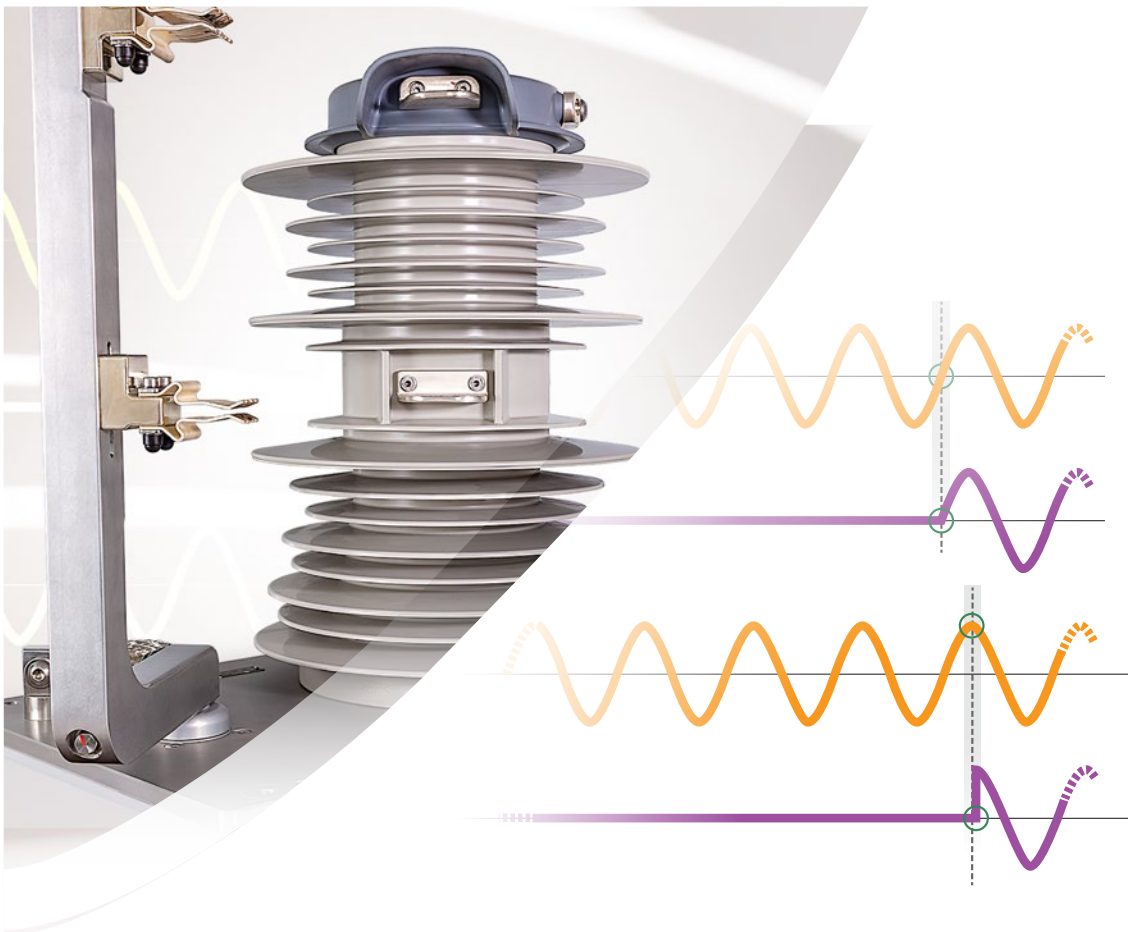


OPTIONAL SYNCHRONOUS SWITCHING FUNCTION

for **AC CIRCUIT BREAKER**

RAIL VEHICLES



GENERAL INFORMATION

Modern rail vehicles running on AC line voltage are equipped with AC vacuum circuit breakers, used to supply the traction circuits with the line voltage and to interrupt fault currents in case of short-circuits on the vehicle.

Closing and opening the AC circuit breaker is made in most cases independently from the phase angle of the line voltage supplying the vehicle. In practice this means that the main contacts of the breaker will close or open on any phase angle from 0 to 360 degrees of the line voltage. Operating the circuit breaker this way forces car builders to design their equipment considering all cases, and mitigating as much as possible the impacts such aleatory switching may have on the vehicle operation.

To help car builders and operators to address this topic while simplifying their equipment, Sécheron has designed a unique Point-on-Wave (PoW)/

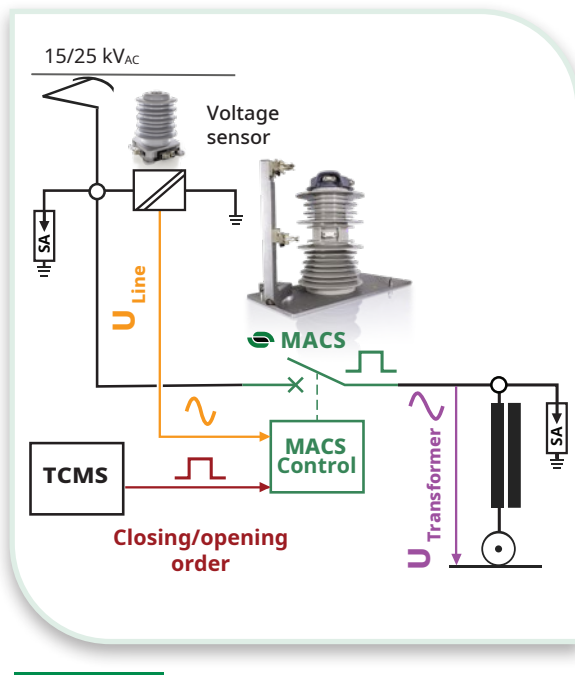
Synchronous switching function that can be installed on our AC circuit breakers type **MACS** or **BVAC**, for new vehicles as well as for vehicles already in service.

This optional function enables to achieve a synchronous repetitive and accurate closing or/and opening of the **MACS** or of the **BVAC** on a predefined phase angle of the line voltage.

With this function, **MACS** or **BVAC** can for instance be closed on the phase angle 0 degree (or 180 degrees) so that the main contacts closes at the exact time when the line voltage is 0 volts, avoiding or limiting Electromagnetic Interferences induced by switching transients when closing.

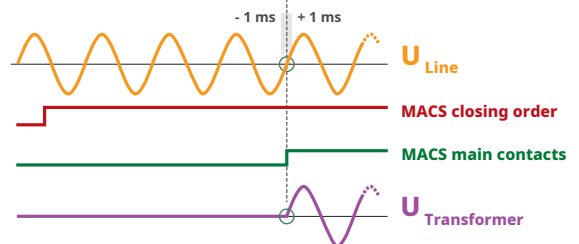
If closing on the phase angle 90 degrees (or 270 degrees) is selected, the AC circuit breaker will switch on when the value of the line voltage wave is at its maximum, minimizing the vehicle inrush current.

APPLICATION SCHEME



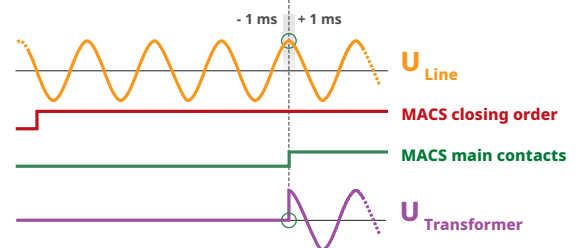
Closing synchronous switching at 0°

⇒ Reduction of Electromagnetic interference (EMI)

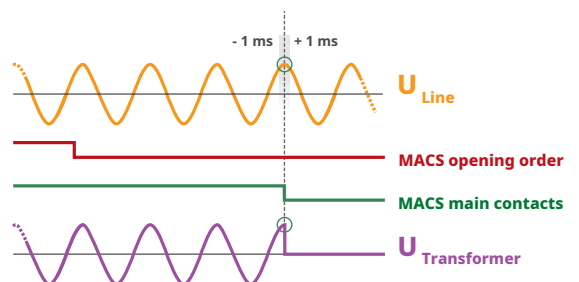


Closing synchronous switching at 90°

⇒ Reduction of transformer's inrush current



Opening synchronous switching at 90°



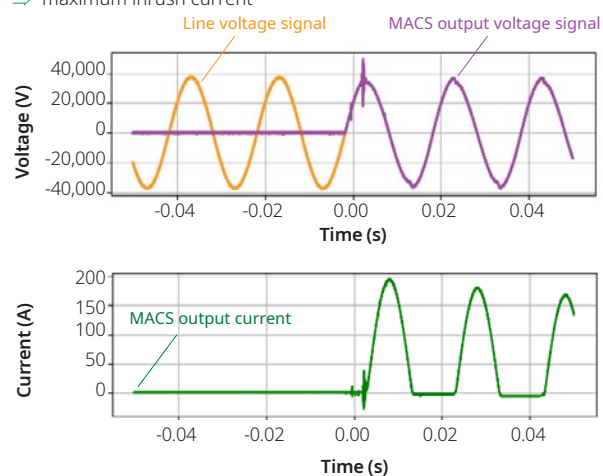
MAIN BENEFITS

- ✓ Synchronous switching of the MACS with the line voltage phase
- ✓ Adjustable setting of the predefined phase angle of line voltage for synchronous closing or/and opening
- ✓ Setting of the predefined phase angle can be different for closing and opening
- ✓ High accuracy for Point-on-Wave/Synchronous switching, typically within ± 1 ms
- ✓ Switching accuracy independent from the ambient temperature
- ✓ Suitable for 12 kV (25 Hz), 15 kV (16.7 Hz), 25 kV (50 & 60 Hz)
- ✓ Reliable closing at 0 Volts crossing to avoid dV/dt and subsequent electromagnetic interferences
- ✓ Reliable closing at maximum voltage of the sine wave to limit vehicle inrush current
- ✓ Auto-calibration, to keep the synchronization accuracy function of ambient temperature and control voltage.
- ✓ Point-on-Wave/Synchronous switching function can be directly integrated in the MACS control unit with no impact on the product's dimensions.

MEASUREMENT CURVES

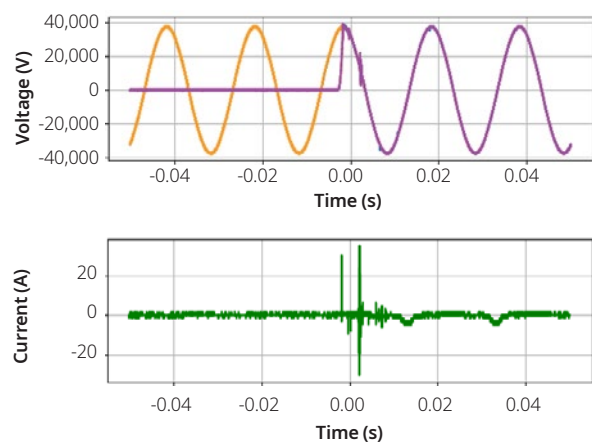
MACS Closing synchronous switching at 0°

⇒ maximum inrush current

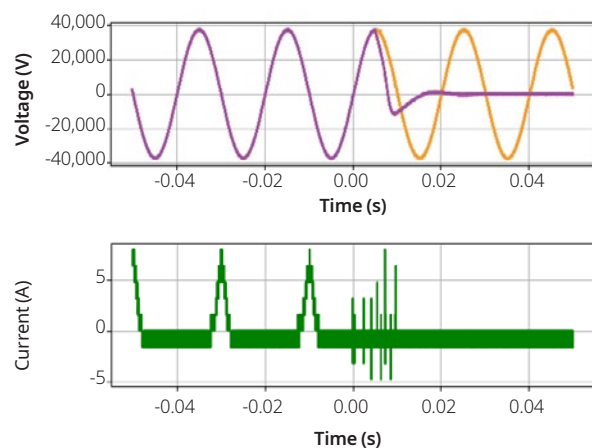


MACS Closing synchronous switching at 90°

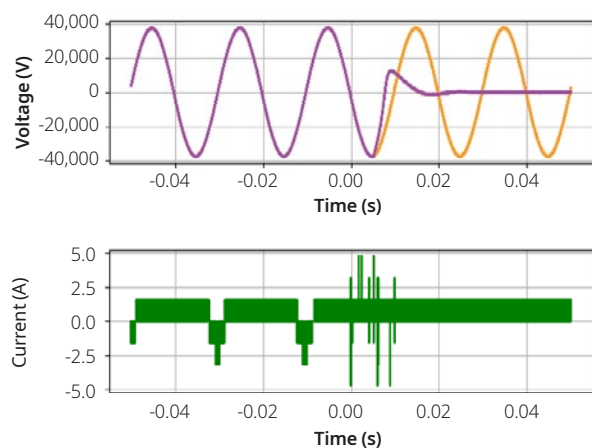
⇒ Minimum inrush current



MACS Opening synchronous switching at 90°



MACS opening synchronous switching at 270°



INSTALLATION

REQUIREMENTS TO ORDER POINT-ON-WAVE/SYNCHRONOUS SWITCHING FUNCTION

- Have one AC voltage sensor's analog output available for connection to the MACS control unit. The output can come from Sécheron's **TMS** voltage & current sensor (current loop output) or from a Voltage Transformer (voltage output).
Voltage sensor analog output range:
 - from 37.5 to 120 V_{AC} ⁽¹⁾
 - 8 to 25 mA
- Define precisely the goal to be achieved using the Point-on-Wave/Synchronous switching function, so that Sécheron can recommend the best settings adapted to your application and requirements: reduce Inrush Current, reduce Electromagnetic Interferences (EMI), others,
- To order the Point-on-Wave/Synchronous switching option, select the code J or L (function of the voltage sensor type) for the line 21 of the ordering code page 15 of the MACS brochure.

⁽¹⁾ for other voltage ranges, please contact Sécheron.

- Upon the needs of the application, the synchronous switching behaviour of the orders can be set in different modes
 - Point-on-Wave/Synchronous switching at closing only (at any predefined phase)
 - Point-on-Wave/Synchronous switching at opening and closing (at any predefined phase angle, possibly different than closing phase angle).

Order 1 trip orders

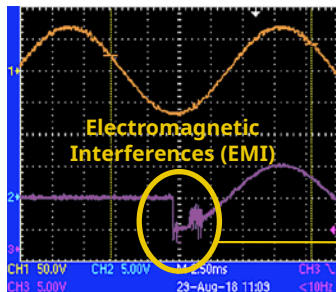
- ✓ Overcurrent or short-circuit
- ✓ Instant opening
- ✓ priority order

Order 2 switching orders

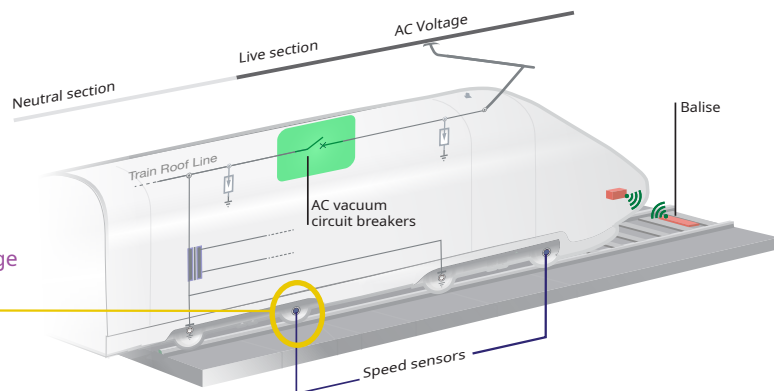
- ✓ Normal operating conditions
- ✓ Synchronous switching
- ✓ Delayed closing or/and opening



REFERENCE CASE



Line voltage
AC breaker output voltage



Case description

This project concerned a vehicle fleet already in service and equipped with a Sécheron AC vacuum circuit breaker. In service, the AC circuit breaker is opened before entering the neutral section, and reclosed when getting back on a live section. Closing of the AC circuit breaker after the neutral section is triggered by a signalling balise.

Vehicles operator identified issue

Based on the line voltage phase angle on which the breaker's main contacts reclose, electromagnetic interferences are generated causing EMC issues on the speed sensors and leading to the activation of the emergency braking.

Sécheron solution

- The synchronous switching function was installed on a test vehicle, and set to enable Sécheron's AC circuit breaker to reliably close on the line voltage phase angle 0° or 180°. The test vehicle was operated during 6 months, with no more records of emergency braking when reclosing the breaker after a neutral section.
- Following this successful field test, Sécheron has been appointed to deliver the synchronization function for all remaining AC vacuum circuit breakers of the vehicles' fleet.



Sécheron SA
Rue du Pré-Bouvier 25
1242 Satigny - Geneva
CH-Switzerland

www.secheron.com
Tel: +41 22 739 41 11
Fax: +41 22 739 48 11
ess@secheron.com