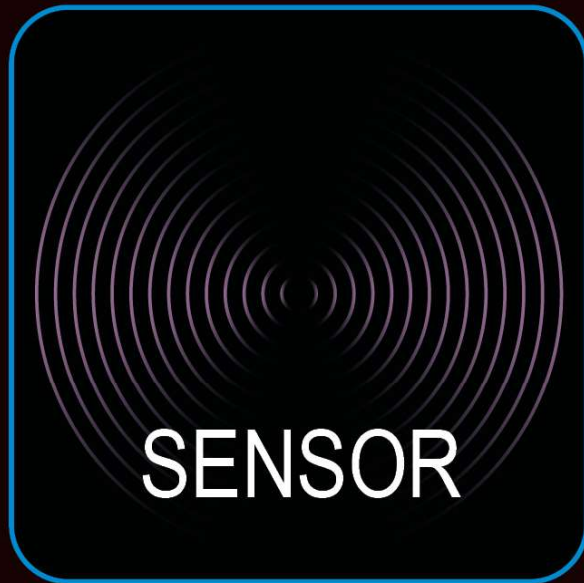


# RUTRONIK TECHTALK MEETS



08.06. - 10.06.2021 | **ONLINE**

HVC (High-Voltage Contactor) for safety disconnection of high-voltage batteries

Claas Rosenkötter

Director Product Marketing High-Voltage Contactors



# High-voltage Contactor Introduction



Plant in Johor Bahru  
Malaysia  
5000 m<sup>2</sup>  
Founded in 2001



Plant Xiaogan,  
China  
7000 m<sup>2</sup>  
Founded in 1997



Location Berlin  
Germany  
600 m<sup>2</sup>  
Founded in 1934

## Business Unit PPD AB

- ~ 800 employees
- Products: High-Voltage Contactors, Surge Arrestor, Switching Spark Gaps
- Certifications
  - ISO 9001
  - ISO 14001
  - IATF 16949

- **HVC Series** is designed to meet high voltage and high current DC applications, especially **disconnection for Lithium Ion batteries**.
- The **hermetically sealed design with ceramic arc chamber** is based on more than 80 years gas tube technology experience exhibits excellent reliability in harsh environments.



# High-voltage Contactor

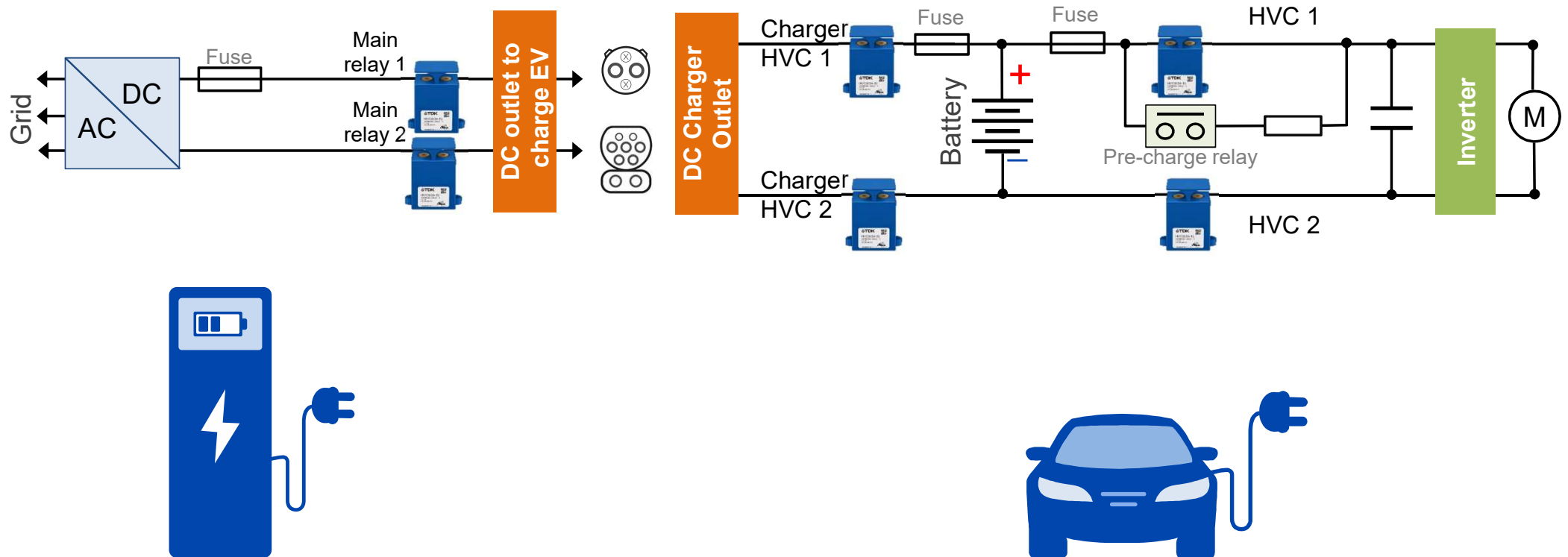
## Why Safety Disconnection of HV batteries?

- Safety is a challenge in every application that uses lithium ion batteries, including chargers.
- Failures can destroy the battery and in some cases even lead to fire.
- The HVC is used to disconnect in case of failures based on the battery management system (BMS) command.
  - Example of battery failures that require disconnection:
    - Separator melts
    - Overtemperature
    - Overcurrent
    - Overvoltage
    - Low voltage
    - Low temperature

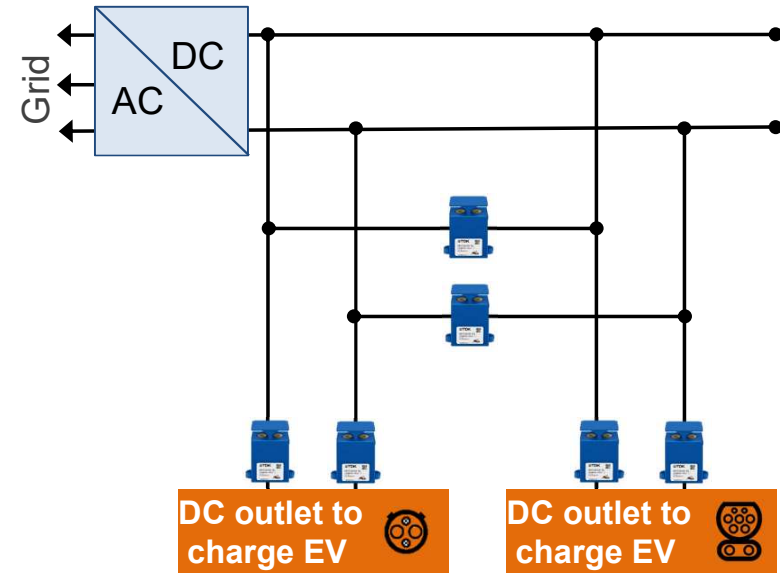
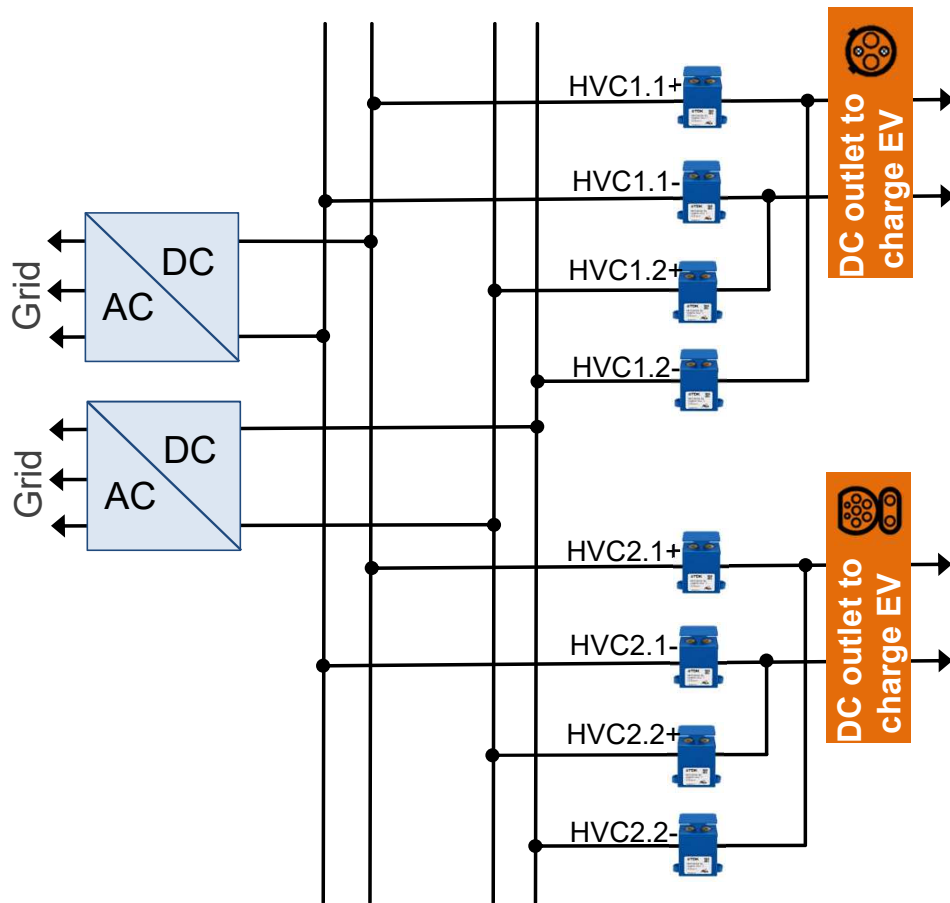


# High-voltage Contactor

## DC Charger and Electrical vehicles



# High-voltage Contactor DC Charger



## Contactor requirements

- Operating carry current depending on charger and operating voltage up to 1000 V
- High number of switchings (min. load) → Dual Coil
- High cut-off current
- Auxiliary contact
- 7 years in the field
- Matching with fuse

# High-voltage Contactor

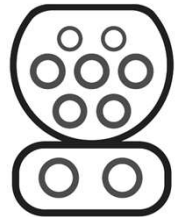
## DC Fast Charging Europe – Requirements

Attracting Tomorrow



- Increased voltage level for Charging and Vehicles, enables same power with smaller wire cross section or higher power with same wire cross section.
- Installations with CCS 2.0 / ChaDeMo 2.0 → 1000 V starting from 2017 /2018
- Today, less than 50% of the installed DC Fast Chargers can charge up to 800 V or more.
- Today, majority of new installed DC Fast Charger made for up to 800 V or more
- Most contactors today require min. 900 V and for higher current it is a must.

Protocol	CCS 1.0	CCS 2.0 published 2016
Power	< 80 kW	< 350 kW
Voltage	< 500 V	200 – 1000 V
Current	< 200 A	< 500 A



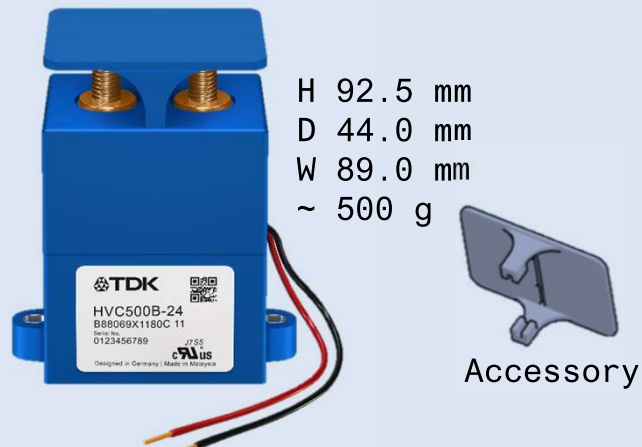
Protocol	ChaDeMo 1.1	ChaDeMo 2.0 published 2017 deployed 2018
Power	< 50 kW	< 400 kW
Voltage	< 500 V	< 1000 V
Current	< 125 A	< 400 A



Sources: ChaDeMo / CharIn



# High-voltage Contactor Portfolio



H 92.5 mm  
D 44.0 mm  
W 89.0 mm  
~ 500 g

Accessory

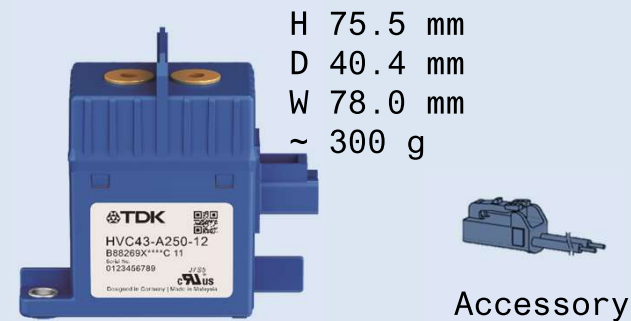
## HVC2.5 series

**HVC200, HVC300, HVC500**

DC Fast Charging Stations (up to 400 kW)

Medium/Large passenger cars, sports-cars, SUV, trucks, busses

- Up to 500 ADC and 1200 VDC
- Contactless Auxiliary Contact
- Single-Coil or Dual-Coil
- Bipolar Design available



H 75.5 mm  
D 40.4 mm  
W 78.0 mm  
~ 300 g

Accessory

## HVC4.3 series

**HVC43-150A, -200A, -250A**

DC Chargers up to 50 kW

Small and compact passenger BEV and PHEV

- Up to 250ADC and 1000 VDC
- Bipolar Design
- 30% smaller, 30% lighter than HVC2.5
- 7 kA short circuit current

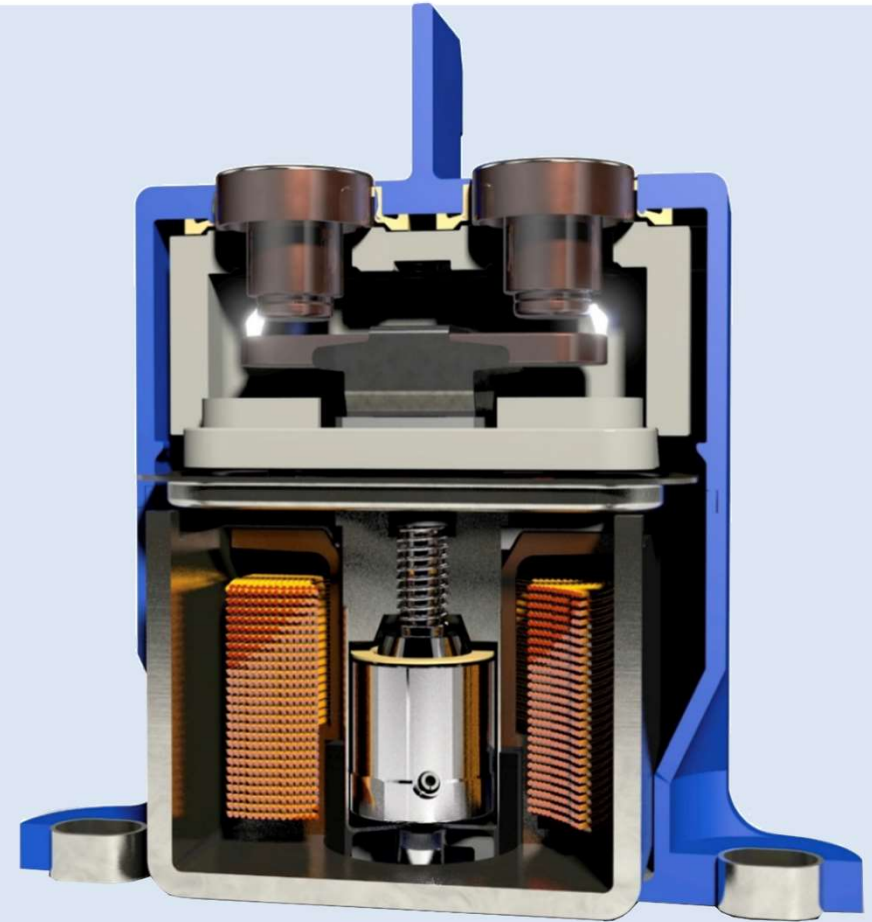
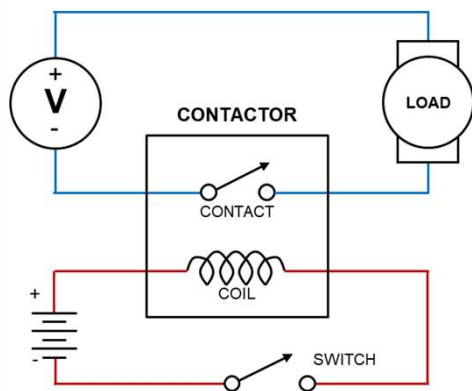
# High-voltage Contactor Principle

- Coil voltage is off → HVC is open → Main contacts disconnect high voltage
- Coil voltage is on → HVC is closed → Main contacts connect high voltage

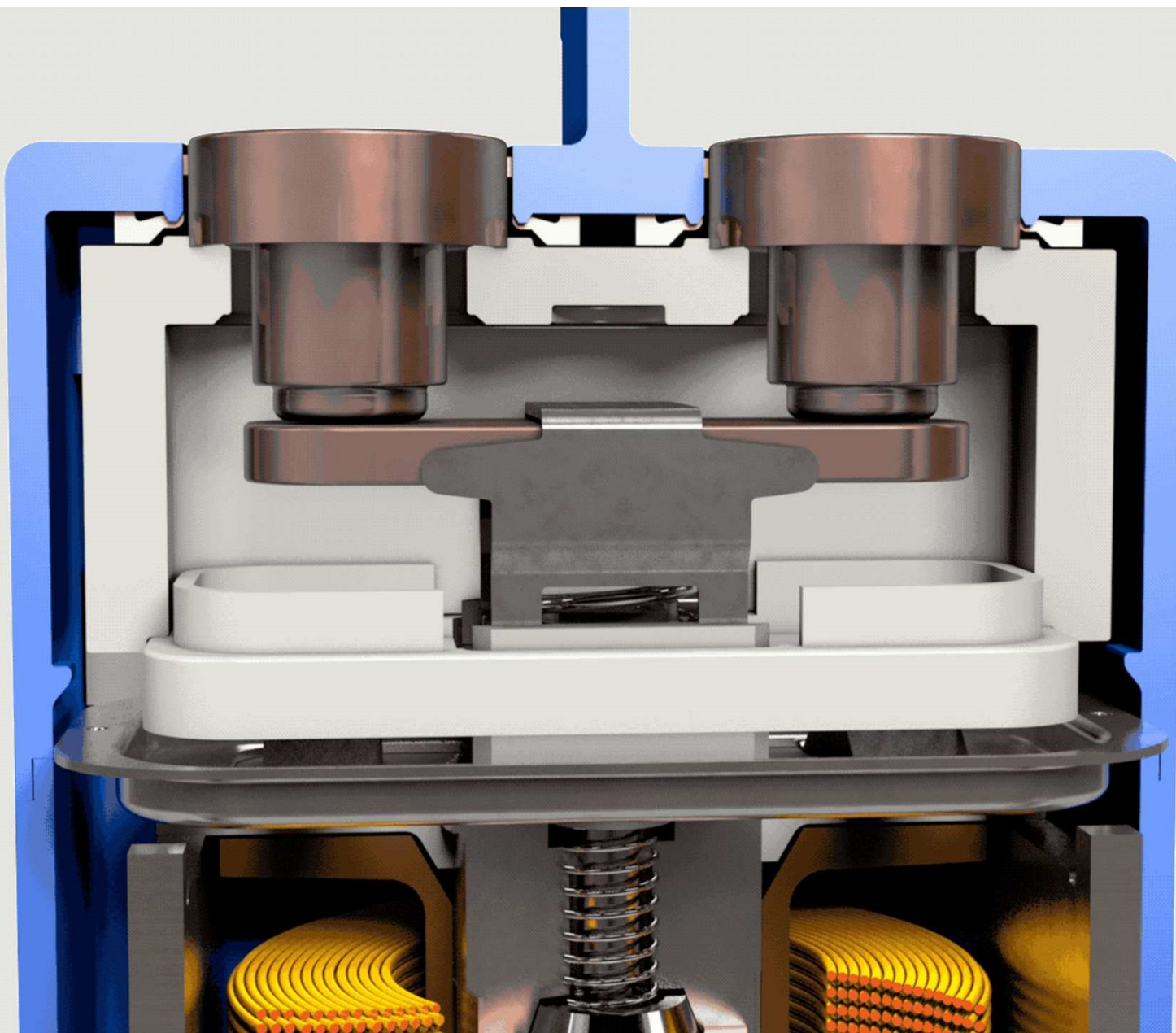
**The high-voltage arc is created when the contact bridge opens**

- Magnets on the side divert the arc to run along the edges
- A hydrogen gas mixture cools and extinguishes the arc

Example Circuit



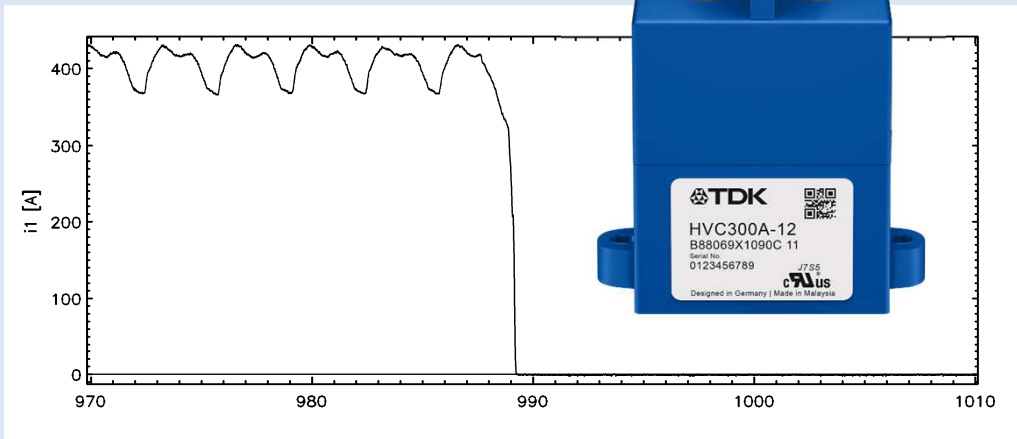




# High-voltage Contactor Extinguishing Characteristics

## TDK HVC

- Extinguishes in 1.2 ms with clear break of current



### Advantages

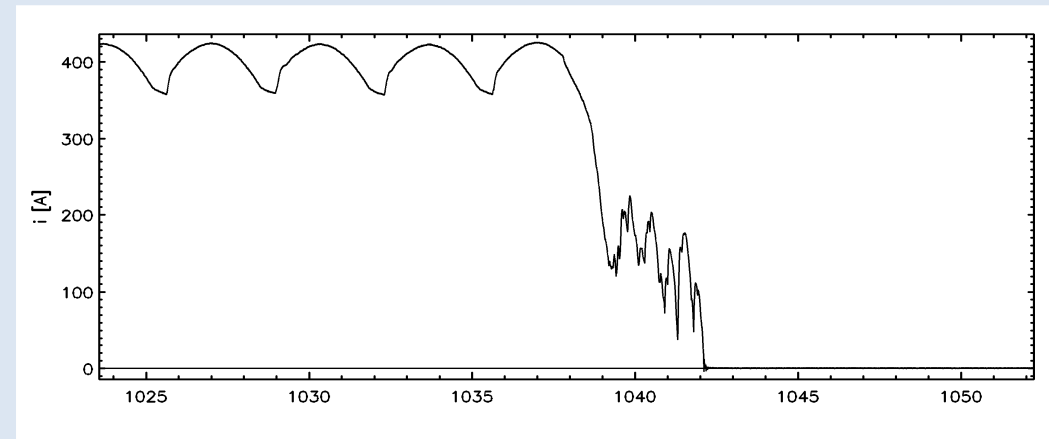
- Less heat on the contacts
- Less likely to become stuck
- Less EMI

### Benefits

- Longer lifetime
- Increased reliability

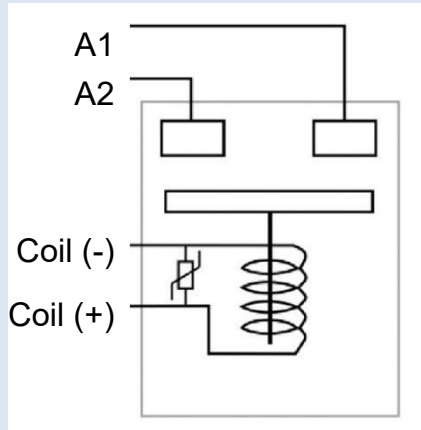
## Typical contactor

- Extinguishes in 4.6 ms with a high degree of fluctuations



# High-voltage Contactor

## Single coil and Dual coil

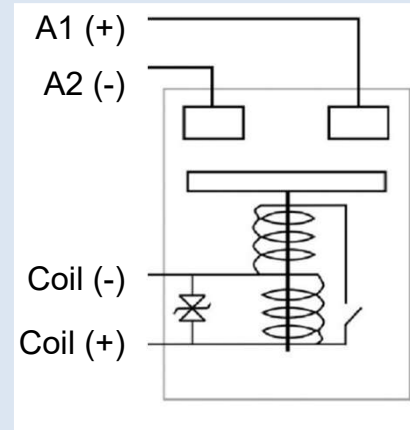


### Single coil

- No additional current during make (pick-up)
- Operating power: 6 W, 0.5 A @12 V
- No economizer required

### Single Coil: No polarity!

- Make and Break Boarder at 200 A
- 1000 V at 100 A: 6000 make/break cycles



### Dual coil: Option E and E2

- Power during make (pick-u) 38 W, 3.2 A @ 12 V during 80...120ms
- Operating power: 4.2 W (0.35 A) @12 V
- Hot-restartability (<1 s)
- Works like an economizer without PWM
- Integrated coil termination

### Option E2: No polarity!

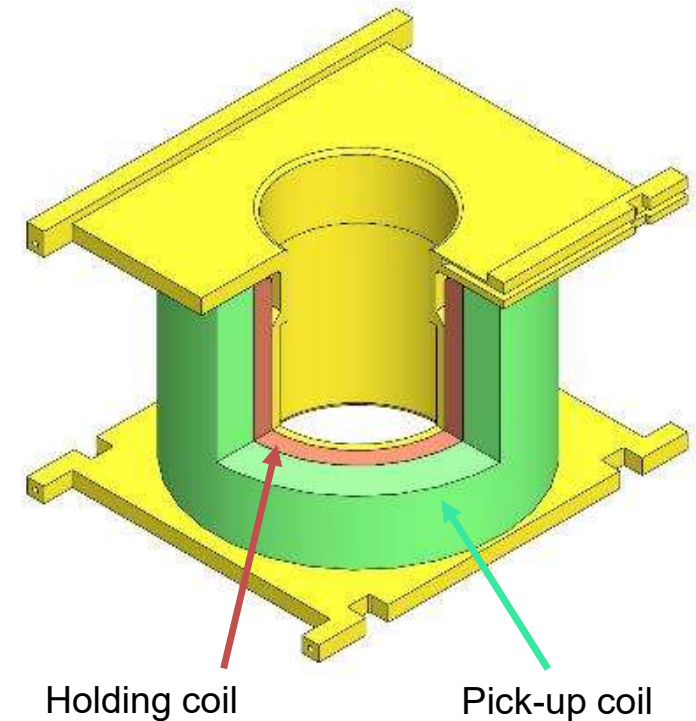
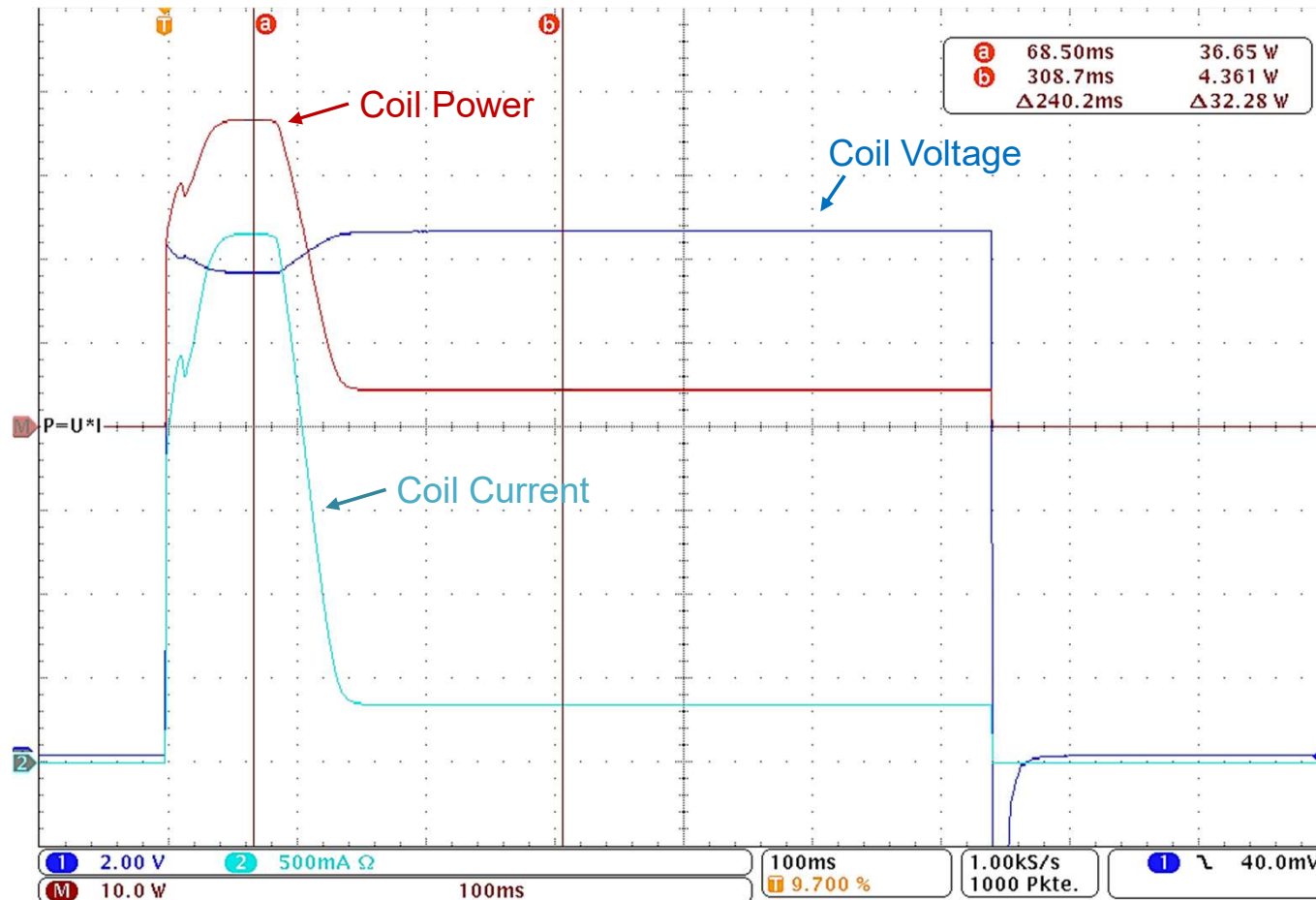
- Make and Break Boarder at 500 A
- 1000 V at 100 A: 6000 make/break cycles

### Option E: Unidirectional → Polarity!

- Make and Break Boarder at 500 A
- 1000 V at 100 A: 8000 make/break cycles

# High-voltage Contactor

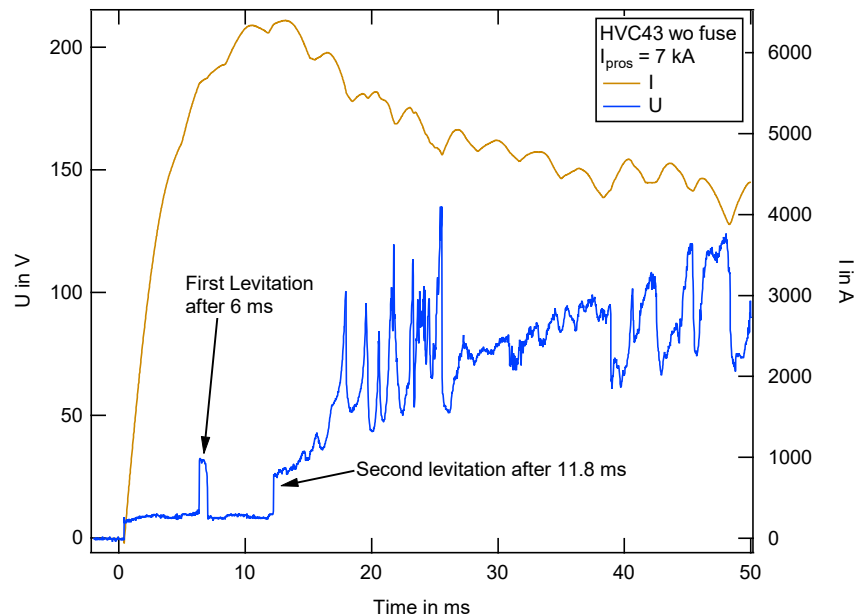
## Principle of the Dual coil



# High-voltage Contactor Short Circuit

## Without fuse

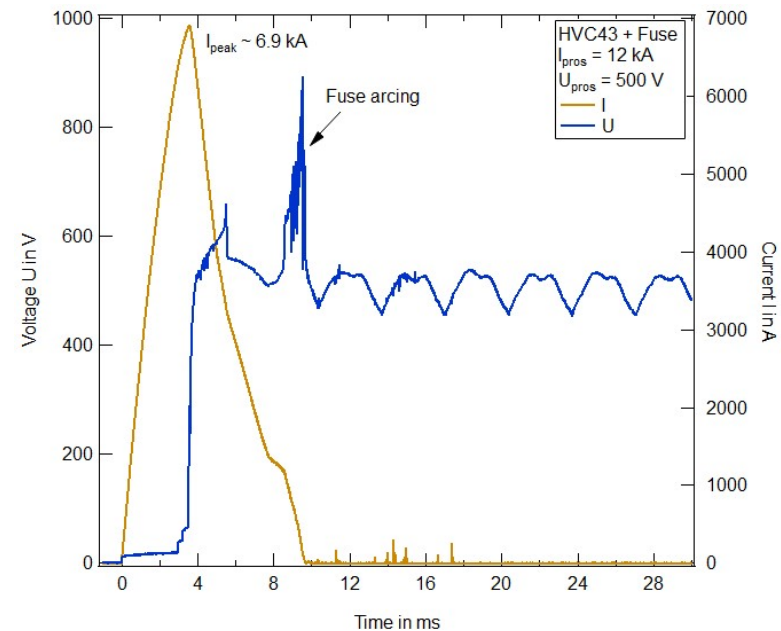
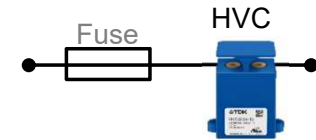
- 7 kA pros. current @ 200VDC
- $\tau = 3.12$  ms, rise time = 2.2 kA/ms



The HVC43 Series can withstand up to 5 ms 7kA w/o fuse.

## With melting fuse: 630A

- 12 kA pros. current @ 500VDC
- $\tau = 4$  ms, rise time = 4 kA/ms



The HVC43 Series can withstand up to 12 kA with 630 A type fuse. After the test, the part is tack-welded but no outer damage occurred.



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