

***SWITCH-MODE
POWER SUPPLIES***

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1 Introduction

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.

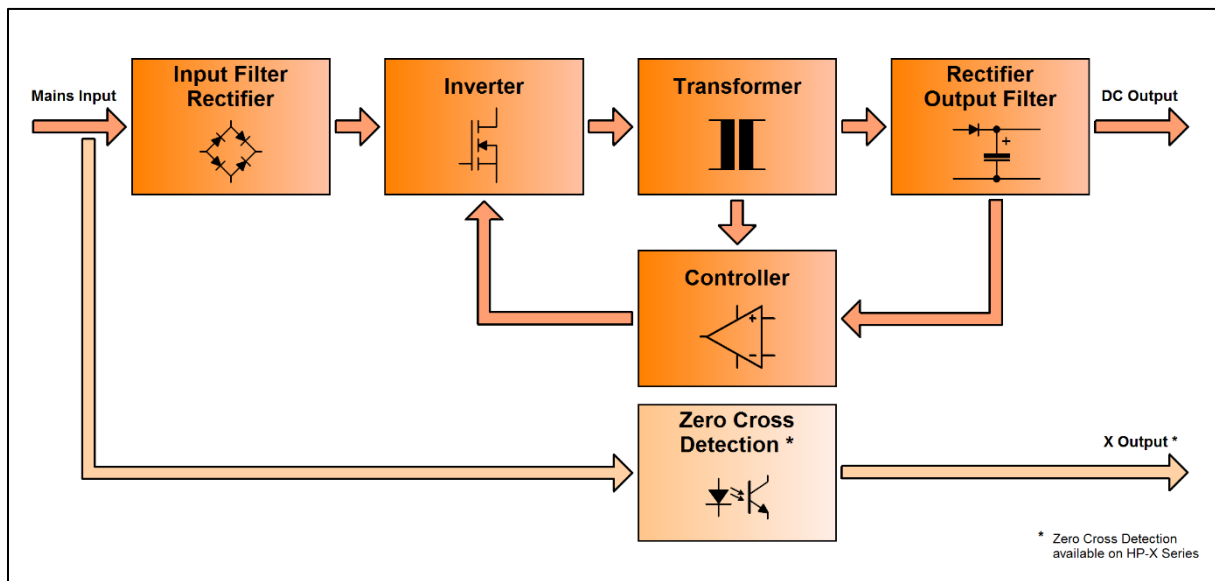


Figure 1: Flyback topology

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.

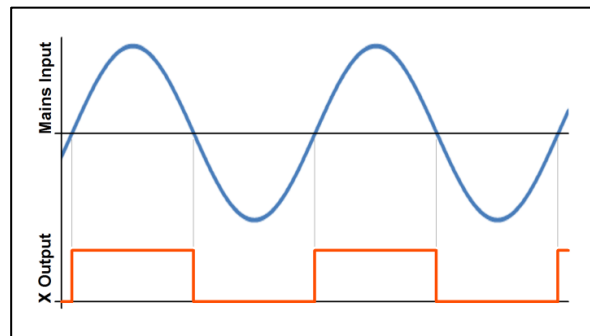


Figure 2: Zero-Cross

ZETTLER Magnetics' HP01-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.



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

Features

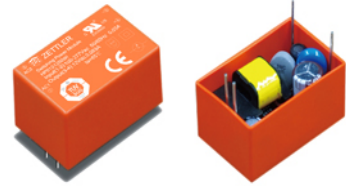
- Compact encapsulated designs
- Low standby power consumption
- Protection Capability: OVP, OSP, OCP, OPP
- Compliance with UL/IEC standards
- EMC compatible
- Long life: MTBF >1 million hours*
- High Efficiency
- Wide input voltage and ambient temperature range options

3.1 ZETTLER High Performance SMPS Solutions

HP01Sxx00WI Series

1 Watt single output High Performance series.

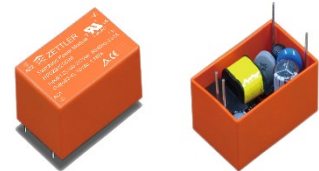
- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 3,3 VDC to 24 VDC available
- Long lifetime: MTBF > 1 million hours
- TUV (Sud) certificate B0718110034
- TUV (Rheinland) certificate R50483987 / 50503882
- UL file E309909
- CE compliant



HP02Sxx00WI Series

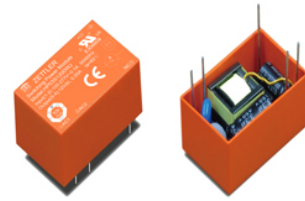
2 Watt single output High Performance series.

- 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 / R50503882
- UL file E309909
- CE compliant



HP03Sxx00WJ Series

3 Watt single output High Performance series.

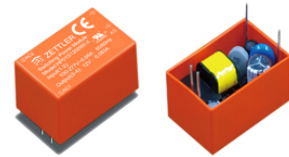


- AC input voltage range: 85 VAC to 305 VAC
- DC input voltage range: 100 VDC to 430 VDC
- Ambient temperature: -25°C to +85°C
- Isolation voltage I/O: ≥ 3000 VAC 60 s
- Output voltage from 5 VDC to 24 VDC available
- Long lifetime: MTBF > 1 million hours
- TUV (Sud) certificate B0718110039
- UL file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

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

HP01Sxx00WI-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 at zero crossing to extend life and reduce switching power losses
- Output voltage from 5 VDC to 18 VDC available
- TUV (Sud) certificate B0718110049
- CE compliant

3.3 ZETTLER High Performance SMPS with ultra-wide input

HPI10Sxx00Ex 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
- TUV (Sud) certificate B0718110048
- UL file E309909
- CE compliant

3.4 ZETTLER Performance SMPS Solutions

ZP03Sxx00WE Series

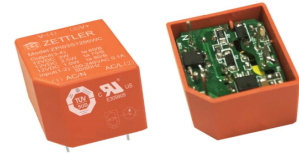
3 Watt single output Performance series.



- 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
- TUV (Rheinland) certificate R50510396 / R50507200
- UL file E309909
- CE compliant

ZPI03Sxx00WC Series

3 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 +85°C
- Isolation voltage I/O: ≥ 3600 VAC 60 s
- Output voltage from 3.3 VDC to 24 VDC available
- TUV (Sud) certificate B0718110063 / B0718110061
- UL file E309909
- CE compliant

ZP05Sxx00WB Series

5 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
- TUV (Sud) certificate B0718110051
- UL file E309909
- CE compliant

ZP10Sxx00W 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 B0718110068
- CE compliant

ZPL15Sxx00WL Series

15 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
- TUV (Sud) certificate B0718110059 / B0718110059
- UL file E309909
- CE compliant

ZPL20Sxx00WL Series

20 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 +50°C**
- **Isolation voltage I/O: ≥ 3000 VAC 60 s**
- **Output voltage from 5 VDC to 24 VDC available**
- **TUV (Sud) certificate B0718110059 / B0718110059**
- **UL file E309909**
- **CE compliant**

3.5 ZETTLER Performance SMPS with wide input

ZPL15Sxx00WS Series

15 Watt single output Performance series.



- **AC input voltage range: 90 VAC to 305 VAC**
- **DC input voltage range: 120 VDC to 430 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 B0718110059 / B0718110059**
- **UL file E309909**
- **CE compliant**

ZPL20Sxx00WS Series

20 Watt single output Performance series.



- **AC input voltage range: 90 VAC to 305 VAC**
- **DC input voltage range: 120 VDC to 430 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 B0718110059 / B0718110059**
- **UL file E309909**
- **CE compliant**

ZPI30Sxx00WN Series

30 Watt single output Performance series.



- **AC input voltage range: 90 VAC to 305 VAC**
- **DC input voltage range: 120 VDC to 430 VDC**
- **Ambient temperature: -30°C to +70°C**
- **Isolation voltage I/O: ≥ 3000 VAC 60 s**
- **Output voltage from 12 VDC to 24 VDC available**
- **TUV (Sud) certificate B0718110074**
- **CE compliant**

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 Engery 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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