
b1	0.38	0.56
e	2.54 BSC	
L	2.92	3.81