Commercial Name: Power-Flow

Product category: Current Generators (high-current output) suitable for powering very low-impedance loads
Input / Output configurations: AC input/AC output & AC input/DC output

Main Features:

- fully tailor-made [very high] current and [very low] voltage ranges
- power range from 1.5kVA/kW to 150kVA/150kW
- current up to 40kA within the 150kVA/kW max power allowance
- voltage output usually < 10Vac/Vdc
- DC output attained with a rectifier downstream the AC/AC inverter
- Custom output frequency range in AC/AC configuration
- Fast current ramp time with customised stabilization time (magnetic curve or thermic curve architectural philosophies)

* as we base our approach on tailor-made solutions the mechanical enclosures vary according to the set of current/voltage requirements provided

Main marketplaces:

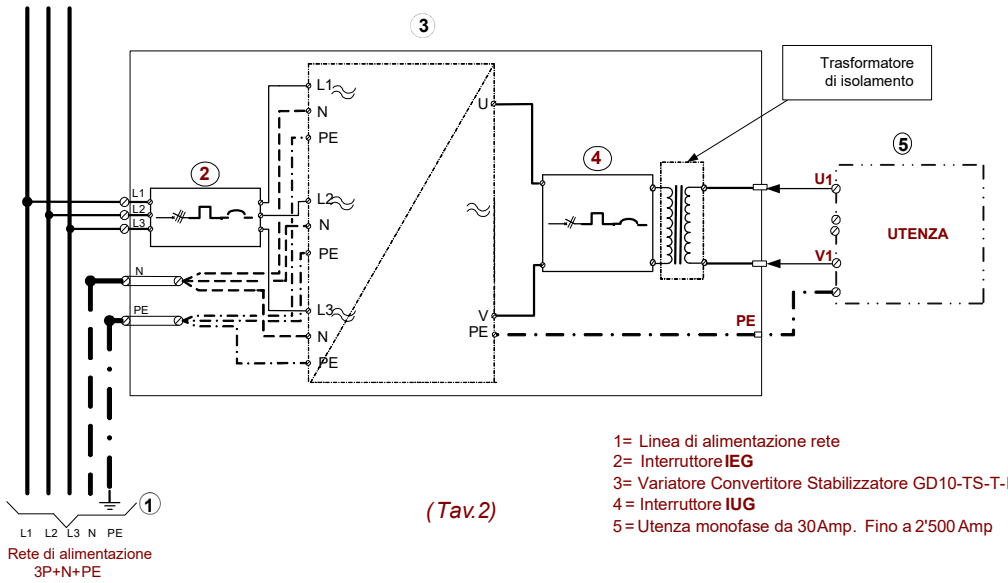
- shunts
- busbars
- circuit breakers
- signal cables
- current and winding transformers
- test stands for electric motors

Technical Insight on MCB electronic architecture:

- ✓ up to 200A output without any demand for quick current ramp, we can still rely on our MCB024 board proper to our AC/AC Power-Boost family (this board is affected by current overshooting up to 300ms current ramp)
- ✓ above 200A we use:
  - MCB104 with thermic curve (100ms transient, no overshooting)
  - MCB036 with magnetic curve (30-35ms transient, no overshooting) – more expensive than MCB104
- ✓ MCB036, as much fast as it is, introduces a time shift by 30ms between the setup of the current value and the measurement of it in output. In order to further shorten this time and line up the current value set and its measure, our systems integrators rely on National Instruments systems.
- ✓ Accuracy: given a scale of 3000A the MCB036 can guarantee, in single range, a minimum current value around 17/18A whereas the MCB104 a minimum value closer to 30A. In order to increase this precision is possible to design multi range output systems but the lower the value requested the higher the costs of the transformers
- ✓ Current Output measurement is carried out with CT (current transformers) up to 3000A and Rogowski coil for currents above 3000A. It's important to be cautious and careful with Rogowski coils installation: as heavily susceptible to EMC disturbances it's important to fix them tightly and properly to the board where they'll be allocated on.

Case History 1 – AC circuit breakers testing (BTICINO)

- ✓ 10kVA 3-phase input 1-phase output
- ✓ 1 – 4Vac
- ✓ 30 – 2500A
- ✓ Needs the current to stabilize in a quarter cycle (30-35ms)
- ✓ Magnetic test with 100ms duration current flick
- ✓ RS232/Ethernet with SCPI



(Tav.2)

1= Linea di alimentazione rete
2= Interruttore **IEG**
3= Variatore Convertitore Stabilizzatore GD10-TS-T-IS
4 = Interruttore **IUG**
5 = Utenza monofase da 30Amp. Fino a 2'500 Amp

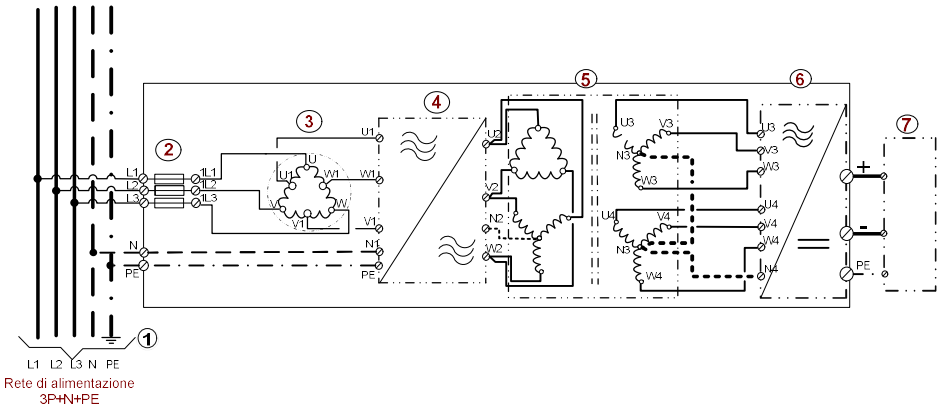
Test consists in two phases:
• Thermic: 30 seconds of test at maximum current
• Magnetic: two quick flicks of maximum and minimum current of 100ms duration for 5 periods

It should be noted that thermic tests are usually performed at 3.5 x nominal current while those in magnetics also at 20 x nominal current.

Furthermore, still within the magnetohermic circuit breakers industry, there are two different products lines to be tested:
• with currents from 0A to 60A nominal and from 10A to 125A nominal
• with currents over 125A nominal

Case History 2 – DC circuit breakers testing AC/DC

- 3-phase input
- 90kW
- 1 - 6Vac
- 1000A - 15000A

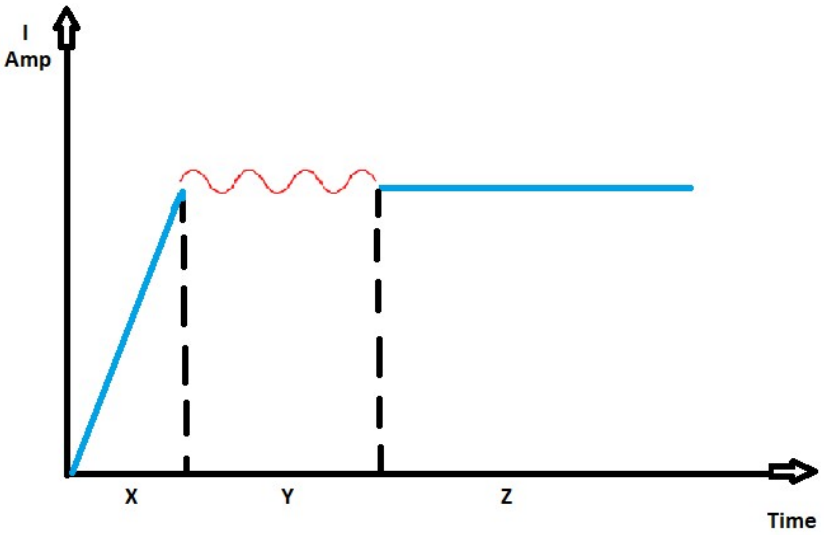


Autotransformer connected as delta in the input is used to limit the generation of harmonics voltages and also reduces the unbalancing of power consumed from AC/AC conversion in the 4th block.

The specific configuration of transformer setup employed in 5th block is used to convert the three-phase (120 degree shift) from AC/AC converter to a six-phase(60 degree shift) supply, thus reducing the ripple factor while rectifying the supply under 6th block. Then the ripples are smoothened using suitable filters providing a stable DC output at high currents.

MAGNETIC CURVE vs THERMIC CURVE

Given the following graph we'll highlight the main differences between the three standard curves.



<u>Thermic Curve MCB024 (up to max 200A output)</u>

- X time (transient time) is around 450ms
- Y time (stabilization time) with current overshoots can last up to further 30ms
- Z time represents the current output constant and stabilized for as long as the operator want to

In this specific configuration all the ramp-up and stabilization times are characterized by overshoots and oscillations that can even cross the current set value. The full stabilized output is reached within 480ms/500ms.

Thermic Curve MCB104

- X time (transient time) is around 100ms
- Y time (stabilization time) within the 100ms with no overshoot
- Z time represents the current output constant and stabilized for as long as the operator want to

Magnetic Curve MCB036

- X time is around 3ms or 4ms
- Y time is around 30ms ***
- Z time represents the current output constant and stabilized for as long as the operator want to

In this specific configuration the ramp-up curve is pretty steep whereas only the stabilization is characterized by overshoots and oscillations. The output stabilization is reaching in 34/40ms***.

Highlights:

- Thermic cheaper than Magnetic
- Thermic has got a quicker turnaround (roughly 2 weeks quicker due to the additional electronic board and calibration time needed with the magnetic curve)

*** Among our tailor-made capabilities we can even further optimize the magnetic curve response shaving the Y time avoiding any oscillation/overshoot but its feasibility has to be assessed case by case as dependent on several variables.