

***SWITCH-MODE
POWER SUPPLIES***

TABLE OF CONTENTS		Page
1	Introduction	3
2	Technology Overview	3
3	ZETTLER SMPS Solutions	6
3.1	ZETTLER High Performance SMPS Solutions	7
3.2	ZETTLER High Performance SMPS X-Cross (zero-cross) detection Solutions	8
3.3	ZETTLER Ultra-wide Input High Performance SMPS Solutions	9
3.4	ZETTLER Performance SMPS Solutions	9
4	Applications	12
5	ZETTLER Contacts	13

1 Introduction

The trend towards energy saving cannot be stopped with regard to modern electronics either. In many applications, regulations apply in various countries to regulate the standby consumption of the devices. This is often difficult to achieve with conventional transformers. The advantages of a power source with a switched-mode power supply are obvious here. Since power is transmitted at a higher frequency here, the volume of the magnetic core can be reduced for the same power in order to minimize power loss and size. Encapsulated Switch-Mode Power Modules (SMPS) are used in a myriad of different applications to ensure an efficient energy supply.

ZETTLERs industry-leading magnetic components are designed for use in a wide area of **electronic applications requiring an energy-saving, small and economic power source.**

2 Technology Overview

In conventional power supplies a linear regulator provides the desired output voltage by dissipating excess electric power in form of heat, and hence its maximum power efficiency is given by the ratio of input to output voltage.

A Switch Mode Power Supply (SMPS) regulates its output voltage by switching energy storage elements such as inductors, by means of a transistor changing “on” and “off” states at high frequencies. In this mode of operation, the transistor has a very low resistance in its “on” state, thus enabling the converters to operate with high efficiency. The PWM duty cycle of the transistor is controlled by an integrated circuit ensuring proper output voltage regulation.

For mains input Switch Mode Power Supplies the necessary isolation is achieved by the built-in transformer which also acts as a mutual inductor for energy storage. Due to the high switching frequency this transformer can be of a much smaller size compared to 50/60Hz iron core types. This results in compact and light weight supplies, enabling applications with high power density.

Switch Mode Power Supplies come in various topologies, all with their specific advantages for certain applications and output power ranges. In the low to medium output power range, Flyback Switch Mode Power Supplies provide a solid and cost-effective solution for a wide array of demands.

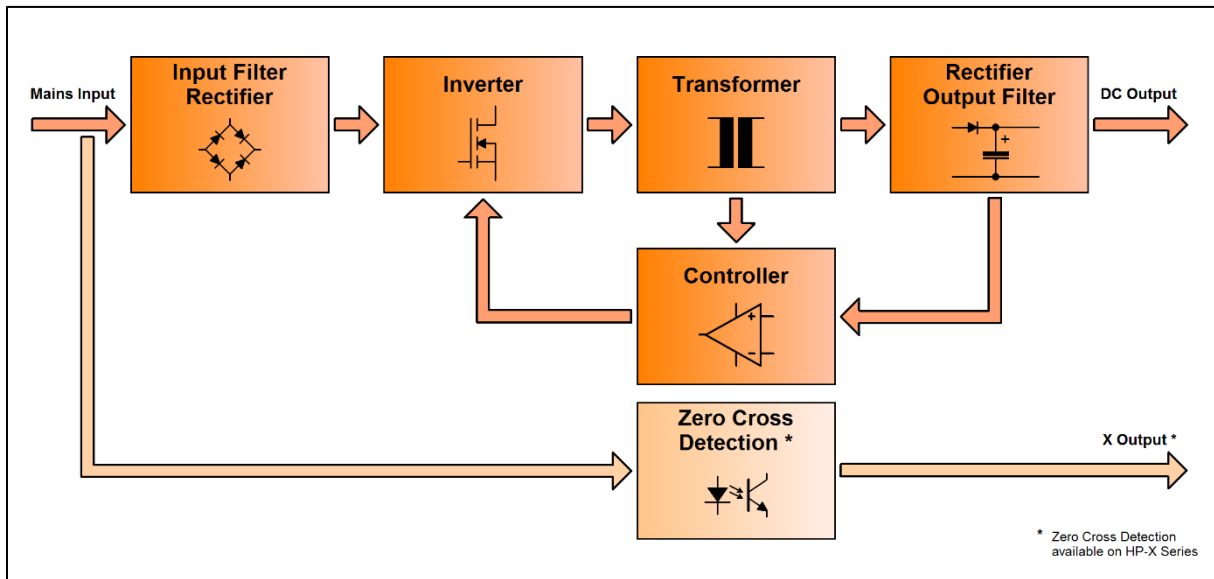


Figure 1: Flyback topology

The first stage of a mains AC input SMPS is the input filter and rectifier stage which converts the mains voltage into an unregulated DC voltage, fed to a large filter capacitor. The current drawn from the AC side is in short pulses at the peak input voltage which causes harmonic distortions. These have to be compensated by suitable line filter circuits and PFC (Power Factor Correction) circuits, usually also contained in the input stage.

The inverter stage converts the unregulated DC voltage to AC by chopping it with a power transistor at high frequency. The duty cycle of the resulting AC voltage determines the amount of energy fed to the primary winding of the transformer, which then converts the voltage down to the required output levels on its secondary side.

SMPS transformers run at high frequency. Most of the cost and space savings in mains input Switch Mode Power Supplies result from the smaller size of the high frequency transformer. The transformer's capability to transfer energy is proportional to the operating frequency. By using a much higher frequency, the core can be greatly reduced compared to 50/60Hz types. However, core losses increase at higher frequencies, thus ferrite material which has a low loss at the high frequencies is used.

The transformer's AC output then is rectified and smoothed by a filter consisting of inductors and capacitors. The higher the switching frequency, the smaller the size of these components is needed.

To compensate for output load variations and input voltage changes, a feedback control loop is needed. This feedback loop typically consists of an isolated auxiliary winding of the transformer fed to the controller IC. In addition, the controller IC serves the purpose of supervisory and security protection features. Common protection features are over temperature protection, output short protection and over voltage protection.

Zero Cross Detection Output

In many applications it is advantageous to synchronize various events to the mains frequency and phase. For example, the efficiency of power Thyristor circuits is increased and component service life, e.g., for relays, is extended if switching occurs at zero-crossing. In addition, sensing applications like those frequently found in the 'Smart Home' market, need to eliminate 50/60 Hz noise, which can be easily accomplished by synchronizing built-in A/D converters with the mains frequency.

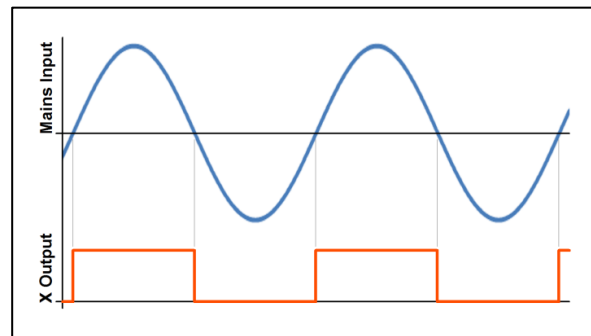


Figure 2: Zero-Cross

ZETTLER Magnetics' patent-pending HP-X Series SMPS come with a **built-in zero-cross detection 'X-Output'**. The output is electrically isolated from the mains input and monitors frequency and phase of the AC input. With this pre-certified solution, customers have an easy and cost-effective way to optimize their design (see more on the following pages).

3 ZETTLER SMPS Solutions

ZETTLER Magnetics offers a series of encapsulated, cost effective and reliable AC-DC power modules with a wide universal input range in a compact, plug & play package. These are ideal for a variety of smart energy solutions such as low power lighting controls, audio or thermostat controls and other smart home electronics applications, as well as industrial controls.



Figure 3: SMPS

Key Features

- Universal Input Range 85VAC-305VAC*
- Compact encapsulated design
- Wide ambient temperature capability -25°C to +85°C*, full power output w/o derating
- Low standby power consumption <0.15W
- Protection Capability: OVP, OSP, OCP, OPP.
- Compliance with UL/IEC standards
- EMC compatible.

Key Benefits

- Easy Plug & Play solution for control board applications
- Long life: MTBF >1 million hours*
- High Efficiency
- Customizable.

ZETTLER Magnetics SMPS Modules come in high performance “HP” and performance “ZP” series.

3.1 ZETTLER High Performance SMPS Solutions

HP01 Series

1 Watt single output High Performance series.

- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 3,3 VDC to 24 VDC available
- Long lifetime: MTBF > 1 million hours
- TUV (Sud) certificate B0718110034
- UL file E309909
- CE compliant



Figure 4: HP01

HP02 Series

2 Watt single output High Performance series.

- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 3,3 VDC to 24 VDC available
- Long lifetime: MTBF > 1 million hours
- TUV (Rheinland) certificate R50483987
- UL file E309909



Figure 5: HP02

HP03 Series

3 Watt single output High Performance series.

- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available
- Long lifetime: MTBF > 1 million hours
- TUV (Sud) certificate B0718110039
- UL file E309909
- CE compliant

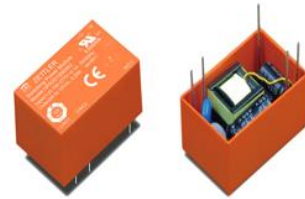


Figure 6: HP03

3.2 ZETTLER High Performance SMPS X-Cross (zero-cross) detection Solutions

HP01-X Series

1 Watt single output High Performance Zero-Cross series.

- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Isolated output synchronous to mains zero crossing
- Suitable to minimize losses in power Thyristor/TRIAC circuits
- Mains phase, frequency and zero-cross detection and monitoring
- Timing applications, A/D converter to mains synchronization
- Mains dropout detection
- Operating components at zero crossing to extend life and reduce switching power losses
- Output voltage from 5 VDC to 18 VDC available



Figure 7: HP01-X

3.3 ZETTLER Ultra-wide Input High Performance SMPS Solutions

HPI10 Series

10 Watt single output wide input High Performance series.

- AC input voltage range: 90VAC to 528 VAC
- DC input voltage range: 120 VDC to 745 VDC
- Ambient temperature: -40°C to +80°C
- Isolation voltage I/O: ≥ 4000 VAC 60 s
- Output voltage from 12 VDC to 24 VDC available
- UL file E309909
- CE compliant



Figure 8: HPI10

3.4 ZETTLER Performance SMPS Solutions

ZP01 Series

1 Watt single output Performance series.

- AC input voltage range: 90 VAC to 265 VAC
- DC input voltage range: 100 VDC to 370 VDC
- Ambient temperature: -25°C to +70°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available



Figure 9: ZP01

ZP03 Series

3 Watt single output Performance series.

- AC input voltage range: 85 VAC to 265 VAC
- DC input voltage range: 100 VDC to 370 VDC
- Ambient temperature: -25°C to +50°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available
- UL file E309909



Figure 10: ZP03

ZP05 Series

5 Watt single output Performance series.

- AC input voltage range: 90 VAC to 244 VAC
- DC input voltage range: 100 VDC to 370 VDC
- Ambient temperature: -25°C to +50°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available
- TUV (Sud) certificate B0718110041
- UL file E309909
- CE compliant



Figure 11: ZP05

ZP10 Series

10 Watt single output Performance series.

- AC input voltage range: 85 VAC to 265 VAC
- DC input voltage range: 100 VDC to 370 VDC
- Ambient temperature: -25°C to +70°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 3,3 VDC to 24 VDC available
- TUV (Sud) certificate B0718110045
- UL file E309909
- CE compliant



Figure 12: ZP10

ZP20 Series

20 Watt single output Performance series.

- AC input voltage range: 90 VAC to 264 VAC
- DC input voltage range: 100 VDC to 370 VDC
- Ambient temperature: -25°C to +50°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available
- UL file E309909



Figure 13: ZP20

4 Applications

ZETTLER SMPS Modules are designed and suited for a broad spectrum of possible applications:

- **Building Automation Control Boards**
 - Smart Home applications
 - Wireless switching
 - Lighting Controls (including LED Driver boards)
 - HVAC control boards (including Thermostats)
 - Motorized Blinds & Shades
 - Smart Energy applications

- **White Goods/Appliances**
 - Washing Machines
 - Refrigerators
 - Microwaves
 - Coffee machines and other small appliances

- **Test & Measurement Devices**
 - Smart Meters
 - Scientific Instruments
 - Smart power outlets/Smart power strips.

SMPS modules from ZETTLER Magnetics are manufactured in our fully automated manufacturing facility in Xiamen, China, and subject to stringent quality controls. They are sold and distributed globally via ZETTLER Group's Magnetics companies operating in China, Europe, North America and Hong Kong.

5 ZETTLER Contacts

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