

1.3MVA Mobile AC Test System



Specification

Rev. e1.33

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1. General Description

On-site transformer testing is the main application of Power Diagnostix' mobile high voltage AC test system. However, it can be used as well for other on-site testing, such as of GIS, rotating machines, or high voltage cables.

The system stays within the load and size limitations for permission-free road use. Additionally, the matching transformer and the reactor are filled with ester instead mineral oil. Thus, it can be easily transported to a substation, power plant, or other high voltage areas for testing HV components after installation or repair. Additionally, it is applicable for condition assessment and fault investigations. PD measurements can be performed in non-shielded environments as part of the on-site acceptance test on a power transformer, or as a method to locate PD failures acoustically, or by electrical measurement.

It is designed for performing routine and special tests according to standards, such as IEC 60060-3, IEC 60076, and IEEE Std. C57.113-2010 and, thus, giving accurate and reliable test results as known from acceptance tests performed in a static test field of a factory.

Applicable Tests:

- Applied voltage tests in a resonant circuit up to a test level of 500 kV
- Induced voltage test (single- or three-phase) up to a test level of 90 kV.
- Electrical and acoustical partial discharge (PD) measurements
- Measurement of no load losses
- Heat run with up to 1.3 MVA

Main component of the Power Diagnostix mobile HV AC test system is a frequency converter based on IGBT technology, which provides the power in a frequency range of 15 to 200 Hz. It consists of three converter units, which can be operated in parallel (0° phase shift) or as a three-phase system (120° phase shift). Thus, always the full power of the converter can be used. The system comes with an inductive and capacitive compensation, and with a step-up-transformer, that can be switched manually to different configurations. Disturbances from the power supply will be filtered by Power Diagnostix T-filter TVC100/123. The special design of these filters allows current measurement on HV potential and voltage measurement from a capacitive divider. Both, current and voltage measurements, are DKD calibrated and the precise values are displayed by a power analyzer.

Measuring Equipment:

- ICMsys8 with spectrum analyzer and PD calibrator
- Three-channel FOsystem (current measurement)
- Power analyzer
- Three HV filters TVC100/123 with integrated voltage divider and current shunts
- DKD calibrated voltage and current measurement

Quadrupoles, preamplifiers, calibrators, and further accessories are also included.

Tests can be performed with the container placed on a trailer (additional stairs are included) or on the ground. The system includes all cables for HV connections, as well as corona shields for the HV bushings. Thus, it is ready to use.

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2. 40' High Cube Container

The mobile test system comes in a 40' container, which has two doors to enter the operation room as well as the converter room. The high voltage test can be performed with the container placed on the trailer (additional stairs are included), or on the ground. A suitable trailer can be quoted separately on demand. All labels on the outer surface of the container can be printed according to the specification of the customer.

Outer Dimensions: 12192mm x 2348mm x 2896mm
 Weight: 27 tons
 Color: RAL9010

Further Dimensions:

Single Container (standard):

L: 12.20m (40')
 W: 2.35m
 H: 2.90m
 W: ~27t

Container on Trailer (optional):

L: 12.50m
 B: 2.35m
 H: 4.00m
 W: ~31t

Total Truck and Trailer (example):

L: 16.10m
 B: 2.55m
 H: 4.00m
 W: ~37.6t



Additional weight capacity for accessories and other material: 2.4 tons

If moving out the reactor on the back door of the container the total length will be 4 meters more.

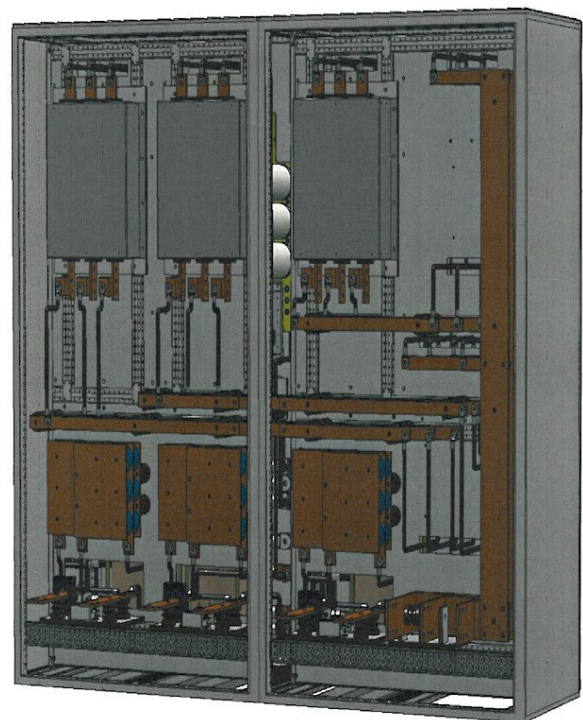
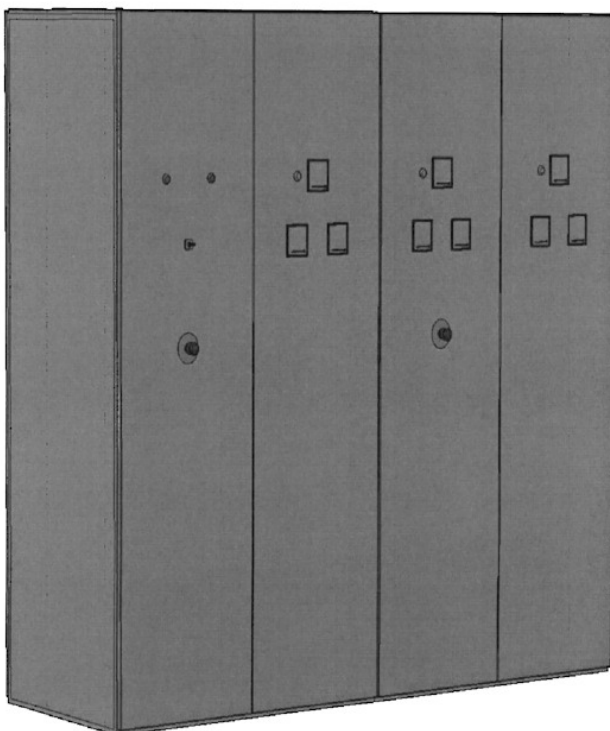
Typically a suitable truck will be rented for each project.

3. Frequency Converter

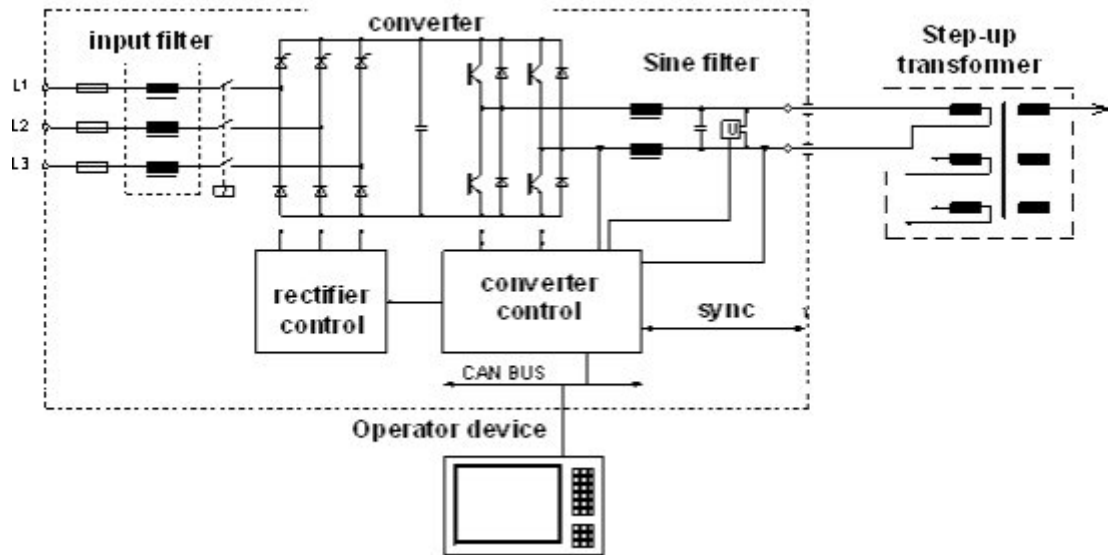
The main component of the AC high voltage test system is the converter. It is based on IGBT technology and provides the power in a frequency range of 15 to 200Hz. The converter consists of three identical converters that can be operated in parallel (0° phase shift) or as a three phase system (120° phase shift). Thus, always the full power of the converter can be used.

On the front panel several control items like emergency stop, main switch, control lights and voltage and current indicators – for each phase – are located. On the top of the converter cabinet the water cooling system with the control panel is mounted. The cooling box with its vents can be pulled out to the back during operation. The doors of the frequency converter system have to be closed during operation. They are also protected with an automatic switch-off system.

Dimensions:	2400mm x 800mm x 2200mm
Power supply:	3 x 400VAC, 50/60Hz
Output voltage:	3 x 360V
Output current:	3 x 1250A max. / 1000A continuous
Output frequency:	15–200Hz
Nominal power:	3 x 450kVA = 1.35MVA max.
Weight:	2 tons

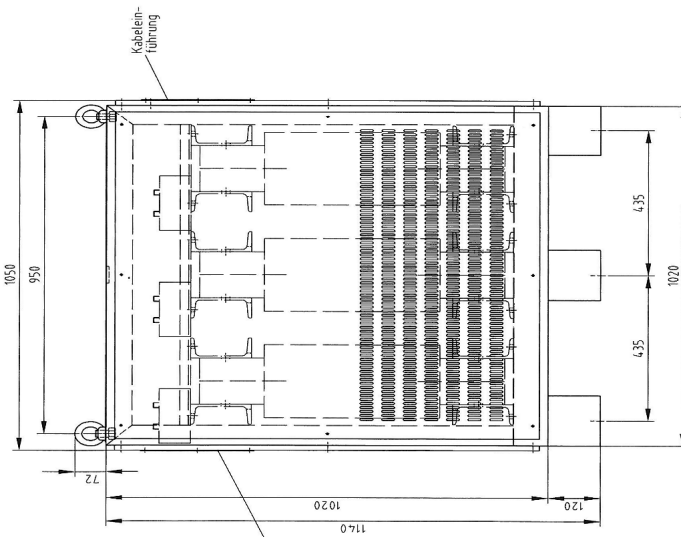
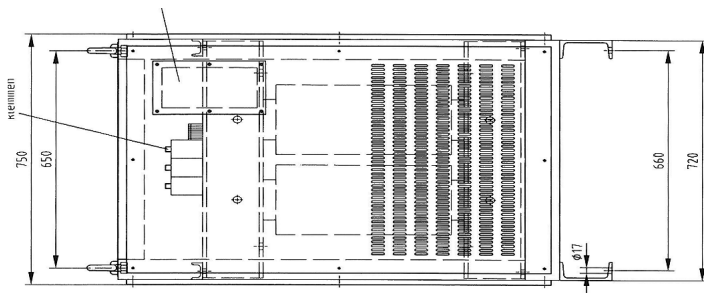


All control signals are transferred via an integrated CAN bus system. The control computer comes with USB-CAN bus interface giving direct access to the electronic control.



4. Inductive Compensation

The inductive compensation is mainly used during induced voltage test to achieve higher test frequencies. The reactor block is located right behind the step up transformer on the back side of the container. The control switch and indication lamps are located on the front panel of the capacitive compensation rack (see next chapter). It is manually controlled.

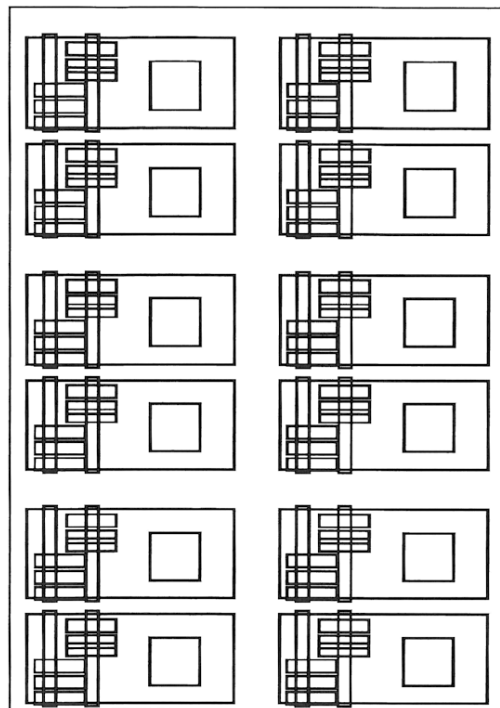


Dimensions:	1020mm x 720mm x 1050mm
Power:	3 x 180kVA
Voltage:	3 x 360V
Frequency:	70–200Hz
Inductivity:	$L = 3 \times 1.64\text{mH}$
Current:	3 x 500A–175A
Control mode:	manual

5. Capacitive Compensation

The capacitive compensation is mainly used during applied voltage test to achieve the 50/60Hz test frequency. The cabinet of the capacitive compensation is placed on the right hand side behind of the front entrance door. It is protected with a switch-off system in case the doors are opened during operation. The full control of the capacitive compensation is automated and will be handled by the control software.

Dimensions:	1200mm x 800mm x 2200mm
Power:	3 x 603kVA
Voltage:	3 x 400V
Cont. current per phase:	1810A
Frequency:	50/60Hz
Capacitance:	3 x 4mF
Tot. capacitance:	12mF
Control mode:	automatic

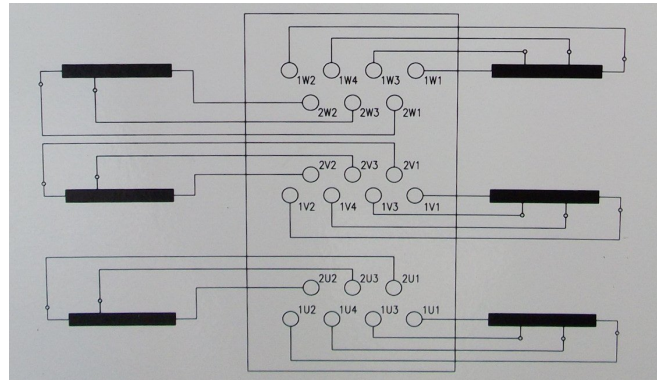


6. Step-up-Transformer

The step-up-transformer is connected to the converter at the low voltage terminals and can be connected to the device under test and the voltage divider at the high voltage terminals. Three separate single-phase transformers are built into the tank ensuring a single-phase operation of the converter as it can be seen on the rating plate. The system comes with bridge connections for each configuration. These copper bars are stored in a storage room on the floor in front of the transformer.



- Rated power: 2MVA
- Rated current US: 1852A
- Rated voltage US: 360V
- Rated current OS: 135A
- Rated voltage OS: 90kV
- Rated frequency: 45–200Hz
- Type of cooling: ONAN
- Total weight: 8.5 tons
- Weight of oil: 1.85 tons
- Type of oil: Biotemp[®]
- Dimensions: 2116mm x 1956mm x 1800mm



Rated Values		2U3/2U2; 2V3/2V2; 2W3/2W2		2U1/2U2; 2V1/2V2; 2W1/2W2		
		360V		360V	1851.9A	
Y	1U1; 1V1; 1W1	1U2-1V2-1W2-N	90.1kV	12.8A	65.2kV	17.7A
	1U3; 1V3; 1W3	1U2-1V2-1W2-N	45.1kV	25.6A	32.7kV	35.3A
	1U4; 1V4; 1W4	1U2-1V2-1W2-N	20.4kV	56.5A	14.8kV	78.1A
Δ	1U1; 1V1; 1W1	1U2-1V1; 1V2-1W1; 1W2-1U1	52.0kV	22.2A	37.7kV	30.7A
	1U3; 1V3; 1W3	1U2-1V3; 1V2-1W3; 1W2-1U3	26.1kV	44.3A	18.9kV	61.2A
	1U4; 1V4; 1W4	1U2-1V4; 1V2-1W4; 1W2-1U4	11.8kV	97.9A	8.5kV	135.2A

7. HV Filters with AC Voltage and AC Current Measurement

High voltage divider, high current transformers, and high voltage filter are combined in this unit. They are connected directly to the unit under test using HV cables. For transportation, the filter are stored on the wall (see the picture below). During the operation they should be placed in the right position according to the voltage used for the test. The filters are mounted in rails at the ceiling to support moving them from storage to operation position.

Current transformers providing an AC voltage in relation to the HV current are placed inside of the filter box on HV potential. Special fiber optic transmitter units are converting this signal into a fiber optic protocol which is sent via fiber optic cables to the receiver unit of the FOsystem. The FOsystem is mounted into the 19" rack at the control room (see chapter 10). Each fiber optic transmitter is powered by an external battery. They can be removed from the HV filter for the charging procedure. Special BNC connection cables are provided to connect the batteries to the charge DC connectors on the rear side of the FOsystem.



The voltage measurement signal can be taken from the capacitive divider on low voltage potential. This signal is directly connected via RG213 coaxial cable to the input of the Power Analyzer.

Both, high current and high voltage measurements, will be DKD calibrated before shipment or before acceptance test by the customer. Power Diagnostix runs an accredited DKD laboratory with in house and on-site calibration concession.

HV Filter Specification:

T-filter characteristic:

- Type of T-filter: LR-C-LR
- Nominal voltage: 100kV_{rms}
- Nominal currents: 80A continuous, 123A short time (10min.)
- Blocking capacitor: C_b=10nF
- DC-(50)-300 Hz line frequency
- Typical 50Ω-insertion loss:

kHz	10	20	50	100	200	500	1000
dB	8	12	14	25	45	>60	>60

High Voltage Measurement:

- Built in divider capacitor: C_d=10μF
- Output signal: max. 100V_{AC}
- Output connector: N-Type



Current Measurement:

- Built in current transformer 1:1000 and shunt resistor (50Ω)
- External connectors for FOT2 battery pack
- Mounting mode: overhead
- Outer dimensions: (WxDxH) $45 \times 45 \times 100 \text{ cm}^3$
- Weight: approx. 55 kg
- includes multi-contact connectors, type: B18N

8. Reactor

The single phase reactor, as shown on the picture below, is used for the applied voltage test in a resonance circuit. To perform the test, the reactor has to be moved out of the container using the motor drive and a special platform to keep the proper distance between the high voltage electrode and the ground potential. The reactor is combined with a 500kV coupling capacitor of 2nF resulting in a no-load frequency of 180Hz, approximately. Given the current limitation of 4A, the 500kV can be reached with a load of 25.6nF or less. Here, the resonant frequency is 49.7Hz. Hence, at minimum inverter frequency of 15Hz, a load of 280nF is permissible (max. 151kV).

Inductance:	400H
Resistance:	1800 Ω
Nominal voltage:	500kV
Effective Q-factor with 2nF divider:	100
Maximum input voltage:	10kV
Maximum input current:	4A
Duty cycle:	1 min ON, 10 min. OFF
Continuous current:	
Coupling capacitor:	2nF
Divider ratio:	1:1000 ($C_d=2\mu\text{F}$)



9. Control Room Equipment

One 19" rack, located in the control room at the front of the container, includes the following measurement equipment:

- Three channel fiber optic signal receiver (FOsystem) and signal re-converter
- High precision power analyzer, like Norma 5000 or equivalent
- PD measurement system ICMsys8 with eight fully equipped parallel input channels
- Two touch panel IPCs (one for converter control system, second dedicated for PD measurements) incl. keyboard and mouse
- Storage for manuals and accessories for the high voltage system.
- All-in-one printer, scanner, and copy device
- Individual power switch for each instrument on front panel

To provide further space, the glass door can be removed during operation of the system.

An operator desk and one swivel chair are located inside of the control room and can be used to store materials, tools, test protocols, literature etc. The emergency exit is located under the desk.

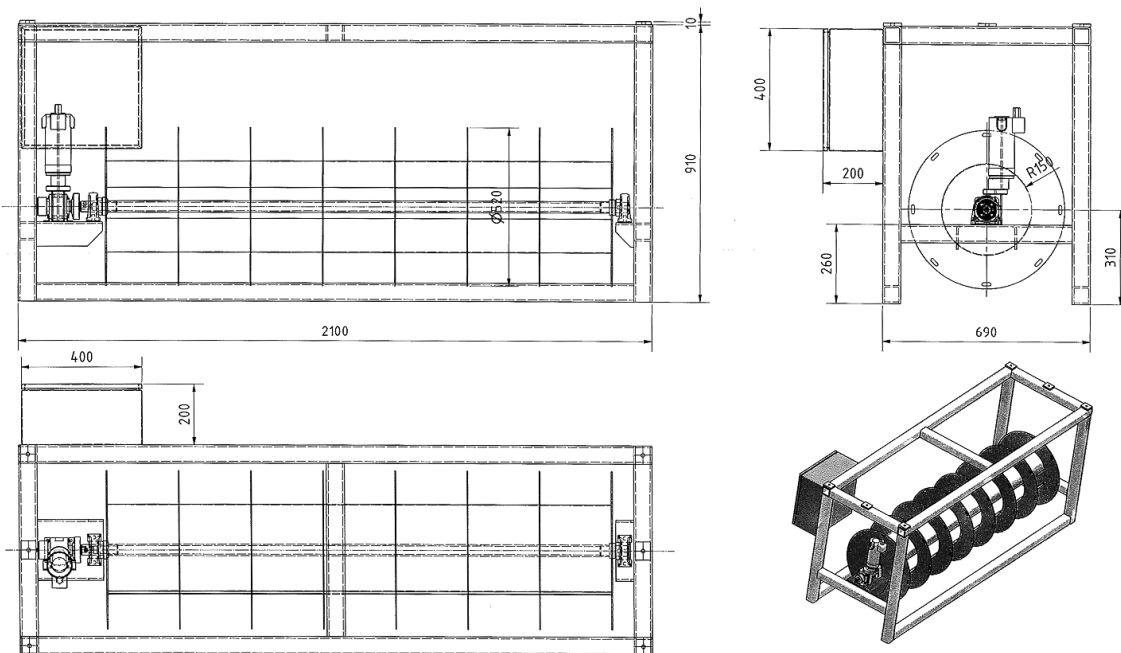


A separate tool cabinet stores the accessories for PD measurement, like quadrupoles, amplifiers, PD calibrator, and BNC cables. Further spare material can be placed into this cabinet if wanted.

10. Power Supply Cable & Connections

The cables stored in the rack are used to connect the converter to the power supply. The rack system is equipped with a motor moved mechanism to restore the power cables. If needed, the cable rack can be also moved out of the container using a forklift and can be stored outside.

The dimensions are shown in the picture below:



Alternatively, it is possible to connect short high current leads to the back side of the container directly. The supply cable for the instruments and control of the system is separated and fully independent from the external HV supply.



11. Accessories, Cables & Tools

The whole system includes four cables of 30m length for the HV connections, grounding leads, and a grounding stick for the HV reactor. A set of three Corona shields will be part of the scope of supply for transformer testing. Two Aluminum stairs are stored on the inner side of the rear door of the container and can be easily mounted before testing. Stair rails are separately stored below on the floor. Two small aluminum stepladders are as well included as fixing belts for transportation purposes.

12. List of Items

The following table lists all components available with the mobile AC test system. Items marked as standard are part of the standard quotation and scope of supply. Optional items need to be quoted separately and are not scope of the standard supply. Please contact Power Diagnostix in case of any special adaptations needed. The column "Checked" can be used for incoming delivery inspection.

No.	Qty.	Description	Package	Checked
Container & Accessories				
1	1	40ft' High Cube Container	standard	
2	2	Aluminum Stairs for permanent installation (6 stairs)	standard	
3	2	Aluminum Stairrails	standard	
4	1	Aluminum Stepladder with 3 steps	standard	
5	1	Aluminum Stepladder with 5 steps	standard	
6	1	Trailer (to be specified)	<i>optional</i>	
7	1	Truck (to be specified)	<i>optional</i>	
8	1	Container Labeling (to be specified)	<i>optional</i>	
HV Components				
9	1	Three Phase Frequency Converter System for up to 1,35MVA and control as specified under (4)	standard	
10	1	Manual Controlled Inductive Compensation System as specified under (5)	standard	
11	1	Automatic Controlled Capacitive Compensation System as specified under (6)	standard	
12	1	Three Phase Step Up Transformer 400V/90kV(max) as specified under (7)	standard	
13	3	HV Filter with integrated High Current and High Voltage Measurement, Type: TVC100/123 (Power Diagnostix) as specified under (8)	standard	
14	1	Single Phase Reactor with Coupling Capacitor for up to 500kV and 4A as specified under (9)	standard	
Control Room Equipment				
15	1	19" Rack of 2m height for Instruments and Computer Systems incl. individual Power Switches on front panel, hermetic ventilation control unit, and front door;	standard	
16	1	FOsystem, 19" version with 3- Channel receiver Unit (built-in); Rem.: Transmitter Unit FOT2E built into the HV Filter TVC100/123	standard	
17	3	FOT2/BAT External Battery Pack incl. Charging cable with BNC connectors	standard	
18	3	FO Cable, 200/230µm/3mm SMA, Length=15m	standard	

No.	Qty.	Description	Package	Checked
19	1	ICMsys8, 19" version, built-in, equipped with 8 parallel input channels AMP3/S incl. spectrum analysis, ADC3, GATE3, DPR3, CTR4, GPIB, and USB	standard	
20	1	USB-GPIB Interface cable	standard	
21	1	ICMsystem Software for Windows XP/7 on CD	standard	
22	6	Quadrupole CIL4M/V0 μ 5/V2 μ 0/DC incl. Connection Set	standard	
23	3	Quadrupole CIL5M/V4 μ 0 incl. Connection Set	standard	
24	1	Impulse Generator CAL1D	standard	
25	6	Preamplifier RPA1L	standard	
26	1	Set of Coaxial Cables consisting of: - 17 x 30m RG58/BNC (color marked) - 17 x 2m RG58/BNC (color marked) - 10 x 15cm RG58/BNC		
27	1	Tektronix Scope TDS2024C for Acoustic PD Localization	<i>optional</i>	
29	3	Acoustic Sensor AS75I incl. Magnetic Holder SFX2/50	<i>optional</i>	
30	1	ICMacoustic localization software for Windows XP/7	<i>optional</i>	
31	2	19", 9HU Panel PC incl. keyboard, trackball system and Touch Display	standard	
32	1	Power Analyzer, e.g. Fluke Norma 5000 or an equivalent system	standard	
33	1	Air Condition and heating system (overhead mounted of control room entrance door)	standard	
34	1	First Aid Kit	standard	
35	1	Fire Extinguisher, 2kg, Carbon Dioxide	standard	
36	1	Blank Sheet Cabinet for Storage material	standard	
37	1	Fold-out Desk	standard	
38	1	Swivel Chair	<i>optional</i>	
39	1	Book Shelv	standard	
40	1	A4 All in One Inkjet Printer	standard	
Accessories, Cables, Tools				
41	2	Pfisterer Grounding Stick, Length: approx. 1m	standard	
42	1	Grounding Stick, Length: appx. 2m	standard	
43	2	Flexible Grounding Lead, L=10m, 50mm ² , Cu, M12	standard	
44	2	Flexible Grounding Lead, L=5m, 50mm ² , Cu, M12	standard	
45	3	HV Cable on a Cable Drum, L=20m, incl. termination	standard	
46	1	HV Cable on a Cable Drum, L=20m, incl. termination	standard	
47	7	Power Cables incl. Power Lock Connector on a cable drum, L=20m,	standard	
48	4	Power Cables incl. Power Lock Connector and cable shoes, L=1,5m,	standard	
49	17	Step-Up Transformer Bridge Connections	standard	

No.	Qty.	Description	Package	Checked
50	1	Copper Tube Bar; L=1,5m, incl. MultiContact Connector	standard	
51	1	Cable for external warning lamp	standard	
52	1	External Warning Lamp with magnetic holder	standard	
53	1	Cable for external Emergency Switch	standard	
54	1	External Emergency Switch	standard	
55	1	Set of Screws, Nuts, and Connection Bolts	standard	
Documents				
56	1	DKD Calibration Certificates for Power Analyzer and TVC100/123 Filter	standard	
57	1	DKD Calibration Certificate of Capacitive Voltage Divider 500kV	standard	
58	1	ICMsys8 Step by Step Instructions	standard	
59	1	FOsystem Manual	standard	
60	1	ICMsystem Manual	standard	
61	1	Power Analyzer Manual	standard	
62	1	HV Control Software Manual	standard	
63	1	Application and Maintenance Guide	standard	
Others				
64	1	Toolbox (to be specified)	<i>optional</i>	