ZETTLER

NEW ENERGY SOLUTIONS

SOLAR RELAYS

TABLE OF CONTENTS

Page

1. Introduction

Innovation and leading-edge product development have always been a hallmark of ZETTLER Group's engineering competence. During recent years, this has been particularly evident by our leadership role in providing component solutions in the field of **Alternative and Renewable Energy** and by developing special electromechanical switching devices for these types of applications.

As solar and other alternative energy technologies continue to grow globally, ZETTLERs **NEW ENERGY SOLUTIONS** division is committed to supporting customers in renewable energy industries around the world, with first-class engineering and new product design, and by leveraging ZETTLER Groups worldwide production and distribution resources.

ZETTLERs industry-leading electromechanical 'new energy' components are designed for use in **solar inverters, electric vehicle charging devices, or any similar applications requiring high loads to be switched and carried.**

2. Solar Relays Overview

Power inverters are an integral part of any solar energy system, converting DC power output coming from solar panels into AC current that can be fed into a commercial electrical grid or into an off-grid local electrical network. In the interface to the power grid, electro **mechanical relays on the AC side of the inverter** play a critical role as switching devices and to provide necessary safety 'circuit-break' functions.

The 'ZETTLER Advantage'

As photovoltaic (PV) power applications proliferate from micro-inverters, to string inverters, to commercial and even utility-scale PV systems, we have continually expanded our line of solar relays. These state-of-the-art ZETTLER components have been **successfully integrated** into many inverter applications by **market-leading manufacturers of PV systems** since many years.

Today, ZETTLER's product line of **AC circuit Solar relays** spans across an extended range of product characteristics:

- **covering PV inverter applications from under 20 kVA to over 100 kVA,**
- **handling continuous currents from 12 A to as high as 200 A and**
- **max. switching currents ranging from 12 A to 100 A, and**
- **featuring min. contact gaps from 1.5 mm to 4.6 mm.**

Since its inception, ZETTLER **NEW ENERGY SOLUTIONS** product design and engineering staff has proactively anticipated the PV inverter industry's desire to replace space and power consuming, relatively expensive contactors with increasingly smaller and more energy and cost efficient PCB relays.

ZETTLER Europe was one of the first companies to have successfully developed and produced a **35 A and 50 A PCB solar relay (AZSR235/250)** with a footprint of just 25mm x 40mm and the capability of handling 2 x 35A (50 A) at a holding power of < 100 mW (see below under **3.2** and **3.3**).

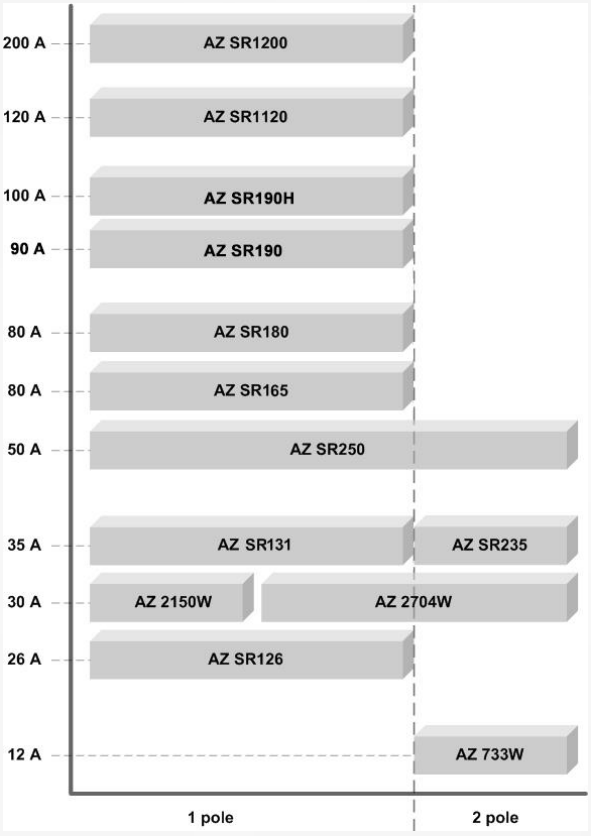

Figure 1: Relay overview

As pertinent safety standards such as IEC 62109, UL 62109 and DIN VDE V 0126-1-1 gradually evolved and internationally converged, additional capabilities of solar relays deployed in solar inverter applications became necessary to fulfil ever higher isolation requirements, which - in turn - continued to raise the bar, especially with respect to wider contact gaps.

For example, for inverters deployed at altitudes from 3000 m of up to 5000 m above sea level, contact gaps of at least 2.22 mm became a standard requirement.[1]

Equally importantly, as the **demand for higher kVA capacities** of solar inverters continues to expand, higher continuous and maximum switching currents need to be accommodated by relays used in these applications.

[1]All mentioned altitudes are based on a maximum system voltage of 849 DC, overvoltage category II and disconnection with two relays per phase according IEC 62109.

Here again, ZETTLER has remained at the forefront of these developments and, in close cooperation with its inverter producing customers, has engaged in the development of **80 A**, **120 A and 200 A** solar AC relay products (see below under **3.3** and **3.4**)

Some of these developments required completely **innovative design approaches,** as not all relays can be structurally modified to achieve widening contact gaps, while handling ever increasing current flows and also being capable of accommodating demanding, and sometimes arbitrary inverter-design driven specifications.

ZETTLERs 200 A **AZSR1200 solar relay** is a perfect example.

In close **cooperation with one of our leading PV inverter industry** customers, and with a great amount of research and testing, ZETTLER has developed a **patent-pending contact system** that works without the otherwise usual contact springs and is able to effortlessly overcome the reset force, or to move it in the first place.

In the AZSR1200 the conventional contact spring was replaced by several highly flexible copper strands that are suspended from a 'gallow'- shaped device, requiring little to no initial spring tension. Only negligible amounts of friction and the elasticity forces of the copper strands have to be overcome to move the 200 A contact into its operating position.

This approach allows peak operating and holding power performances to be achieved; with a low holding power of only 0.6 W (also suitable for PWM), this 200 A PCB relay has entered a dimension that was hardly imaginable just a few years ago.

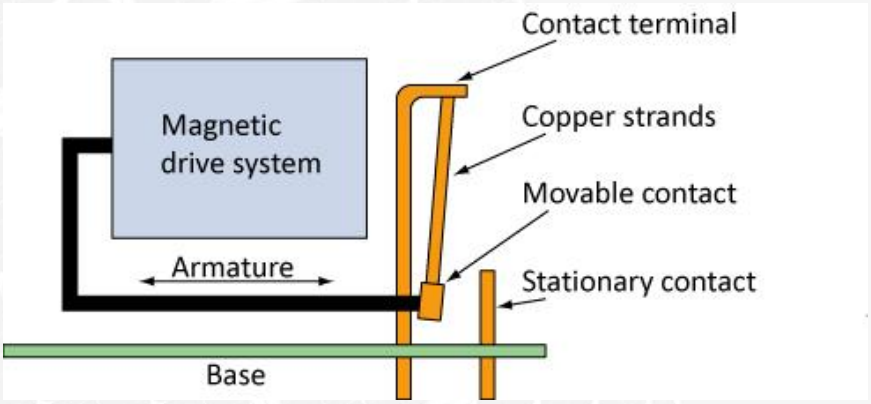

Figure 2: AZSR1200 contact system

An additional significant advantage of this innovative contact configuration is the avoidance of contact welding risks that are often associated with short circuit currents in conventional contact spring solutions. The magnetic force between parallel contacts springs, created by short circuit currents, usually pushes the contacts apart and causes them to open which frequently leads to contact welding and relay damage.

With the AZSR1200 contact system the opposite occurs: the stronger the surge current, the more the contacts are pressed together. Even temporary short-circuit currents of up to 3000 A, therefore, would not pose any welding risks for the relay contacts.

An equally innovative engineering approach was applied in the development of **AZSR180**, a single pole AC side **80 A solar relay** that features a thermally conductive copper bridge, riveted directly behind the contact studs of two movable parallel contacts. This patent pending 'thermal bridge' allows the two parallel contact springs to be thermally 'connected' which, in turn, provides for a more even-leveled distribution of any excessive heat between the two contacts that can result from a significantly uneven distribution of currents carried in one vs. the other contact. Uneven resistances and currents in parallel relay contacts are not uncommon.

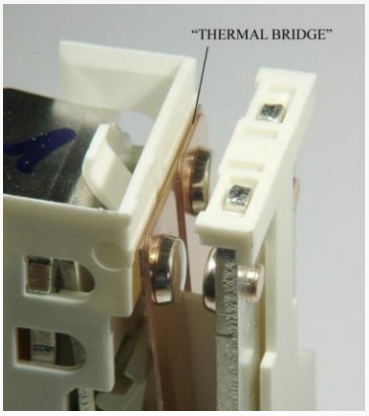

Figure 3: AZSR180 Thermal bridge

Even in the highly critical instance of a total failure of one of the two parallel-connected contacts, in which one would be completely isolated while the other would have to carry the entire current in a severe overload condition, the 'thermal bridge' of the AZSR180 will prevent the extreme overheating of the latter contact that would inevitably result in the destruction of the entire relay.

The above mentioned design elements of both the AZSR1200 and AZSR180 relays have also been combined in our most recent development, the **AZSR1120** solar relay, a single pole AC side **120 A relay** that requires only about 40 % of the volume space of the 200 A solar relay, yet still performs with very favorable, low self-heating characteristics.

These are just a few examples for ZETTLERs approach to finding innovative and intelligent engineering solutions for our partners in the solar inverter industry.

3. ZETTLER AC circuit Solar Relays

3.1 ZETTLER AC circuit Relays for Solar Inverters < 30 A

AZ733W

This **12 A** DPST miniature PCB power relay has been marketed by ZETTLER for 20 years. It is suitable for residential PV inverters up to 3 kVA (single phase) / 8.3 kVA (three phase) and deployments at up to 2000 m above sea level. The relay features a standard pin layout and a relatively small footprint with a contact gap of 1.5 mm.

Figure 4: AZ733W

- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 8 mm**
- **UL, CUR file E44211**
- **TÜV certificate R50129285**

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AZSR126

This highly efficient **26 A** SPST miniature power relay has been on the market since about 10 years and features a **wider contact gap of 1.8 mm**. It is suitable for residential and small commercial / rooftop PV systems of up to 6.5 kVA (single phase) / 18 kVA (three phase) and deployment levels of up to 3000 m above sea level.

Figure 5: AZSR126

- **Dielectric strength 4500 Vrms**
- **Clearance / creepage > 6.4 / 7.5 mm**
- **UL, CUR file E44211**

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3.2 ZETTLER AC circuit Relays for Solar Inverters ≥ 30 A

AZ2150W

This **30 A** SPST high power PCB relay is a modified version of a reliable relay which is about 30 years in the market. With its standard pin layout it is suitable for PV inverter applications of up to 7.5 kVA (single phase) / 21 kVA (three phase) and deployment levels of up to 3000 m above sea level, in residential and smaller commercial / roof-top solar systems.

Figure 6: AZ2150W

- **1.75 mm contact gap**
- **High dielectric strength 4000 Vrms contact to coil**
- **All plastics PTI 250**
- **UL, CUR file E44211**
- **VDE certificate 40023154**

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AZ2704

This **30 A** DPST high power PCB relay is suitable for PV inverter applications of up to 7.5 kVA (single phase) / 21 kVA (three phase) and deployment levels of up to 7000 m (5000 m standard contact gap version) above sea level, in residential and smaller commercial / roof-top solar systems.

Figure 7: AZ2704

- **30 A AC7a approved**
- **900 A short circuit current (carrying)**
- **Dielectric strength 4000 Vrms**
- **Standard (2.4 mm) or wide contact gap (3.0 mm) available**
- **UL, CUR file E44211**
- **TÜV certificate R50164753**

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AZSR131

This highly efficient **35 A** SPST miniature power relay is the result of consequent further development for higher requirements and features a **wider contact gap of 2.3 mm**. It is suitable for residential and small commercial / rooftop PV systems of up to 9 kVA (single phase) / 24 kVA (three phase) and deployment levels of up to 5000 m (3000 m standard contact gap version) above sea level.

Figure 8: AZSR131

- **Dielectric strength 4500 Vrms**
- **Standard (1.8 mm) or wide contact gap (2.3 mm) available**
- **Clearance / creepage > 6.4 / 7.5 mm**
- **EN 60335-1 (GWT) approved version available**
- **UL, CUR file E365652**
- **TÜV certificate B170488793005**

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AZSR235

This **35 A** DPST high power PCB relay is part of the first group of Zettler relays that were **specifically developed for solar applications** and has been deployed in many PV inverters since eight years. It is suitable for larger residential and small to medium commercial / rooftop PV systems up to 9 kVA (single phase) / 24 kVA (three phase), features a wide contact gap of > 2.05 mm making it suitable for deployment levels of up to 4000 m above sea level.

Figure 9: AZSR235

- **Wide contact gap > 2.05mm**
- **Very low holding power <100 mW**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 10 mm**
- **Reinforced insulation, EN 60730-1 (VDE 0631, part 1), EN 60335-1 (VDE 0700, part 1)**
- **UL, CUR file E44211**
- **VDE certificate 40033251**

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3.3 ZETTLER AC circuit Relays for Solar Inverters ≥ 50 A

AZSR250

A sibling to the AZSR235, this **50 A** DPST high power PCB relay is designed for deployment in solar inverters of up to 12.5 kVA (single phase) / 35 kVA (three phase) - suitable for larger residential and midsize commercial PV systems, deployable at up to 3000 m above sea level. Key features of this relay are its very low holding power and a small footprint of just 10 cm2.

Figure 10: AZSR250

- **Wide contact gap > 1.85mm**
- **Holding power <100 mW**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 10 mm**
- **Reinforced insulation, EN 60730-1 (VDE 0631, part 1), EN 60335-1 (VDE 0700, part 1)**
- **UL, CUR file E44211**
- **VDE certificate 40033251**

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AZSR165

Scheduled for mass production in 2017, this **65 A** relay is the economy version of the new AZSR190 series. Developed for PV applications of up to 18 kVA (single phase) / 45 kVA (three phase) this relay is well suited for medium sized to larger roof top based / commercial systems, deployable up to 7000 m above sea level.

Figure 11: AZSR165

- **Wide contact gap > 3.0 mm (3.6 mm upon request)**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 10 mm**
- **UL, CUR file E365652**
- **TÜV certificate B170988793008**

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AZSR180

The **80 A** high power PCB relay takes the AZSR235/250 series to the next logical level. Developed for PV applications of up to 20 kVA (single phase) / 55 kVA (three phase) this relay is well suited for medium sized to larger roof top based / commercial systems, deployable up to 4000 m above sea level. It features a patent pending Thermal Bridge, designed to protect the parallel contacts from overheating as a result of uneven distribution of currents.

Figure 12: AZSR180

- **Wide contact gap > 2.05mm**
- **Very low holding power <100 mW**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 10 mm**
- **Reinforced insulation, EN 60730-1 (VDE 0631, part 1), EN 60335-1 (VDE 0700, part 1)**
- **UL, CUR file E44211**
- **VDE certificate 40044305**

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AZSR190

Scheduled for mass production in 2017, this **90 A** standard version / **100 A** "H"-version high power PCB relay will close the gap between AZSR180 and AZSR1120. Developed for PV applications of up to 25 kVA (single phase) / 69 kVA (three phase) this relay is well suited for medium sized to larger roof top based / commercial systems, deployable up to 8000 m above sea level.

Figure 13: AZSR190

- **Wide contact gap > 3.6mm**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 10 mm**
- **UL, CUR file E365652**
- **TÜV certificate B170988793008**

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3.4 ZETTLER AC circuit Relays for Solar Inverters ≥ 100 A

AZSR1120

New Development

This **120 A** extreme high power PCB Relay has been designed for PV applications of up to 30 kVA (single phase) / 83 kVA (three phase) – a highly attractive, small footprint substitute for conventional contactors. This relay is suitable for larger commercial / rooftop based PV systems and small commercial solar fields, deployable up to 5000 m above sea level.

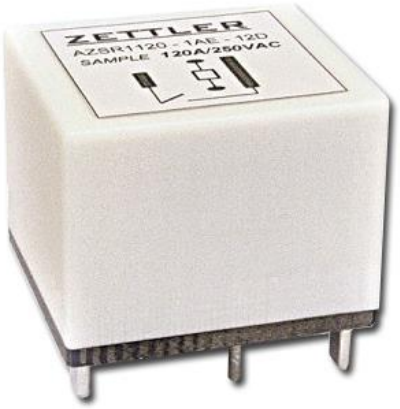

Figure 14: AZSR1120

- **Wide contact gap > 2.3mm**
- **Holding power <300 mW**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 8 mm**
- **UL, CUR file anticipated**
- **VDE certificate anticipated**

Please contact us for technical information / preliminary datasheet.

AZSR1200

New Development

This **200 A** extreme high power PCB relay is designed for 50 kVA (single phase) / 138 kVA (three phase) solar systems suitable for large roof top based commercial systems and small commercial solar fields, deployable up to 10000 m above sea level, another highly cost attractive, small footprint substitute for conventional contactors.

Figure 15: AZSR1200

- **Wide contact gap > 4.6mm**
- **Holding power <0.6 W**
- **Dielectric strength 5000 Vrms**
- **Isolation spacing greater than 8 mm**
- **UL, CUR anticipated**
- **VDE anticipated**

Please contact us for technical information / preliminary datasheet.

4. ZETTLER Relay for Insulation Measuring in Solar Applications

AZ742-2A-xxD(200)

Figure 16: AZ742-2A-xxD(200)

As photovoltaic installations with transformerless solar inverters are not galvanically isolated, permanent measuring of the insulation is not possible when in operating mode, i.e. feeding energy into the grid. However, current safety standards for solar inverters and solar panels require that only systems with correct insulation can be grid - connected. Common switching components to connect the insulation measuring circuit with the inverter usually come in the form of relative expensive reed relays. ZETTLER's **solution** is a modified and **very cost effective** two-pole electromechanical relay meeting necessary standards.

- **Widened contact gap > 0.6 mm**
- **Dielectric strength between open contacts 2000 Vrms for 60 sec.**
- **Isolation spacing greater than 10 mm**
- **Test conditions**
  - **Configuration: two contacts connected in series**
  - **Load: resistive 1000 VDC / 15.3 mA**
  - **Ambient temperature: 85°C**
  - **Duty cycle: 1.5 s On / 1.5 s Off**
  - **Electrical lifetime: 30k cycles**
- **UL, CUR file E43203**
- **VDE certificate 40012572**

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