Welcome to the world of EMC
The company

From its foundation in 1987, EM TEST is known worldwide for high quality, customer-oriented EMC testing products. The integration of customers' requests, new test standards, and new technology has led to the growing success of our equipment. At EM TEST, we focus our considerable knowledge and experience on our testing equipment and application support for the benefit of our customers.

Our sales network, based on local representatives and partners. Headquartered in Reinach/CH, and Kamen/DE, EM TEST has sales and service facilities in Switzerland, Germany, France, Great Britain, Ireland, Italy, the United States, Sweden, Japan and China as well as 50 agents and 25 distributors in all over every continent. The continuous growth and success of EM TEST is proof that we are on the right path.

Today, EM TEST is one of the leading suppliers of EMC generators for conducted immunity testing in the world.
EM TEST was founded on July 1st, 1987. Uwe Flor, Germano Taddio and Harald Kunkel, 3 people with several years of experience in development, production, application and sales of EMC test generators formed a team to unite their knowledge in one company. From the beginning, innovation was the guideline for all their efforts; they wanted to supply test generators built on the latest level of technology and different from any competitor's devices. To this day, an EM TEST generator is immediately recognisable.

**The founders agreed: it is not the test generator that is of interest but the test set-up, the test itself, and the test results.**

El.-Eng. Harald Kunkel was working for Haefely from 1980 until 1987. He was in charge of the development of high voltage impulse generators and the commissioning of these installations world-wide. The first Burst generator with an output voltage of 8kV was developed by Harald Kunkel as well.

El.-Eng. Germano Taddio was working for Sprecher & Schuh from 1979 until 1981 as a development engineer. The following three years he was working for W+H Elektronik. In 1984 he joined Haefely and was leading the International Sales Support until 1987 when EM TEST was founded.

El.-Eng. Uwe Flor started in 1981 as a Sales Manager at Haefely (Germany) in 1981. In 1984 he joined Schaffner where he was in charge of the sales. In 1987 he was one of the founders of EM TEST.
Headquaters

EM TEST AG

Tasks
- Development
- Production
- Quality assurance
- Service, Calibration

Sales
- South Europe
- North & South Amerika

Service
- Repair
- Calibration
- Application support

Standard work
- National
- International

EM TEST GmbH

Tasks
- Development
- Marketing
- Design
- Service, Calibration
- Germany
- Poland, Romania, Bulgaria, Slovenia, Benelux
- Repair
- Calibration
- Customer Service
- EMC Engineering
- Training & Seminars

Service
- EMC Lab.

Standard work
- National
EM Test History ...each product a world news

1987 The first Burst Simulator with for up to 8kV (IEC 801-4). The first simulator for electrostatic discharges with exchangeable discharge circuits (IEC 801-2)

1989 The first fully electronic Burst simulator for up to 4,5 kV (IEC 801-4)

1990 The first fully remote-controlled automotive test system (ISO 7637-2/-3)

1991 The first fully remote-controlled test system for conducted immunity (IEC 801-4/-5/-11)

1995 UCS 500, the first compact simulator for conducted immunity testing (IEC 61000-4-4/-5/-11).

1996 CWS 500, Simulator for RF conducted disturbances induced by radio frequency fields (IEC 61000-4-6)

1998 UCS 500M6, the first modular-built compact simulator for up to 6.5 kV (IEC 61000-4-4/-5/-8/-9/-11/-12

2000 dito, ESD Simulator with automatic data collection (IEC 61000-4-2)

2004 UCS 200M, Compact Simulator incl. Freestyle Mode (ISO 7637-x and worldwide car manufacturer standards)

2009 VSS 500N10.2, New testing solution for photovoltaic panels (GreenPower Testing)

2009 NETWAVE, Multifunction AC/DC Power Source 7,500VA

2010 AMP 200N, for Ford EMC–CS-2009.1
Highlights that testify the progress

Foundation

Development of the first EM TEST test generators
Highlights that testify the progress

1st fully automated test set-up 1991

1st ESD Simulator up to 25 kV (1987)

1st Burst generator (1987)
Highlights that testify the progress

10 years of EM TEST 1997
Largest range of Immunity testers

Innovative Technology

- Use of state-of-the-art technology
- Compact design
- Modular built test systems
- Integrated measurement facilities,
- Pre-programmed test routines
- Use of semi-conductive switches for all test pulses
- Integrated safety features (interlock, warning lamp)
- More than 40 different standard simulators
- Special custom-made simulators

Simulators

- Automotive
- Telecom
- Industry
- Medical
- Residential
- Broadcast
- Components
- Military
- Aircraft

EM Test Services

- Seminar
- Workshop
- Testing Laboratories
- Service and Support
- Calibration Laboratory
EM TEST is the leading manufacturer of high-class, full-compliance EMC test and measurement equipment for the following branches:

- Industrial
- Electronic components
- Medical
- Residential
- Telecom
- Automotive
- Avionics
- Military
- Broadcast
- Renewable Energy
IEC- TESTING EQUIPMENT

**UCS 500N7 / UCS 500N5**
IEC/EN 61000-4-4,-5,-8,-9,-11,-29

**ESD 30N / Dito**
IEC/EN 61000-4-2

**CWS 500 N1**
IEC/EN 61000-4-6

**NETWAVE**
IEC/EN IEC/EN 61000-4-13,-14,-17,-28

www.emtest.com
Harmonic & Flicker Systems

1-Phase System 6 kVA
IEC/EN 61000-3-2,-3

3-Phase System 30 kVA
IEC/EN 61000-3-2/-3
Automotive Test Systems

UCS 200N
ISO 7637, Pulse 1, 2a, 3a, 3b, 6

VDS 200N30
ISO 7637, Pulse 2b, 4

WAVEGENERATOR
Car manufacturer specifications

CWS 500N2
ISO 11452-4

50A ISO-System

www.emtest.com
Renewable Energy

VSS 500N10

UCS 500N7.2
Technical assistance and customer support

In the future, EM TEST will continue to be the optimum solution for your testing needs, always offering you the most efficient, most economic, and most exacting test equipment.

Our innovative spirit is alive.
Nothing to hide – have a look inside

Top-Level Quality Demand

- Production acc. to ISO 9001
- Long-duration tests in a heat chamber at 38 degrees Celsius
- All necessary safety requirements are well considered
- Carefully selected components are extensively tested to prove their suitability
- EM TEST runs their own calibration and service laboratories
EMC Testing Laboratory

**EMC Consulting / EMC Testing**
- Shielded room
- Full anechoic chamber
- Semi anechoic chamber (EMI and EMS testing up to 18 GHz)
- Open Test Side area
- ESD-/ Fast Transient-/Surge-/Power Fail Testing
- Harmonic & Flicker Measuring
- Automotive testing acc. to ISO 7637-2 and car manufacturer specifications

**EMC seminars and workshops**
- EMC competence
- EMC compliant design
- Immunity to automotive
- Emission / CE-marking
- Harmonics & Flicker
- Customized seminars and workshops
Services

Calibration
• Europe
• Asia
• USA

Rental service

www.emtest.com
Mr. Flor is member of German national standards DKE.
He sits also in special committees and working groups

Mr. Burger is member of international standards IEC,
IEC TC 77 and ISO 7637

Mr. Taddio is member of Swiss national standards CES
He is also active in the European standards CENELC, IEC TC 77 and CISPR
OCS500N6F (fast)
a new generator for Damped Oscillatory Waves
as per IEC 61000-4-18 and IEC 61000-4-12
Content
1. Standard overview
2. General phenomena
3. Test levels
4. Test generator
   4.1 Characteristic Ringwave
   4.2 Characteristic slow damped wave
   4.3 Characteristic fast damped wave
   4.4 Coupling networks
5. Test procedure
   5.1 Test setup
   5.2 Performance the test
# 1. Standard overview

<table>
<thead>
<tr>
<th>Standard Code</th>
<th>Description</th>
<th>Edition Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61000-4-12 ed2.0</td>
<td>Electromagnetic compatibility (EMC)</td>
<td>2006-09-13</td>
<td>- Part 4-12: Testing and measurement techniques</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Ring wave immunity test</td>
</tr>
<tr>
<td>IEC 61000-4-18-am1 ed1.0</td>
<td>Electromagnetic compatibility (EMC)</td>
<td>2010-04-22</td>
<td>- Part 4-18: Testing and measurement techniques</td>
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</tr>
</tbody>
</table>

Note: IEC 61000-4-18 ed1.0 was withdrawn on 2006-11-09.
2. General phenomena

Der “Ring wave“ simulates interferences induced in low-voltage cables due to the switching of electrical networks and reactive loads.

Faults are due to interferences in power supply circuits and insulation breakdown or lightning.

It is in fact the most diffused phenomenon occurring in power supply (HV, MV, LV) networks, as well as in control and signal lines.

The propagation of the wave in the lines is always subject to reflections, due to the mismatching impedance of lines and their protection devices, input line filters, etc. These reflections produce oscillations.

The rise time of the ring wave is in the range of some 10 ns to a fraction of µs. The resultant phenomenon at the equipment ports is an oscillatory transient, or ring wave.

This ring wave has a defined 0,5 µs rise time and 100 kHz oscillation frequency. This typical impulse is widely used for testing products related to power distribution and railways application.
2. General phenomena

The damped oscillatory wave phenomena are divided into two parts.
- **Slow damped oscillatory wave** includes oscillation frequencies between 100 kHz and 1 MHz.
- **Fast damped oscillatory wave** includes oscillation frequencies above 1 MHz

**Slow Damped Oscillatory Wave** simulates the following two specific phenomenas:

Switching of **disconnectors in HV/MV open-air substations**, and is particularly related to the switching of HV busbars, as well as to the background disturbance in industrial plants. In electrical stations, the opening and closing operations of HV disconnectors give rise to sharp front-wave transients, with rise times in the order of some tens of nanoseconds.

Because of reflections, due to the mismatching of impedances on HV circuits an oscillating impulse occurs. The length of the HV busbars from some 10 meters to hundreds of meters characterizes the fundamental oscillation frequency.

A frequency of 1 MHz may be considered representative in most situations, but 100 kHz has been considered appropriate for large HV substations.

The repetition rates selected, 40/s and 400/s, represent therefore a compromise, taking into account the different durations of the phenomena.

In **industrial plants**, repetitive oscillatory transients may be generated by switching transients and the injection of impulsive currents in networks and electrical equipment.
2. General phenomena

*Fast Damped Oscillatory Wave* covers the following two specific phenomena:

**Disturbances produced by switchgear and control gear**

In *Air insulated substations* (AIS) these transients will radiate an electromagnetic field in the substation environment. The phenomena with frequencies higher than 1 MHz can also take place in these substations.

In *gas insulated substations* (GIS) with SF6 as insulating gas, the inside distances are smaller and therefore the electric field is much higher. The oscillation frequencies of 3 MHz, 10 MHz and 30 MHz for the fast damped oscillatory waves seem to be suitable for realistic reproduction of such phenomena.

**Disturbances produced by the high-altitude electromagnetic pulse (HEMP)**

The high-altitude electromagnetic pulse (HEMP) as described in IEC 61000-2-9 is generated by a nuclear explosion in high altitude.

Cables at earth level act as antennas and couple the pulse which has a rise time of 2,5 ns and a pulse width of approximately 25 ns.

The repetition rate selected, 5 000/s, is set considering the higher repetition rates measured in GIS.
3. Test levels for ringwave

IEC 61000-4-12

<table>
<thead>
<tr>
<th>Level</th>
<th>Common mode [kV]</th>
<th>Differential mode [kV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

\(a\) x can be any level, above, below or in-between the other levels. This level can be given in the product standard.

Test levels for ringwave
3. Test levels for damped oscillatory wave

**IEC 61000-4-18**

The preferential range of test levels for the damped oscillatory wave tests, applicable to power, signal and control ports of equipment, is given in Tables 1 and 2. The test level is defined as the voltage of the first peak (maximum or minimum) in the test waveform.

### Test levels for the slow damped oscillatory wave (100kHz or 1MHz)

<table>
<thead>
<tr>
<th>Level</th>
<th>Common mode [kV]</th>
<th>Differential mode [kV]</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>2(^a)</td>
<td>1</td>
</tr>
<tr>
<td>4(^b)</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

\(^a\) The value is increased to 2.5kV for substation equipment

\(^b\) x can be any level, above, below or in-between the other levels. This level can be given in the product standard.

### Test levels for the fast damped oscillatory wave (3MHz, 10MHz or 30MHz)

<table>
<thead>
<tr>
<th>Level</th>
<th>Common mode [kV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4(^b)</td>
<td>4</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

\(^b\) x can be any level, above, below or in-between the other levels. This level can be given in the product standard.
4. Generator

The generator output shall have the capability to operate under short-circuit conditions. A block diagram of a ring wave and damped oscillatory wave generator is shown below.

![Ringwave Generator](image1)

![Generator for Damped Oscillatory waves](image2)

The generator output shall be floating and the stray capacity unbalance of the output terminals to earth shall be less than 20%. This condition is necessary to test EUT control and signal ports in differential mode. A dual output generator is necessary. The fast generator output has a single coaxial output. Test with this generator shall be made only in common mode.
4.1 Characteristics of OCS500N6F Generator (Ringwave)

Specifications **open circuit voltage:**
- Open circuit voltage: 250V – 6000V ± 10 %;
- Voltage rise time T1: 0.5µs ± 30 %;
- Oscillating frequency V: 100 kHz ± 10 %;
- Repetition rate: 1-999s
- Voltage decaying: from Pk1 to Pk2 40% - 110%
  from Pk2 to Pk3 and Pk3 to Pk4 40% - 80%
- Output voltage: 12Ω, 30Ω ± 20% switchable
- Open circuit voltage: Pk1 Value, 250 V to 4.4 kV ± 10 %;
- Polarity first half cycle: positive, negative, alternating
- Phase synchronization: 0 - 360° resolution

Specifications **short circuit current:**
- Current rise time T1: ≤ 1µs
- Short circuit current Pk1: 12Ω: 500A ± 10%
  30Ω: 200A ± 10%
### 4.2 Characteristic OCS500N6F Generator (Slow damped oscillatory)

**Specifications open circuit voltage:**
- Open circuit voltage CDN: Pk1 value, 250 V to 2.5 kV ± 10 %
- Open circuit voltage direct: Pk1 value, 250 V to 3.0 kV ± 10 %
- Voltage rise time T1: 75 ns ± 20 %
- Oscillation frequencies U: 100kHz and 1MHz ± 10 %
- Repetition rate: 100kHz: 20/s – 50/s
  1 MHz: 400/s
- Decaying: Pk5 > 50 % of Pk1
  Pk10 < 50 % of Pk1
- Burst duration: 0.1 to 99.9s (Norm ≥ 2s)
- Burst period: 0s – 99.9s (0=const. burst)
- Output impedance: 200 Ω ± 20 %
- Polarity of the 1st half-period: positive and negative

**Specifications short circuit current:**
- Short-circuit current Pk1 CDN: 1.25 A to 12.5 A ± 20 %
- Short-circuit current Pk1 direct: 1.25 A to 15 A ± 20 %
4.3 Characteristic OCS500N6F Generator (Fast damped oscillatory)

Specifications **open circuit voltage**:  
- open circuit voltage: Pk1 value, 450 V to 4.4 kV ± 10%  
- Voltage rise time T1: 5 ns ± 30 %;  
- Oscillation frequencies V: 3, 10 and 30 MHz ± 10%  
- Repetition rate: 1 to 5000/s ± 10 %  
- Decaying: Pk5 > 50 % of Pk1  
  Pk10 < 50 % from Pk1  
- Burst duration: 3 MHz: 1- 50 ms ± 20%  
  10 MHz: 1 - 15 ms ± 20%  
  30 MHz: 1- 5 ms ± 20%  
- Burst period: 0.3-99.9s ± 20 % (Norm 300ms)  
- Output impedance: 50 Ω ± 20 %;  
- polarity of the 1st half-period: positive and negative

Specifications **short circuit current**:  
- Current risetime T1: 3 MHz:< 330 ns, 10 MHz:< 100 ns, 30 MHz:< 33 ns  
- Oscillation frequencies I: 3 MHz, 10 MHz and 30 MHz ± 30 %;  
- Current decaying: Pk5 > 25 % from Pk1  
  Pk10 < 25 % from Pk1  
- Short-circuit current Pk1: 9 A to 88 A ± 20 %
4.4 Coupling network for AC/ DC Power ports

The coupling decoupling network should be suitable for coupling the Ringwave or Fast DOW onto AC/DC power.

**Coupling capacity**
- 0.5 µF (slow damped oscillatory wave)
- 33 nF (fast damped oscillatory wave)
Damping through the coupling capacitors is <10%

**EUT input residual voltage power supply:**
The maximum residual voltage of the Damped Oscillatory waves at EUT power supply input is 707V.

**Coupling network for signal and data lines:**
The HFK Capacitive Coupling Clamp, also used for Burst testing acc. 61000-4-4, is used for DOW testing.

**Note:** Decoupling through the HFK port might not be sufficient enough. In such cases further decoupling actions are necessary.
5. Execution of the test

When performing the tests, the test equipment and manufacturer EUT safety earth requirements shall be taken into consideration. For cables where only one end of the screen is earthed, the unearthed side of the screen shall be connected to the cabinet through a 0.5 μF coupling capacitor.

Test setup for table top equipment

- Distance between EUT and conducted structures >0.5m
- EUT placed on an insulating support 0.1m ± 1cm
- Distance coupling/decoupling network to EUT =1m
- The input and output circuits connected to auxiliary equipment shall be provided with CDN to prevent interference to the aux equipment.
- The cables supplied or specified by the equipment manufacturer shall be used, alternatively suitable unshielded cables shall be adopted.
- The communication lines shall be elevated 0.1 m above the GRP and be at least 1 m in length.
- Groundplane (GRP) should be copper or aluminium of >0.25mm thickness; other material >0.65mm thickness
Floor-standing equipment

Where a GRP is used, floor-standing equipment shall be placed on a 0,1 m ± 0,01 m thickness insulating support.

The EUT shall be connected to the earthing system according to the manufacturer's installation specs. The equipment cabinets shall be connected to the GRP via a connection of minimum length starting from the earth terminal of the EUT. No additional connections are allowed.
5.2 Test procedure
Prior to testing, the test equipment shall be checked. This test procedures includes:

– the verification of the laboratory reference conditions;
– the preliminary verification of the correct operation of the equipment;
– the execution of the test;
– the evaluation of the test results.

The test duration shall be at least 1 min. To avoid synchronization, the test time may be broken down into six 10s bursts separated by a 10s pause. In a real environment, bursts will occur randomly as single events. It is not intended that the burst is synchronized with EUT signals. Product committees may choose other test durations.

The test plan shall specify:
– type of test that will be carried out;
– test level;
– test generator;
– polarity of the test voltage (both polarities are mandatory);
– duration of the test;
– EUT ports to be tested;
– mode of application of the test voltage (line-to-ground, line-to-line, between cabinets);
– sequence of application of the test voltage to the EUT ports;
– representative operating conditions of the EUT;
– auxiliary equipment.
emtest

the benchmark for emc