

**Operating manual**

**VLF Test Extension for Centrix System**

**VLF CR-80-B**

**VLF CR-80-P**

**VLF CR-60-HP**



## Consultation with Megger

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

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Megger warrant that at the time of delivery Megger products are free from manufacturing or material defects which might considerably reduce their value or usability. This warranty does not apply to faults in the software supplied. During the period of warranty, Megger agree to repair faulty parts or replace them with new parts or parts as new (with the same usability and life as new parts) according to their choice.

This warranty does not cover wear parts, lamps, fuses, batteries and accumulators.

Megger reject all further claims under warranty, in particular those from consequential damage. Each component and product replaced in accordance with this warranty becomes the property of Megger.

All warranty claims versus Megger are hereby limited to a period of 12 months from the date of delivery. Each component supplied by Megger within the context of warranty will also be covered by this warranty for the remaining period of time but for 90 days at least.

Each measure to remedy a claim under warranty shall exclusively be carried out by Megger or an authorized service station.

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For damage resulting from a violation of their duty to repair or re-supply items, Megger can be made liable only in case of severe negligence or intention. Any liability for slight negligence is disclaimed.

Since some states do not allow the exclusion or limitation of an implied warranty or of consequential damage, the limitations of liability described above perhaps may not apply to you.

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## 1 Safety Advice

	<p>Since the <i>VLF test extension</i> is subject to the safety system of the <i>Centrix</i> system, all cautions and warnings specified in the “<i>Operating manual: Centrix</i>” have to be observed.</p>
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**Safety precautions** This manual contains basic instructions for the operation of the *VLF test extension* in a *Centrix* test van. It is essential to make this manual and, moreover, the “*Operating manual: Centrix*” accessible to the authorised and skilled operator. He needs to read these manuals closely. The manufacturer is not liable for damage to material or humans due to non-observance of the instructions and safety advices provided by these manuals.

Locally applying regulations have to be observed!

**Symbols used in this manual** Important instructions concerning the protection of staff and equipment as well as technical safety within this document are labelled with one of the following symbols:

Symbol	Description
	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or material damage.
	Notes have important information and useful tips on the operation of your equipment. Non-observance may result in useless measurement results.

**Working with equipment of Megger** All electrical regulations of the country where the system is operated have to be observed as well as national regulations for prevention of accidents and existing regulations for the safety and operation of equipment of the involved companies.

After working with the equipment, make sure to de-energise, protect against re-energising, discharge, ground and short-circuit the instrument and installations that have been worked on.

Original accessories ensure safe operation of the equipment. It is not allowed and the warranty is lost if other accessories than the original ones are used with the equipment.

**Operating personal** Only trained and/or instructed staff is permitted to deal with this system and its peripherals. Keep any other person away from it.

**Repair and maintenance** Repairs and service must only be done by Megger or authorised service departments of Megger. Megger recommends having the equipment serviced and checked once per year at a Megger service location.

Megger also offers direct on-site support. Please contact our service office for more information.

**Handling SF<sub>6</sub> greenhouse gas** This system / device contains the greenhouse gas SF<sub>6</sub> with a Global Warming Potential (GWP) of 22.200 which is listed in the Kyoto protocol. The mass of gas is indicated at the type label. SF<sub>6</sub> gas has to be recovered and must not be allowed to escape into the atmosphere. For detailed information please refer to IEC 62271-303 „Use and handling of sulphur hexafluoride (SF<sub>6</sub>)“.

## 2 Technical Data

Technical data The following technical data are specified for the *VLF test extension*:

Parameter	Value
<b>Output voltage (DC)</b>	
60 kV HP	5 ... ±60 kV
80 kV Basis	5 ... -80 kV
80 kV Plus	5 ... ±80 kV
Source output current	
60 kV HP	17.1 mA
80 kV Basis / Plus	12.5 mA
Range of indication, Leakage current measurement	
60 kV HP	0 ... 17.1 mA
80 kV Basis / Plus	0 ... 12.5 mA
Resolution of indication	10 µA
Output voltage, VLF	0 ... 80 kV
Test frequency	0.1 Hz
Voltage wave shape	cosine rectangular
Testable cable capacitance	
60 kV HP	max. 6.5 µF at 60 kV and -25 ... +40 °C
80 kV Basis	max. 6.0 µF at 60 kV and +40 ... +55 °C (derating)
80 kV Plus	max. 2.0 µF at 80 kV max. 2.5 µF at 80 kV
Discharge unit	
60 kV HP	integrated, 17.5 µF at 60 kV
80 kV Basis / Plus	integrated, 10 µF at 80 kV
Safety system	The <i>VLF test extension</i> is subject to the safety system of the <i>Centrix</i> system (Safety circuits, FOhm, earth monitoring), see " <i>Operating manual: Centrix</i> ".
<b>Power supply</b>	
230 V ±10 %, 50 ... 60 Hz or 115 V ±10 %, 50 ... 60 Hz	Front panel fuse: 6.3 A MT Front panel fuse: 10 A MT
Power consumption	max. 1900 VA
Operating temperature range	-25 °C ... +55 °C
Operating humidity	+30 °C, 70% relative humidity
Storage temperature range	-40 °C ... +70 °C
<b>Weight (without Centrix system)</b>	
60 kV HP	365 kg
80 kV Basis	345 kg
80 kV Plus	365 kg
Protection class (DIN VDE 0140 T.1)	I
Type of protection	IP 20 according to EN 60529

## 3 Technical Description

**Introduction** The *VLF test extension* is a hardware extension to the *Centrix* test van. It contains its own HV source and does use its own HV path while sharing the connecting equipment with the *Centrix* system.

The VLF tests and DC tests performed with the *VLF test extension* are controlled by the *Centrix* control panel. Thus, the handling of the additional test modes is identical to the handling of the *Centrix* operation modes. Even the test results and the curve progressions obtained during a test procedure are represented in the well known *Centrix* user interface, which makes the operator feel as if the *VLF test extension* is an integral part of the *Centrix* system.

**VLF technique** Based on comprehensive scientific research, relevant DIN and VDE standards which we recommend to your attention, and more than 10 years of practical experience on more than 300 VLF Test Systems, we can today take it for granted that the 0.1 Hz VLF method for testing cables with plastics insulation outclasses any other test method using DC voltage or power-frequency AC voltage as used so far.

A 0.1 Hz VLF Test System is required to meet the following demands:

- The repetition rate has to be so slow, that the power set free in any partial discharge (PD) channel that may already exist is small enough not to cause further erosion and so increase gas pressure.
- The inversion of polarity, on the one hand, must be slow enough to exclude any transients caused by travelling waves. On the other, it must be fast enough that any space charge at the tip of a PD channel from where it grows in the direction of the opposite electrode is preserved.

A system that meets the requirements described above has to supply a 0.1 Hz oscillation with the inversion of polarity taking place within the time duration of a 50 Hz half-wave.

Every cycle starts with a charging phase in which the test object as well as the back-up capacitor switched in parallel are charged from a DC source until the desired test voltage is reached.

After a period of 5 seconds, the voltage source is disconnected from the system and discharged. Subsequently, polarity of the test voltage is changed from minus to plus. Depending on the capacitance of the connected test object, the ring-around process takes between 2 and 10 ms. Owing to the losses which occur in the polarity inversion coils during polarity inversion, the positive voltage is decreased by these losses (Basis version only).

After a 5 seconds dwelling period at positive polarity (Basis version) or equalisation of the polarity inversion losses due to recharging by the positive DC voltage source (Plus/HP version), the return to negative polarity takes place.

The negative voltage source is again connected to the test object.

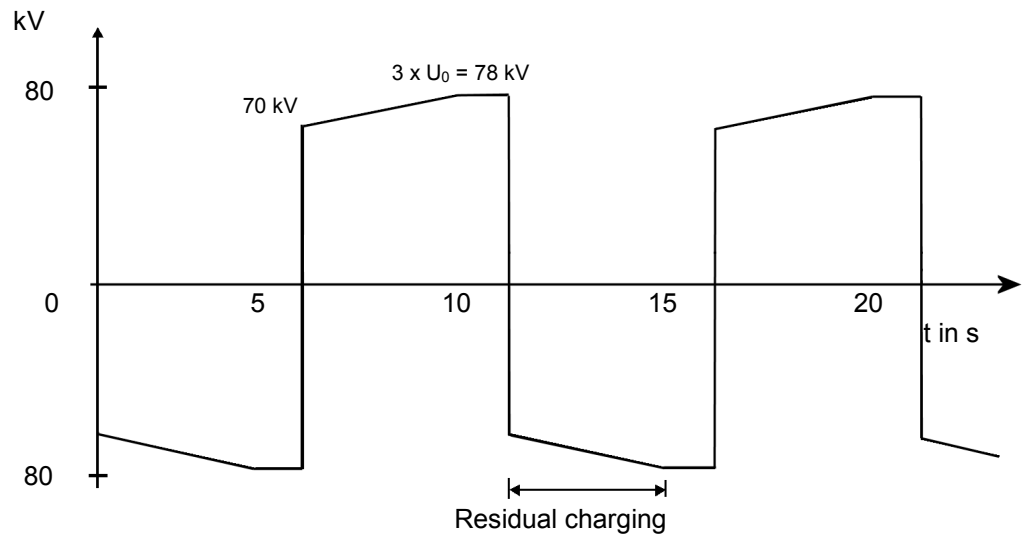
The drop in voltage caused by twice ringing around (Basis version) will now be compensated by recharging from the negative DC source. In contrast to this, for the Plus/HP version, the polarity inversion losses of a single ring-around event are consistently compensated.

The back-up capacitor has the following tasks:

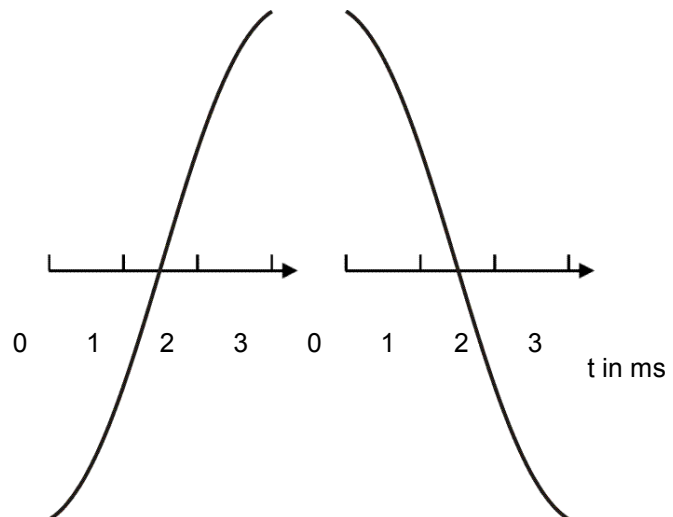
- It slows the polarity-changeover down to the millisecond range even for short cables and
- it reduces the polarity reversal stress caused by travelling waves.



Waveform The following figure shows the typical voltage waveform (Plus version at 46 kV XLPE cable):

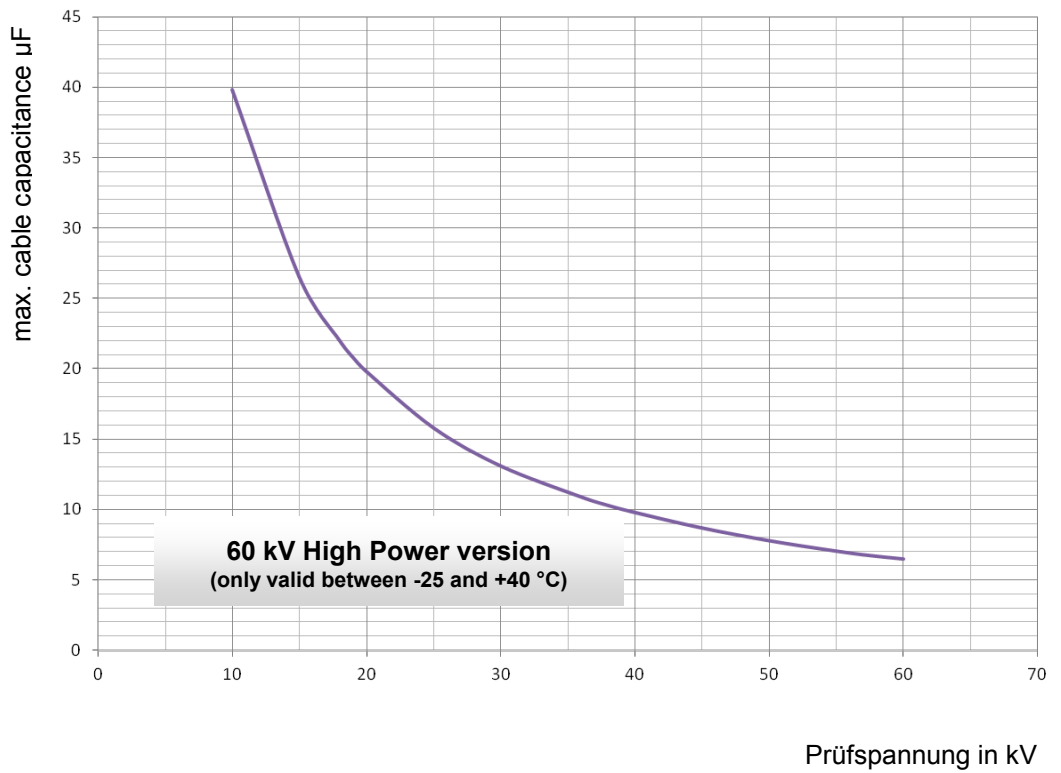
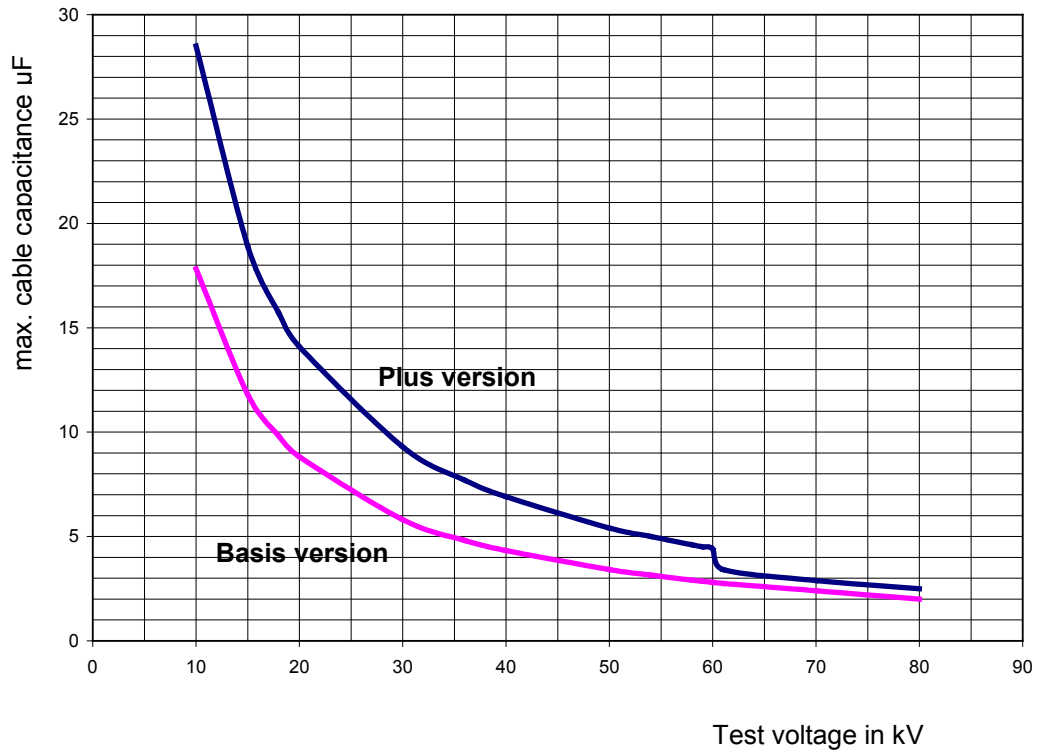


The following figure shows a more detailed example of the waveform during polarity change (Plus/HP version):



Testable cable capacity

The course of the following graph shows maximum testable cable capacitance against the test voltage:





## 4 Setting-up the System

Introduction In order to set-up the system for a test measurement, the following steps have to be performed in the given order:

- Place the test van and secure the test site
- Connect the system earth
- Connect the cable under test
- Establish the mains connection
- Switch-on the system

For a detailed description of the individual procedures, please refer to the “*Operating manual: Centrix*”.

 <b>WARNING</b>	<p>When setting-up the system following the steps listed above, the regulations VDE 0104 (DIN EN 50191) about setting up and operation of electric test equipment and the specific regulations noted in the “<i>Operating manual: Centrix</i>” have to be observed.</p>
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 <b>CAUTION</b>	<p><b>Checking the humidity</b></p> <p>Prior to putting the system into service, read off the hygrometer mounted at the workspace to check the relative humidity. If the value exceeds 70%, the system must not be operated with HV. Instead, the humidity has to be decreased to a value within the tolerance limits by dehumidifying the air using the internal air condition. These conditions have to be maintained for at least 30 minutes. It is recommended to operate the system with a nominal voltage of 0 kV during the dehumidification period in order to keep the system fans in operation.</p>
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Preparing the system for VLF operation

Before a VLF test using the *VLF test extension* can be initiated via the *Centrix* user interface, the HV connection between the test extension and the connecting equipment has to be established.

For this purpose, the backside connection of the cable reel, the cable under test is connected to, has to be disconnected from the *Centrix* HV unit and connected to the HV output of the test extension.

If the test extension is not needed for further tests after a test series has been finished, the connection to the *Centrix* HV unit has to be re-established in order to gain access to the *Centrix* operation modes again.

Whenever an operation mode is started, the system automatically checks the present connection setup and generates an error message, if the connection setup does not correspond with the selected operation mode.

## 5 Operation

**Introduction** The *VLF test extension* makes use off all the generic system functions provided by the *Centrix* user interface e.g. protocol function, history function, print function, data import / export and so on.

For detailed information how to access and how to use these functions, please refer to the “*Operating manual: Centrix*”.

**Operation modes** With the *VLF test extension* installed in a *Centrix* test van, two new operation modes are added to the **Test** menu (TEST):

 - **VLF Test Aux** ... to perform a VLF test with up to 60/80 kV






 - **DC Test Aux** ... to perform a DC test with up to 60/80 kV

For detailed information how to navigate through the menu structure and how to access these operation modes, please refer to the “*Operating manual: Centrix*”.

**VLF test regulations** Use the information given in DIN VDE 0276 - 620 and 0276 – 621 as a guideline to start from. These standards recommend a test level of  $3 \times U_0$  and a test duration of 30 or 60 minutes, respectively.

When you follow these guidelines, the test level is near the peak voltage of a 50-Hz test ( $2 \times U_0$  rms).

**Test parameters** After a test operation mode has been accessed, the following test parameters can be adjusted:

Menu item	Description
	Test duration in minutes.
	Maximum voltage range.
	<p>The VLF test can be performed in an automatic Ramp mode or in Manual mode.</p> <p>In <b>Ramp</b> mode, the test voltage is constantly increased by an adjustable voltage value per time until the defined maximum voltage value is reached. Thereupon, this test voltage applies for the remaining time of the test. The operator is able to pause / continue the voltage rise and to change the ramp <b>slope</b> during the test.</p> <p>In <b>Manual</b> mode, the operator has to adjust the test voltage value manually using the jogdial.</p>
	<p>In <b>Ramp</b> mode, the <b>slope</b> of the ramp can be manually defined in percent of the maximum voltage range per time.</p> <p><b>Example:</b> For a defined maximum voltage range of 40 kV a slope of 10 % / s results in a voltage raise of 4 kV / s</p>
	For DC tests performed using the Plus/HP version of the VLF test extension this menu item enables the operator to select whether the DC test shall be performed using either plus or minus polarity.

**Test procedure** For detailed information how to start / perform a test procedure, please refer to the “*Operating manual: Centrix*”.

## 6 Evaluating the Test Data

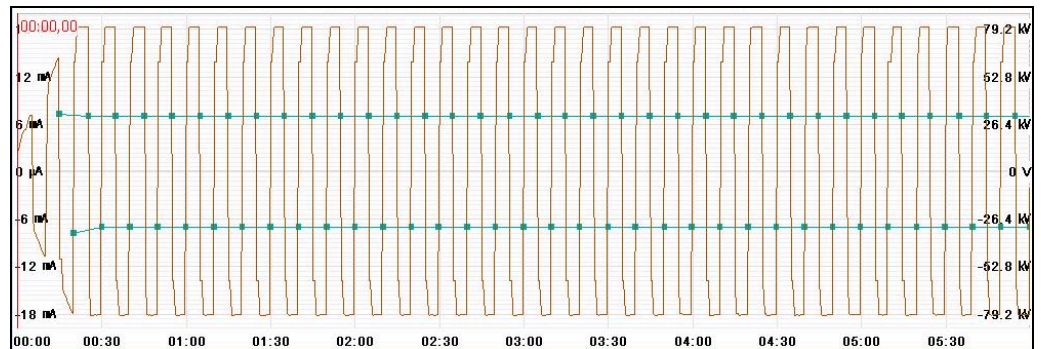
**Introduction** If a voltage breakdown occurs during the test, the system automatically stops the test procedure and generates an error message providing information about the voltage value causing the breakdown and the point in time it occurred.

Otherwise, if no voltage breakdown occurs and if the test is not interrupted by the operator, the test stops automatically after the test duration is passed. A confirmation message informs about the successful test run.

For evaluating the test data, the user can switch between a **standard** and an **expert** view using the  $\frac{STD}{EXP}$  menu item.

**Standard view** The **standard** view shows the time dependent trace of the test voltage (brown trace) and the leakage current values (blue dots) which were measured just before a polarity inversion took place (in 5-second intervals). These blue dots are joined to one trace which makes it much easier to recognise a drift of the leakage current over time.

By using the cursor ( $\rightarrow$ ), the user can move from dot to dot along the time axis and read off the respective numeric leakage current and voltage values in the lower right of the display.



**Expert view** The **expert** view shows the time dependent trace of the test voltage (brown trace) and, contrary to the **standard** view, also the time dependent trace of the charging current (blue trace). As known from the **standard** view, the leakage current measuring points are indicated as dots on the blue trace.

By using the cursor ( $\rightarrow$ ), the user can read the numeric values of each, the test voltage and the charging current, in  $\frac{1}{4}$ -second intervals along the time axis. Leakage current values and the respective voltage values are shown in brackets.

