Reed relays a standard for Insulation Measurement

David Stastny – Product Manager Reed Relays and Optocouplers

POWER ELECTRONICS
Power Electronics & Energy Storage event
28 mei 2024 | 1931 Congrescentrum 's-Hertogenbosch
ENERGY STORAGE

Standex Electronics – Reed Technology and Magnetics

Products

Switches

Relays

Sensors

Magnetics

SST
Switching and Sensing Technologies

MAG
Magnetics

Global Footprint

GLOBAL SALES & DESIGN CENTERS

GLOBAL MANUFACTURING LOCATIONS

Standex Electronics VISION

We strive to be a leading provider of innovative engineering solutions to our customers, to be an employer of choice, and to generate best in class value to our shareholders.®

- Auto & EV
- Industrial
- Appliances
- Smart Grid & Home

❖ **PARTNER** // TEAMWORK

❖ **SOLVE** // UNDERSTAND

❖ **DELIVER** // QUALITY

Standex Electronics

heynen

Insulation Measurement

- **E-car batteries** operate nowadays in the range **500-800 Volts** and moving towards **1000 Volts**, especially for trucks and high-power vehicles
- Solar invertors operates even up to 1500 V and moving towards 2500 VDC
- The **High Voltage line** needs to be perfectly and safely separated from the car's chassis to prevent an electric shock and malfunction during the usage and mainly during the battery charging
- For this reason the **isolation** (dielectric strength between battery and chassis) needs to be measured after production and then regularly during the life-time
- Acc. to standards it has to be generally **3-4 times higher** than the operation voltage.
  (2x operating voltage + 1000V safety). E.g. up to 4000V for the line voltage of 1500V
- High Potential test needed to prove the safety after production of the e-car and then regularly during the life time
- The measurement is done by taking a small probe current from the connection between the battery and the chassis and monitoring its value
- In order to do that, the High Voltage battery circuit needs to be connected with the Low Voltage measurement circuit for a short time and then disconnected

Standex Electronics

heynen

Solar inverter – requirements for Insulation monitoring

Energy Storage on Power Generation	Energy Storage on Power Transmission and Distribution	Energy Storage on Power Consumption

General Requirements

- High Isolation between control and load circuit
- High Isolation across contacts
- High Switching Voltage
- Capability of carrying very low current (leakage current detection)
- High Reliability & Long Lifetime
- Standards IEC 62109-1/2, UL
- Operating Temperature -40 ~ +105°C
- Creepage Distance
- Compact Size

Standex Electronics

heynen

E-vehicle BMS - requirements for Insulation monitoring

Battery Isolation Systems	Battery Conditioning	Power Inverters

General Requirements

- **High Isolation** between control and load circuit
- **High Isolation** across contacts
- High Switching Voltage
- Capability of carrying very low current (leakage current detection)
- High Reliability & Long Lifetime
- Automotive Standards AEC-Q200, IEC 60664-1, ISO 6469-3
- Operating Temperature 105°C
- Creepage Distance
- Compact Size

Standex Electronics

heynen

Norms and Standards

- Primary function for the switching component is to reliably connect the HV and LV circuitry while connected to the system voltage and it also needs to withstand certain voltage in the open state
- Secondary, it needs to withstand a voltage prescribed by the norms, which is much higher than the operating voltage. It needs to fulfil also specified creepage and clearage distances between pins, CTI or requirement for reinforced isolation
- Examples of norms are IEC 62109-1/2, GB18384, IEC 60664-1, ISO 6469-3, UL, AEC-Q200
- Current requirements are for the withstand voltage up to 4000VDC and 4-8 mm creepage distance
- Withing the next 5 years it is expected the system voltage to go up to 2500V, which would require the reinforced isolation with withstand voltage up to 6000V and creepage distance of 15 mm under the CTI class 1 (400-600)

Standex Electronics

heynen

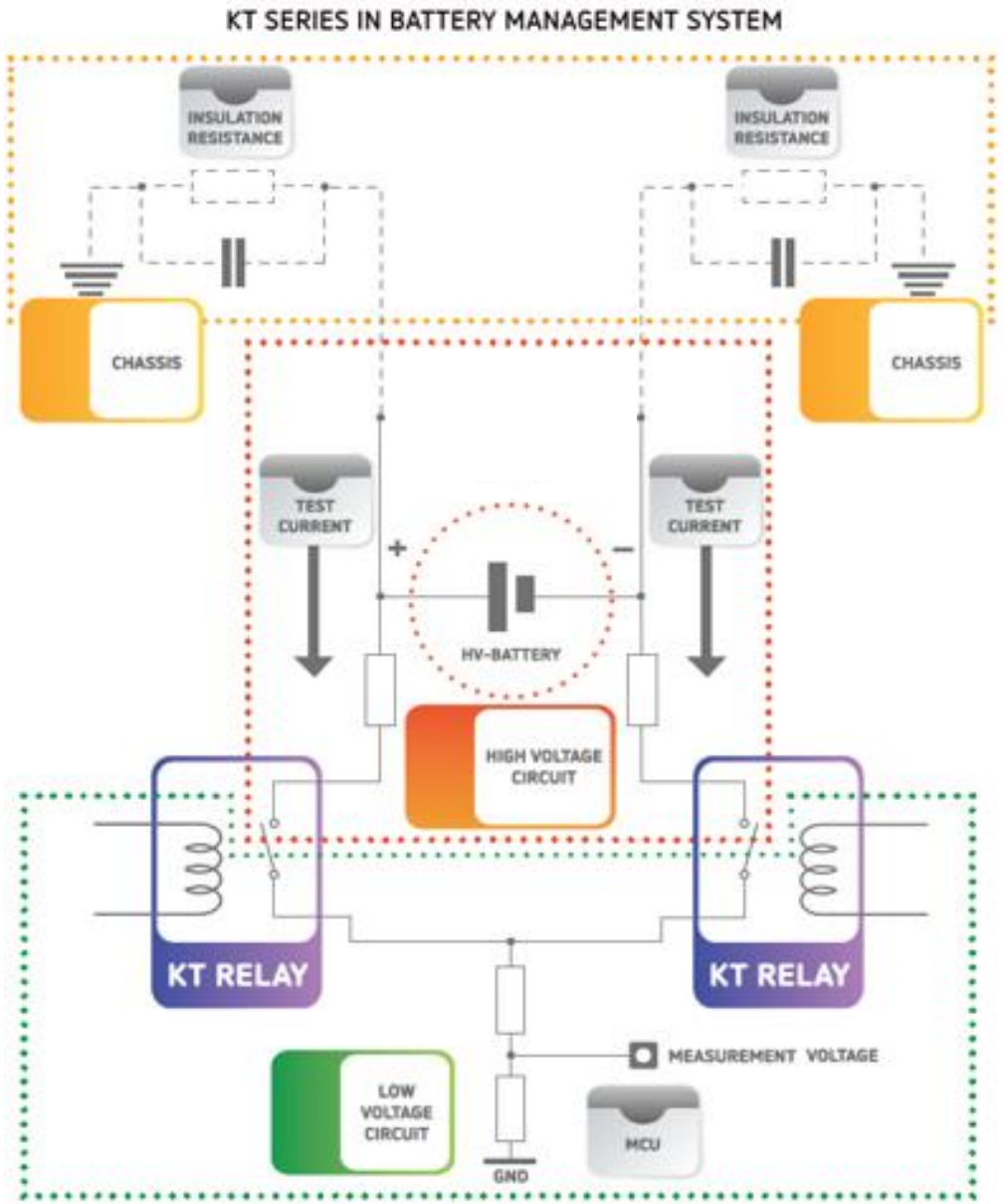
ESS Inverter Description

- **ESS inverter** changes Direct Current to Alternating Current for the line grid and the Isolation
- Inverters are important because they tie the whole system together. Nowadays, they operate in a voltage level up to **1500 VDC**, depending on the nominal power of the solar system and its utilization for the residential or industrial application, such as solar farms.
- Modern high voltage inverters are using a **transformer-less** circuitry design, which provides higher efficiency, reduced cost and lower weight.
- On the other hand, without the transformer, the system lacks a proper **galvanic isolation** between the low and high voltage circuits.
- In order to ensure a safety and prevent unwanted leakage currents to ground, a regular **Isolation monitoring** needs to be implemented. This is prescribed by the norm IEC 62109-1/2 – isolation must not drop below a specific minimum, this threshold is power-dependent

Standex Electronics

heynen

Insulation Resistance (R_{iso}) in ESS system - Diagram Example

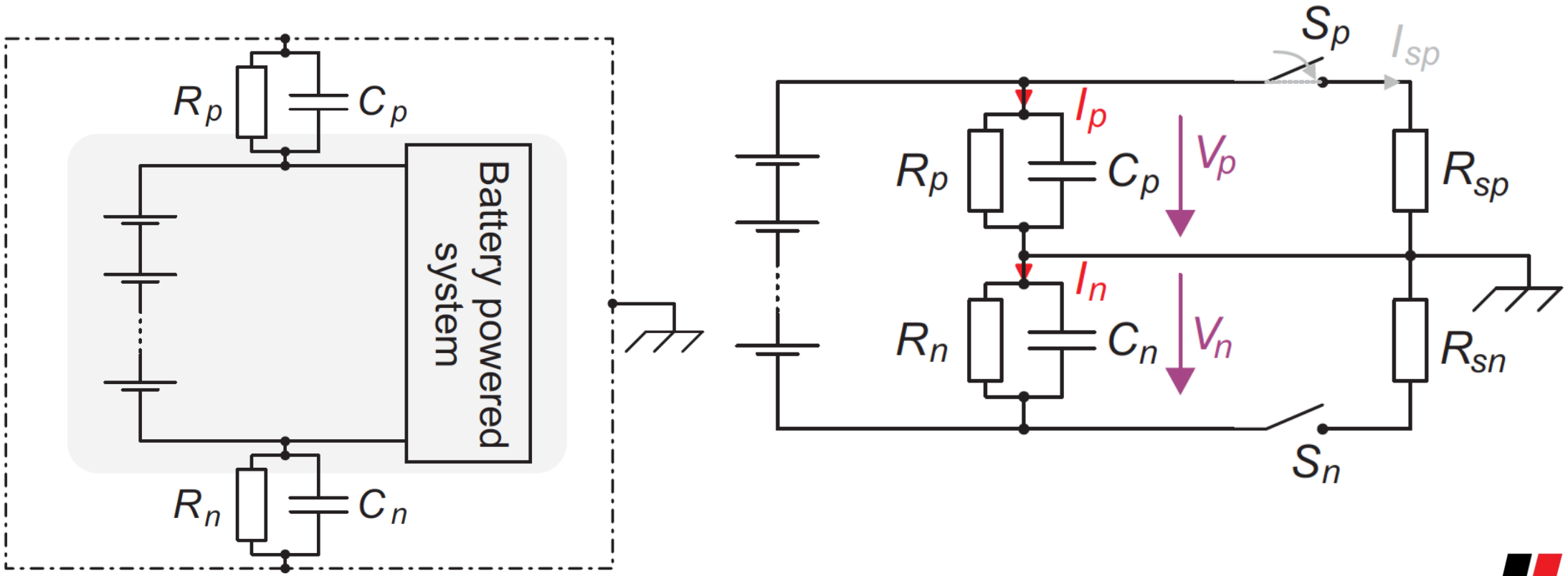


- Due to the missing galvanic isolation, the isolation monitoring cannot be continuous by the transformer-less design, but only before of after grid connection
- The total unwanted leakage current consist of the DC cables, Inverter and PV panels, if applicable.
- When the system is not operating, a small test current between the system and ground is taken, measured and compared with the reference value
- Relay works as a bridge between the system and the ground, ready to carry the test current when activated
- When open, the high breakdown voltage provides a perfect isolation
- When closed, the low contact resistance doesn't influence the measurement results

Standex Electronics

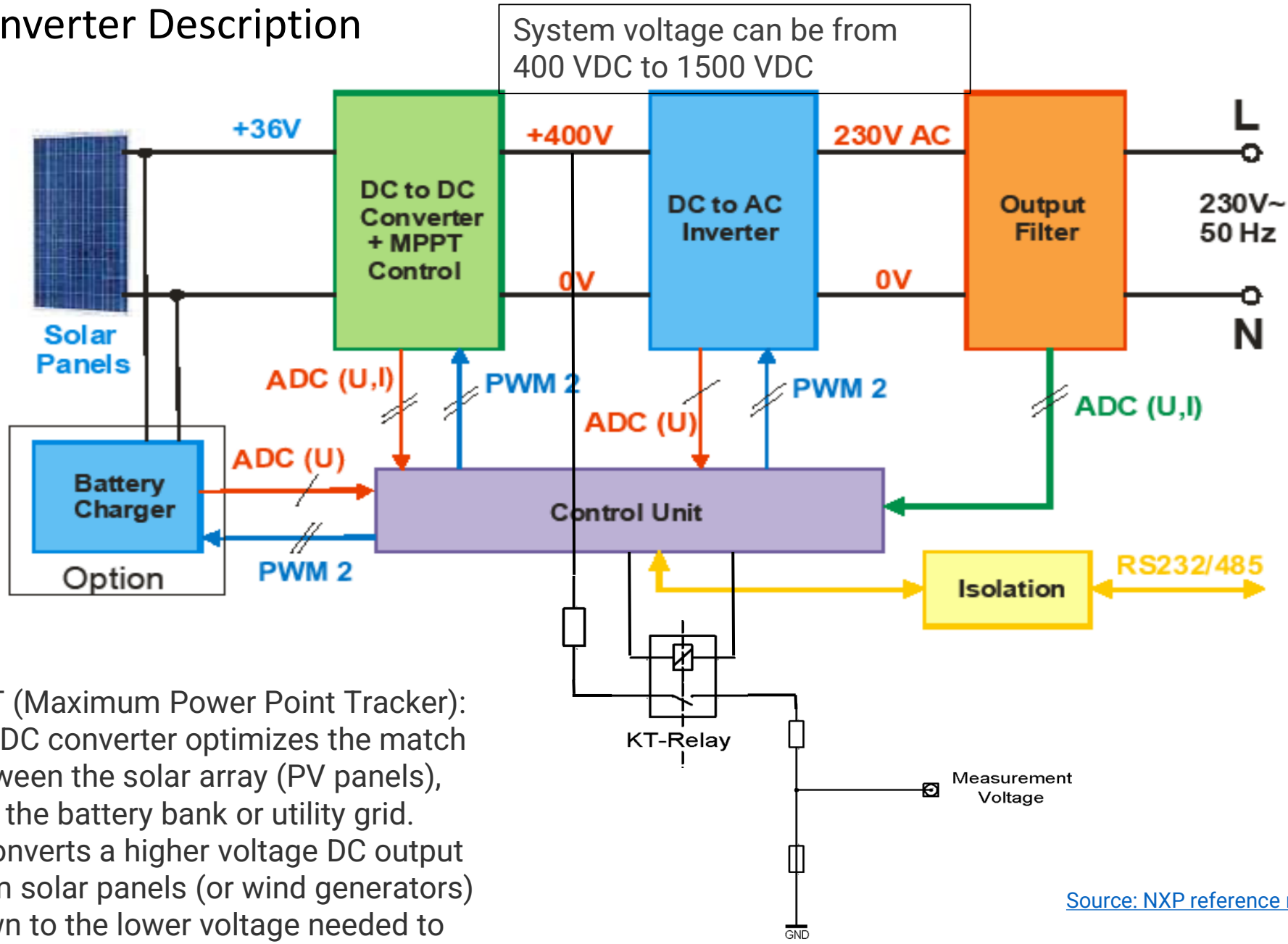
heynen

Insulation Monitoring – connection example with two relays



Source: Battery Management System Hardware Concepts

ESS Inverter Description



MPPT (Maximum Power Point Tracker):

- DC/DC converter optimizes the match between the solar array (PV panels), and the battery bank or utility grid.
- It converts a higher voltage DC output from solar panels (or wind generators) down to the lower voltage needed to charge batteries.

Source: NXP reference manual

Standex Electronics

hcynen

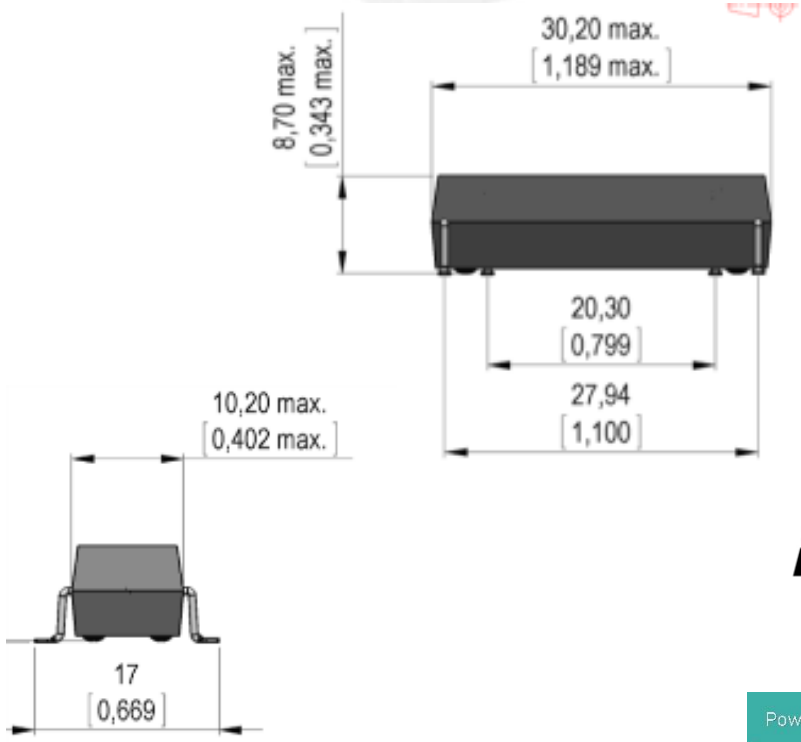
Reed Relay Technology – Advantages & Challenges

Features

- Up to 1,000 VDC Switching Voltage
- Up to 4 kVDC Breakdown Voltage across switch
- Innovative Design with no internal solder joints
- Meets creepage distance requirements acc. to IEC standard
- In compliance with AEC-Q200

Applications

- Battery Management Systems E-Cars and Solar
- Medical
- High Voltage ATE - Automated Test Systems
- Multiplexer/Matrix Switches



Standex Electronics

heynen

Thank you for you attention and feel free to contact me, you find me at boot 28 with our partner Heynen BV.

David Stastny

Product Manager Reed Relays & Optocouplers

dstastny@standexelectronics.com

Tel. +49 7733 925 3304

StandexMeder Electronics GmbH

Friedrich-List-Str. 15

78234 Engen/Welschingen

Germany

www.standexmeder.com

Marcel van Venrooij

Sales Engineer

Marcel.vanVenrooij@Heynen.nl

Tel. +31 6 12192434

Heynen BV **(Stand 28)**

De Groote Heeze 11

6598 AV Heijen

www.Heynen.com