

8 VFT - Measuring System TR-AS® (RC) VFT

The VFT-Measuring System TR-AS® for VFT is specially designed for high bandwidth and allows measurements of very fast transients (VFT) in a frequency range from power frequency up to 100 MHz directly with help of capacitive sensors, e.g. PD-sensors installed in Gas - Insulated Switchgear (GIS). Additionally measurement of lightning and switching impulse voltages as also a.c. measurements on the finally installed GIS can be performed.



VFT-Measuring System
TR-AS® RC for VFT

Digital Recorder with
200 MS/s sampling rate and
12 Bit resolution

Remote controlled by
external Laptop Computer

8.1 Principle of measuring system

The measuring system consists of an electrical field sensor with capacitance C_1 , a directly coupled low voltage capacitor and a coaxial measuring line with capacitance C_2 which forms together a capacitive voltage divider with a ratio of approximately $C_2:C_1$.

The measuring line is connected to the 250 V input of the digital recorder which includes an input divider with ratio 25:1.

The 10 V output of the divider is connected with a BNC-bridge to the 10 V input of the programmable measuring amplifier channel 1 of the digital recorder.

GND, a ground connection screw on the front can be used for additional grounding closed to the mains ground potential.

CONTROL signals, show the status of operation

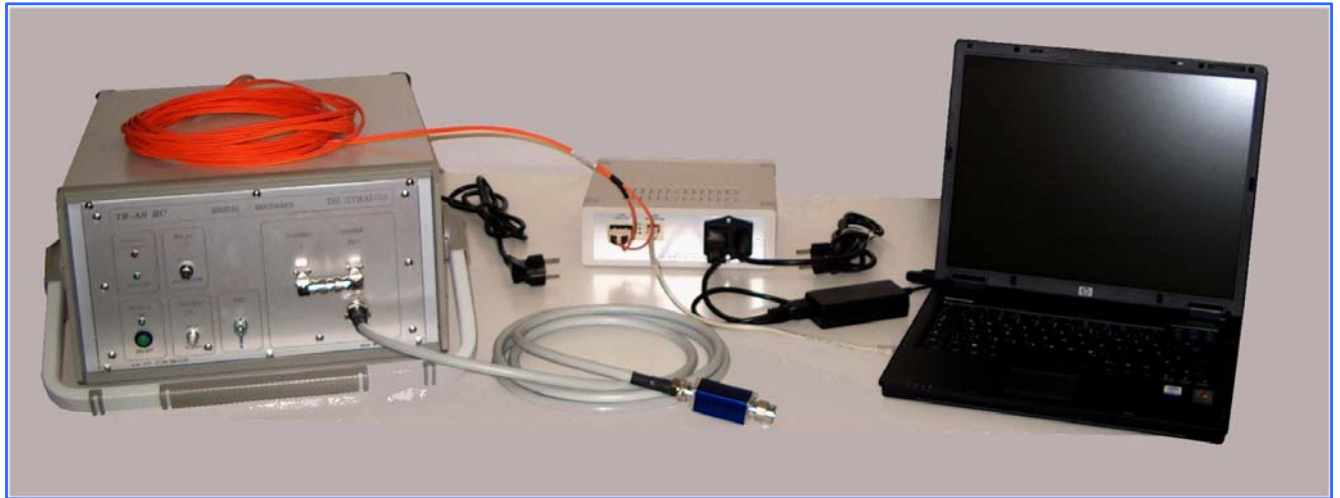
RELAY output, only for control of external Impulse Calibration Generator

POWER ON/OFF switch

TRIGGER Input, not used for VFT-measurements

8.2 VFT System Components

The following picture gives an overview of the components of the VFT-Measuring System TR-AS® RC:



Low Voltage Capacitor (blue) with N-Connectors

Coaxial Connection cable with N-connectors (grey)

Digital Recorder TR-AS® RC with power cord (left side)

Fibre-optic connection Cable (orange)

Connection Box with power cord (in the middle)

LAN-connection cable to PC (0.5 m length)

Laptop Computer (PC) with power supply (black) and special short power cord (0.3 m length)

8.3 Basic Connections



Gas - Insulated Switchgear GIS

Flange with PD-sensor inbuilt
with N-Connector

Low-voltage capacitor

Measuring cable to TR-AS® RC

Short-Circuit-Connector on chain

Caution:

After removing the Short-Circuit-Connector during connection of the Low Voltage Capacitor to the PD-Sensor **High-Voltage** may occur on the N-Connector at the GIS, the respective measures must be foreseen for personal protection.

At first, the following connections and procedures are necessary before any measurement under high voltage can be carried out:

1. Connect the GND terminal of the VFT measuring device to the central GND of the test object.
2. Connect the cable input from the VFT measuring device to the sensor output.

Be careful, the not terminated sensor output may be energized.

In any case refer to special instructions of the Manufacturer of the GIS.



TR-AS® RC, front side

BNC-bridge

Measuring cable from GIS

LED control signals

RELAY output, only for control of external Impulse Calibration Generator

POWER ON/OFF key

TRIGGER Input, not used for VFT-measurements

Grounding Screw, for additional grounding closed to the mains ground potential



TR-AS® RC, rear side

LAN connection to connection box,
fibre-optic link

Mains switch and fuse

Mains connection with power cord
1.5 m length

VFT Connection Box

Mains connection with power cord
1.5 m lengthMains connection to Laptop
Computer with special power cord
of max. 0.3 m lengthLAN connection to TR-AS® RC,
fibre-optic linkLAN connection to Laptop
Computer, twisted pair with max.
0.5 m length

8.3.1 Mains Connection

The mains connection of the TR-AS® RC and of the Connection Box can follow to different mains or to a common mains, in all cases the cables should lay closed to metal ground floor or inside metal cable channels to reduce electromagnetic interferences in noisy environment. The power source should be without significant electromagnetic distortions, interrupts or overvoltages.

The mains connection of the power supply of the Laptop PC follows from the Connection box only by a short power cord.

In case of problems during operation, connection to different mains each with a suitable potential transformer or an uninterruptible power supply (UPS) is recommended.

8.3.2 Power ON

After prepairing the necessary connections described above following sequence is recommended for save operation:

1. Power ON the Laptop PC and wait until the operating system is ready
2. TR-AS® RC: Switch ON the mains switch on the rear side
3. Press the green Power ON key for approx. 1 Second
4. Wait 1 Minute for booting the TR-AS® RC
5. Laptop PC: for connection with TR-AS® RC click the Icon (Ultra)VNC or "connect to WinTR-AS"



8.3.3 Power OFF

1. Finish the WinTR-AS® program on the Laptop PC:
 - by closing the WinTR-AS® window [x] or
 - press "ALT-F" → "Q" or
 - select in the top bar File/Quit
2. Confirm finishing WinTR-AS® program (quit) if asked
3. Confirm Power OFF the TR-AS® RC if asked
4. Power OFF the Laptop PC as last step

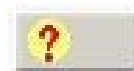
8.4 Software Control

The VFT-Measuring System is remote controlled via the local area network (LAN) by an external Laptop Computer with special remote control software.

The VFT-Measuring System includes an Industry computer with hard-disc and LAN-interface but without display and keyboard.

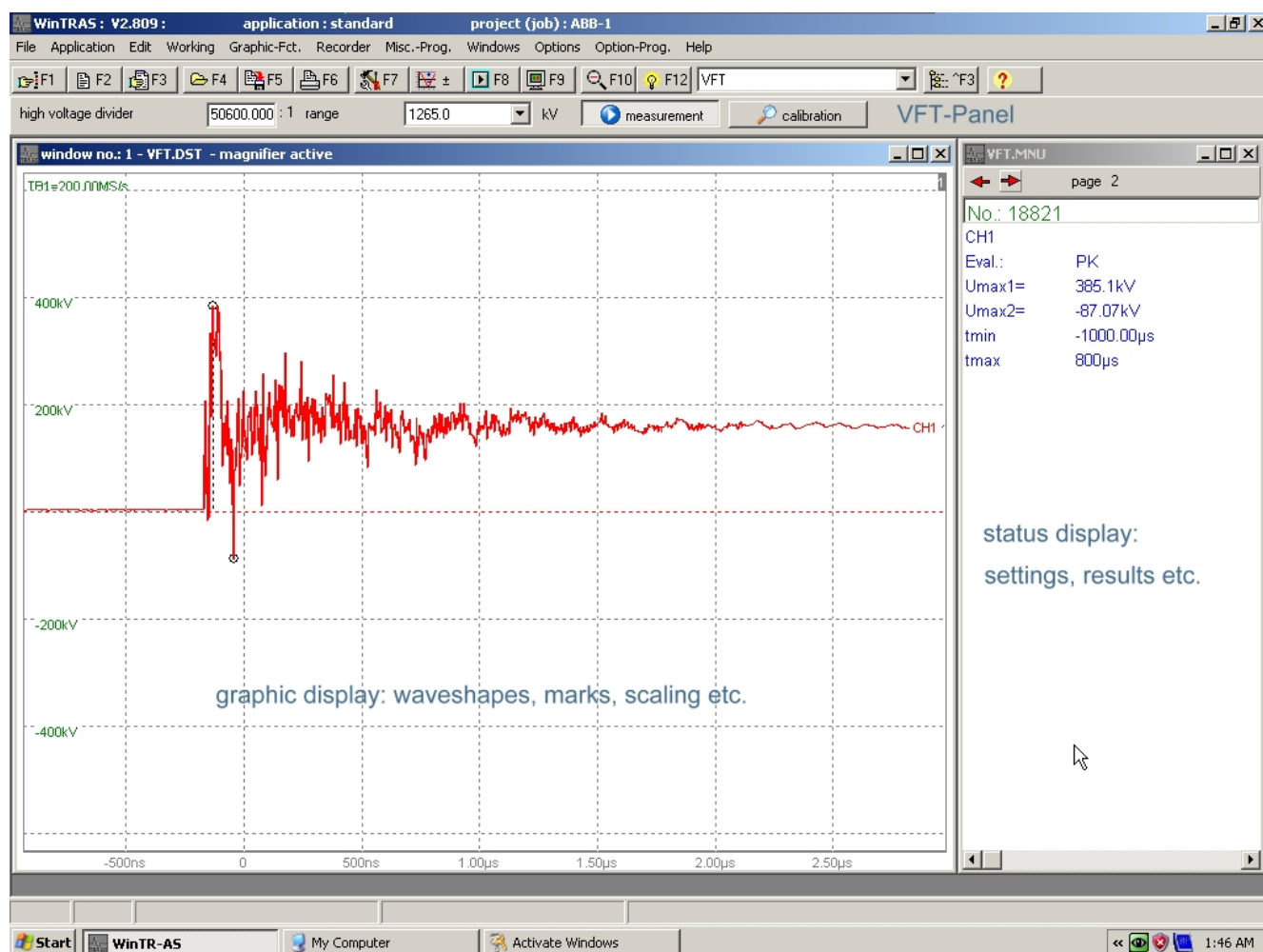
The WinTR-AS® software for control and measurement is installed on the hard-disc of the VFT-Measuring System and can be transparently operated with help of the remote control software on the Laptop Computer.

For details of Software Operation refer to the Online-Help-Manual included into the WinTR-AS® software.



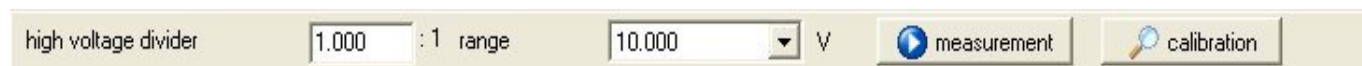
8.4.1 Measuring Surface of the WinTR-AS® program

The Main window of WinTR-AS® includes the graphic display, the status window and the control area in the upper area including the VFT-panel bar.



8.4.2 The VFT-panel

For VFT-Measurements an additional control panel can be displayed under "Options" which includes following control fields:



This panel comprises following parts :

- the value of your high-voltage divider
- the corresponding measuring range (including high-voltage divider-ratio)
- the two buttons for calibration and measurements

You can directly change settings for your measurement / calibration from this panel.

8.5 Starting Measurement

In the following a job can be done from creation a project to the final test report.

Measurements are handled depending from the application as projects to have a good overview regarding the performed jobs.

Select under Applications “**Standard Test**” for your Measurements.

Before starting a measurement create a project in case of a new job or select the project were you want to continue measurement.

When your measurements are performed you can print out the respective test report.

8.5.1 Create / select a project with

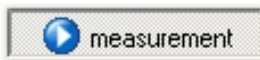


Here you are able to input various values which represent your further measurements.

There are several masks for different kind of measurements available, please search for the one that fits best to your requirements under “mask options”.

8.5.2 VFT-Measurement

Select the Measuring button (M)

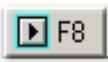


Select the test-setup VFT for VFT-Measurements.

Before starting the measurement a measuring range must be selected which should be approx. 12 to 14 times greater than the a.c. system voltage (rms) with reference to ground (or approx. 7 to 8 times greater than the rated a.c. system voltage).

For 400 kV system voltage a measuring range of approx. 2800 upto 3200 kV should be selected.

In case the divider ratio is not calibrated continue with Calibration.

Start with  will start a record and waits for trigger.

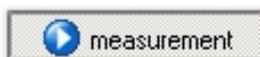
Now start the respective operation at the GIS, e.g. move the disconnect switch.

The TR-AS® RC will trigger automatically to the transients, finish the record and show the lapse on the graphic display.

In case of OVERFLOW please select a higher measuring range and repeat the measurement procedure.

8.5.3 AC-Measurement

Select the Measuring button (M)



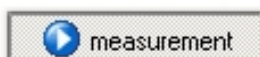
Select the test-setup AC.

In case the divider ratio is not calibrated continue with Calibration.

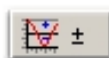
Start with  and apply the test voltage

8.5.4 Impulse-Measurement

Select the Measuring button (M)



Select the test-setup LI or SI, select the polarity



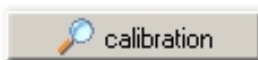
In case the divider ratio is not calibrated continue with Calibration.

Start with  and apply the test impulse

8.5.5 Calibration

For measurements with the VFT-Measuring System the ratio of the capacitive voltage divider C2:C1 must be known as input value for the external input divider used in the WinTR-AS® software. The ratio of the capacitive voltage divider depends from the capacitance C1 of the actually used sensor which is normally not known, therefore a calibration with a.c. voltage can be performed to determine the actual input divider ratio.

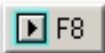
Select the Calibration button (C)



As first step an estimated input divider ratio must be input which can be calculated to C2 : C1 using an estimated value or the rated value of the sensor and C2 according to the specified rated value.

E.g.: for a capacitance of the actually used sensor C1 of 0.1 pF and the rated capacitance C2 of 13 000 pF a ratio of $C2 / C1 = 13\ 000 / 0.1 = 130\ 000$ is calculated.

In a second step a measuring range must be selected which should be approximately 5 times greater than the a.c. voltage with reference to ground applied for calibration.

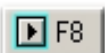
Starting now with (F8) , the calibration formular is displayed and the test-setup VFT-KAL is selected which must not be modified by the user.

Input here the value (RMS or $U_{peak} \cdot 0.707$) of the actual a.c. voltage with reference to ground measured e.g. on the secondary side of a voltage transformer.

After pressing START (S) the calibration will be performed automatically by recording the applied a.c. voltage by the VFT-Measuring System an the actual value of the input divider ratio is calculated and overtaken and displayed as new value. This new ratio will be applied for the further measurements.

Additionally the measuring ranges are actualized new considering the new value of the input divider.

In case of OVERFLOW please select a higher measuring range and repeat the calibration procedure.

Repeat Starting one more time with (F8)  to overtake the calculated values in all cases.

8.5.6 Saving Measuring Results

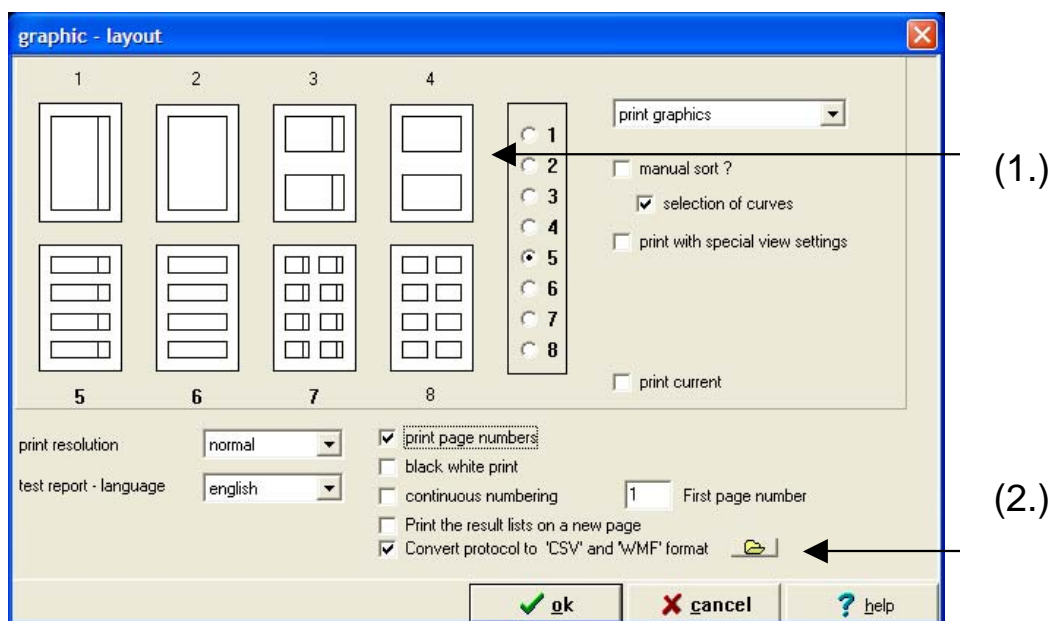
All waveshapes will be saved automatically after recording at two different locations.

- the first one is local on the TR-AS® RC in the main database
- the second directory on a network drive connected to the control computer drive E:\DATA-REPORTS\WinTR-ASBackup\ {Project name}

This path must be selected under Options/test sequence setup/save curves respectively under File/Path for AutoBackup.

8.5.7 Creating a test-report

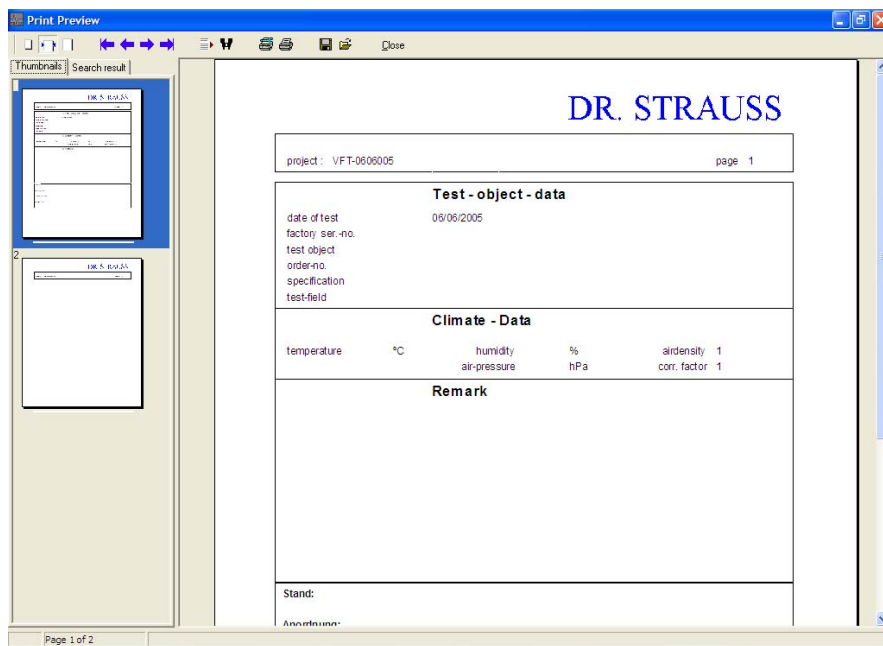
After hitting button  the following dialogue will be opened:



1. Here you can select the layout of the test-report when printing corresponding graphics
2. Furthermore there is an option to automatically export the test-report to a MS Office® compatible format
 - measuring tables are converted to csv-files which can be imported in Microsoft® Excel,
 - graphics are exported as Windows Metafiles which can be imported as pictures to each of the MS Office® programs

For this option there the target directory must be set where the files are stored, as default this directory is set to the control computer, preset to E:\DATA-REPORTS\Reports-PDF

8.5.8 Previewing and printing test-report :



This is the preview of the test-report. After hitting print button on top panel the user will be asked for the location and filename of the final test-report (in Acrobat PDF-format).

This file can later be printed directly from the control computer to a local (connected) or network printer.

8.5.9 Using WMF-Pictures

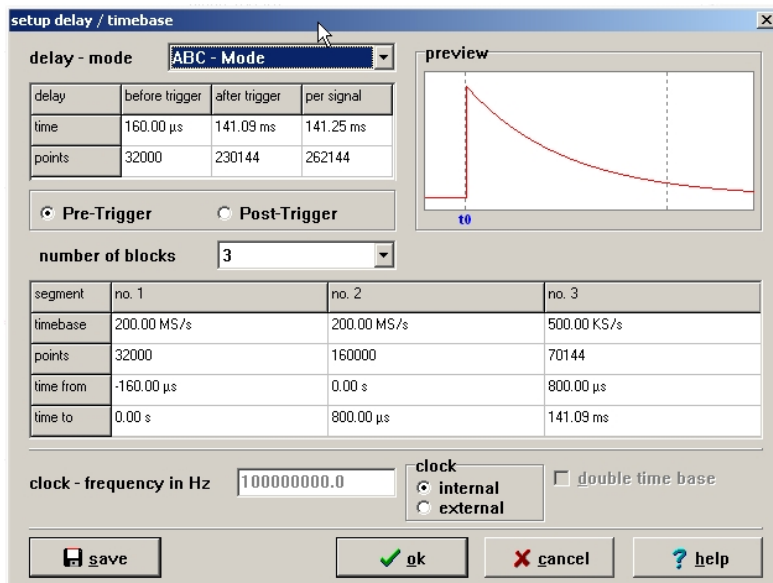
The test results on the screen can be automatically converted into a WMF-file, select under Options/data save setup/ [x] save as WMF. While saving a test result now automatically also the WMF-file is saved in the respective directory selected under File/ Path for Autobackup preset to E:\DATA-REPORTS\WinTR-ASBackup\ {Project name} \WMF.

It is a good Idea to set this path to a folder on the hard disc of the Control computer (Laptop PC) so you have not to copy the data from the TR-AS® RC to the Laptop PC after finishing the tests.

The WMF-files can be loaded into Text programs and output to a printer.

Connecting a Printer to the USB port of the Laptop PC the WMF-files can be loaded into a suitable Text program and printed out.

8.6 Default settings for the test-setup VFT



3 timebase blocks:

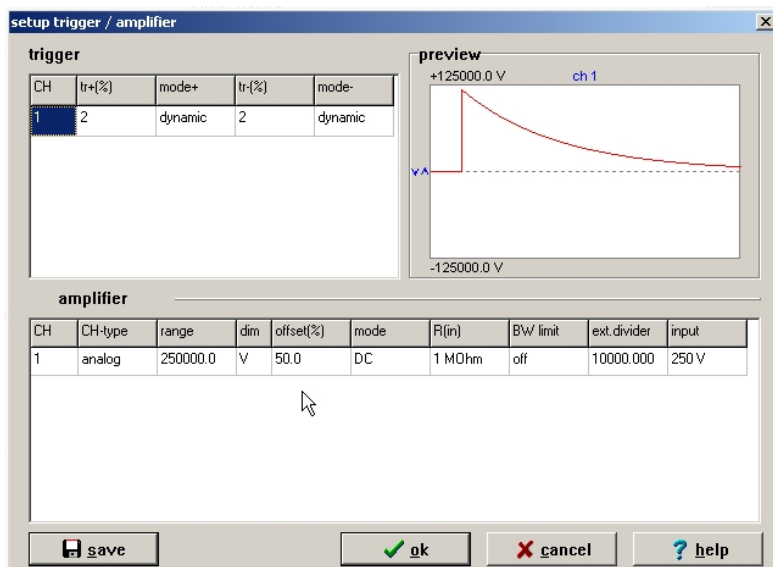
seg 1 = 200 MS/s 32000 pts

seg 2 = 200 MS/s 160000 pts

for VFT-lapse

seg 3 = 500 kS/s with
remaining points

for display of AC-voltage
behind the VFT-lapse



Trigger conditions:

2% dynamic positive and

2% dynamic negative

Amplifier range: (auto-set
from VFT panel)

Mode: DC

BW limit: OFF

External divider: (auto-set
from VFT panel)

Input: 250 V

In case triggering is too sensitive a value of 5% for + and – can be chosen.

The dynamic trigger calculates continuously the derivation dU/dt with dU in % of the range and dt fixed to 2 (4) sampling intervals. This dynamic trigger method ignores absolute values of the input voltage e.g. A.C. voltages and triggers only in case of steep impulses, e.g. VFT-Voltages.

8.7 Technical Data

VFT Measuring System for GIS	
Low-Voltage Capacitor	N-Connectors
rated Voltage	250 V
Measuring Cable	Triaxial 75 Ohm with N-Connectors, 10 m length
Rated Capacitance C2	13 000 pF ± 15%
Digital Recorder	TR-AS® 200 - 12
Rated resolution of output data (Bit / %)	12 / 0.025
Sampling rate selectable	2.5 kHz-200 MS/s
Sampling interval uncertainty	0.2 ns
Non-linearity of Quarz Time Base	0.01%
Record Length	256K Data
Input Stage	
No. Measuring Channels	1
Measuring input, single ended	250 V input divider 25:1, N-connector
Measuring range	5 V - 250 V
Input impedance	20 MOhm / 30 pF
Input test voltage 0.1/2000 us	1000 V
Measuring input, single ended	10 V input, BNC-connector
Input impedance	1 MOhm / 10 pF
Measuring frequency range for VFT	10 Hz - 100 MHz
Input Setting Sequence	Factor 1.2
automatically controlled	16 Stages
Impulse scale factor	
constancy 0,1 µs to >> 1 s	1%
long term stability (one year)	0.5%
Limits on overall errors	according to all applicable Standards (IEC 61083, IEC 60060, IEEE 1122, IEEE 4, ...)
Calibration Interval	every 2 to 4 years recommended
Control Computer	Industrial type, CPU 1 GHz
RAM	256 MByte
Harddisk	80 GByte
Netconnection	100 M fibre-optic SC
Desktop-Housing	TR-AS® RC 64-4HE
Dimensions: (BxDxH)	approx. 37x47x24 cm
Weight:	approx. 12 kg
Connection box	For connection of TR-AS® RC and external Laptop PC with following components:
Media Converter	TP – fibre-optic SC, 100M, with power supply

Power connections	To mains and Laptop PC
Power Requirements	
Voltage	115 –230 V
Frequency	50-60 Hz
Power	200 VA
Environmental:	
Ambient Temp	+5...+40°C
Humidity	10...90%, non condensating
Laptop PC	External
Specification	According to separate Operation Manuals
Technical data and design subject to change without notice. Alternative design on request.	