Technology and Application of DC-Pulse Technology for MT-Testing and Demagnetization of Steel Components

Peter HIRSCH, HPT Hirsch Prüftechnik, Zweibrücken, Germany

1. **MT-Test devices with DC-pulse technology**

HPT Hirsch Prüftechnik GmbH in Zweibrücken supplies small, low weight, mobile DC-pulse testing devices for surface crack detection and demagnetization of ferritic components (image 1)

![Image 1: MT-Testing device with 4-Pole-DC-pulse technology](image)

MT-testing devices with 4-Pole-DC magnetization generate short, fierce direct current pulses in order to magnetize the parts under test.

With condenser discharge strong current pulses are pushed through the parts under test for a few milliseconds only (image 2). The DC-pulses have an extremely high slew rate and lead to magnetic field pulses in the part.

At surface defects, i.e. surface cracks magnetic fields are leaking out of the component under test.

These magnetic leak pulses are pushing the iron-oxide particles towards the surface cracks on the part under test.

In many cases only 3 pulses are enough to bring an sufficient amount of particles to the crack to make it visible.
Because of two independent current circuits, magnetic field pulses flow alternating in two directions through the part under test.

Depending on the dimensions of the component under test, MT-testing devices with a rated power of 6,000 A up to 20,000 A are used.

Depending on the test application, MT-testing devices with one-box or two-box design are being used.

*One-box-design:*

At one-box-design (Image 3) power supply and the testing unit are mounted in one common box.

One-box-units are used when the parts under test are freely accessible from outside and when there are no test voltage restrictions by whatever safety standards.
Two-box-design:

![Image 4: MT-testing unit with two-box-design](image4)

At two-box-design (Image 4) power supply and testing unit are mounted in two separate enclosures. They are galvanically insulated from each other.

That way testing in narrow, even moist rooms is possible. Test voltage restrictions according to certain safety standards are being complied with.

MT-Testing units with DC-pulse-technology are operated in combination with the following magnetization methods.

- Direct current flow
- Combined method with current flow and coil magnetization
- Non-contact magnetization with double coil

MT-testing devices can be used for MT-testing with dc-pulse-technology as well as for demagnetization of the parts under test.

Die MT-Testing units are complemented by some accessories:

UV-Lamp:

![Image 5: UV-Lamp](image5)
When fluorescent iron-oxide particles in testing liquids are used, the surface cracks are being made visible with the UV-lamp.

First of all testing liquid needs to be sprayed on the surface of the part under test and the parts needs to be magnetized with DC-pulses. Then the UV-lamp will illuminate the surface and provide some greenish crack indications.

By switching on flood light it can be checked, if a crack indication is real.

Current-, Field strength- und residual field strength measuring unit

![Image 6: Measuring unit](image6.png)

Using the current-, field strength- und residual field strength measuring unit, the operator can make sure, that MT-testing is done properly.

Measurements are taken for:

- Amperage \([\text{A}]\) of DC-pulses
- Field strength \([\text{A/cm}]\) at the surface of the part under test

If after the part under test has been demagnetized after MT-testing, the result can be checked with the measuring unit

- Residual field strength at the surface of the part under test

Magnetic poles

![Image 7: Magnetic poles](image7.png)

Magnetic poles (Image 7) with high adhesive force are used to attach the cables at the part under test. Testing current can enter the part without sparks.
2. Magnetization methods with DC-pulse-technology

Magnetic stray fields exit the surface of magnetized parts right at the location of surface cracks.

Using iron or ironoxide powder suspensions and UV-light cracks become visible.

Only cracks with a vertical orientation versus the field can be seen, those with parallel orientation cannot be seen.

Because of that magnetization always needs to be done in two directions (30°…90°)

Direct current method

The DC-pulses cross the component under test alternating in two different directions under an angle of at least 30°. That way large areas on the components can be tested at once and all surface cracks of any orientation become visible.

Image 8:  

Image 9:

Combined method

The combined method (image 10) combines direct current flow and magnetization by a coil. It is best suited for large shafts.
Non-contact MT-testing and demagnetization with double coils

For non-contact MT-testing (image 12) DC-pulses pass two coils, which are mounted at an angle of 30°. Several parts can be tested and demagnetized simultaneously.

Demagnetization

In order to eliminate residual magnetism from steel components DC-pulses of alternating direction and decreasing intensity go through the part.
3. Non-contact MT-testing with DC-pulses and digital image processing

MT-testing with DC-pulses produces clear crack images within a few seconds. Large parts, i.e. tooth wheels, shafts, welded components castings, etc. can be tested quickly.

Using a digital camera and image processing software cracks can be detected automatically.

Non-contact MT-testing plus digital camera and image processing software are suited especially for series production. Parts are being tested automatically and faulty parts are sorted out automatically.
4. Application

MT-testing devices with DC-pulse technology are being used in various industries.

Image 16: Non-contact testing of elevator links for off-shore application (oil drilling platform)

Image 17: MT-Testing of structural parts of a mobile crane
Image 18: MT-Testing of a cantilever of a mobile crane
(overall length = 9m)

Image 19: MT-Testing of clamping tongs for off-shore application