INSTRUCTION MANUAL

Combination Wave Generator
PG 24-2500

Cover is an option

Distributed by: Reliant EMC LLC, 3311 Lewis Ave, Signal Hill CA 90755, 408-916-5750, www.reliantemc.com

Table of Contents:

1. General 3
2. Introduction 5
3. Functional Description 6
3.1 Safety interlock, external warning lights 6
3.2 USB Output 7
3.3 Trigger Input / Trigger Output 7
3.4 Remote Control 7
3.5 Input/output connectors on the rear panel 8
4. Operation 10
4.1 Turn-key Switch 11
4.2 Main menu 11
4.3 Setup 12
4.3.1 General Setup 12
4.3.2 User Setup 13
4.3.3 Date/ Time 13
4.3.4 Netzwerk 14
4.3.5 Remote Mode 15
4.4 Information and firmware update 16
4.5 Manual Test 17
4.5.1 Start Manual Test 18
4.5.2 Create Test Procedure 19
4.5.3 Variation of test parameters 21
4.5.4 Start test procedure 21
4.5.5 Open a result file 22
5 Environment Conditions 23
6. Technical specification PG 24-2500 24
7. Final Testing PG24-2500 25
7.1 Function test: 25
7.2 ESD-TEST acc. to IEC 1000-4-2, Level 3 25
7.3 EFT-TEST acc. to IEC 1000-4-4, Level 3 25
7.4 CWG-TEST acc. to IEC 1000-4-5, Level 3 25
7.5 Safety test 25
7.6 Enclosures (in paperform) 25

1. General

CAUTION

- Before using the generator, please read this instruction manual and obey all safety precautions.

- The generator delivers life-threatening high-voltage at its output. The generator is an inherently dangerous device.

DANGER

- High-voltage pulse tests and especially Electrical Fast transient tests are able to radiate energy to the vicinity of the test set-up. It is the responsibility of the user to avoid any critical failure of, or interference to, other electrical devices when making these tests in a given installation. Operating the generator inside a screened room, with additional filtering of the mains power supply, may be necessary. People who have any electronic medical devices (e.g. heart pacemaker) fitted, should not operate the generator and should be excluded from the immediate vicinity of the test set-up.

- It is the responsibility of the operator to ensure the safe use of the generator, and to ensure that it is not possible to touch the output terminals, the connected test device or any connecting leads. Before energising the generator the operator must assure that all safety measures are complete and fully functional.

- The device must only be operated by professionally trained and educated personnel. Safety regulations according to VDE 0104, VBG 4 or specific national safety codes must be obeyed.

- The generator must only be operated from a properly installed mains supply with protective earth. Interruption or isolation of the protective earth connector is not permitted. The cabinet, chassis and grounded parts of the coaxial measuring and output voltage connectors all have an equal potential and are connected with protective earth of the mains supply.

- If safe operation of the generator is not possible then the generator must be shut down and secured against improper use. For example, this may apply if the generator exhibits any external damage, contains loose parts or components, no longer operates according to its technical specifications or after storage under adverse conditions.

- There are no serviceable parts inside the generator. Any calibration or service work, involving operation of the generator whilst the cabinet is open, must only be conducted by professionally educated personnel, who are aware of the inherent high-voltage hazards.

- Any unauthorised modification or any use which is contrary to the instructions contained within this manual will invalidate the equipment warranty. Neither HILO-TEST, nor its agents, will be held responsible for any consequences resulting from such improper use.

- The information contained in this manual, including but not limited to all schematics, PCB-layouts and parts lists are the sole copyright of HILO-TEST GmbH. An reproduction or unauthorised use, of the information contained herein is expressly prohibited.

2. Introduction

The Combination Wave Generator PG 24-2500 is a combined impulse-current-/impulse-voltage generator which, for high-impedance loads, RL > 100Ω, delivers a standard impulse voltage with waveform 1.2/50µs and, for short-circuited output, a standard impulse current with waveform 8/20µs, cf. IEC 60, VDE 0433 etc.

In addition, the generator may be used for surge testing of components and devices, as well as for galvanic coupling of surges to cable shields, shielded enclosures and cabinets.

The PG 24-2500 features a microprocessor controlled user interface and a 5” touch screen unit for ease of use. The microprocessor allows the user to execute either standard test routines or a “user defined ” test sequence. A standard USB port provides the ability to print a summary of the test parameters to a USB stick.

PG 24-2500 features a micro-processor controlled user interface and display unit for ease of use. The microprocessor allows the user to either execute standard test routines, or a user defined test sequence. The test parameters, which are shown on the built in display, are easily adjusted by means of the rotary encoder. A standard parallel interface provides the ability to print a summary of the test parameters whilst testing is being carried out.

Moreover all generator functions may be computer controlled via the isolated optical interface. The software program HILO-Remote allows full remote control of the test generator as well as documentation and evaluation of test results, accordingly to the IEC 17025.

The PG 24-2500 excels by its compact design, simple handling and precise reproducibility of test impulses.

3. Functional Description

The generator features a micro-processor controlled touch display unit. The micro-processor control circuitry includes the mains switch, the monitoring of the external safety interlock and the control of external warning lamps.

3.1 Safety interlock, external warning lights

The external safety interlock and external warning lights serve as a safety measure for the total test set-up.

The external safety interlock loop is connected to the SAFETY connector on the rear panel. Interruption of the external safety loop automatically de-energizes the high-voltage power supply and discharges the energy-storage capacitor. The green signal lamp lights to indicate that the generator is in stand-by mode, and the generation of high-voltage output pulses is inhibited.

After closing the external safety-loop the red signal lamp lights, indicating that the generator is now in operating mode. The red light indicates “DANGER” and lights if the high-voltage section of the generator is either in stand-by mode or in operation. After any further operation of the control interface, life-threatening high-voltages may be present at the generator output.

The external red & green warning lights may be connected to the EXT. RD/GN output connector on the rear panel of the generator. They will have the same function as the red and green lights on the front panel but are powered by the mains voltage, 60W max. The external red and green warning lights must be used in test arrangements complying with further safety measures according to VBG 4, VDE 0104 or specific national safety codes.

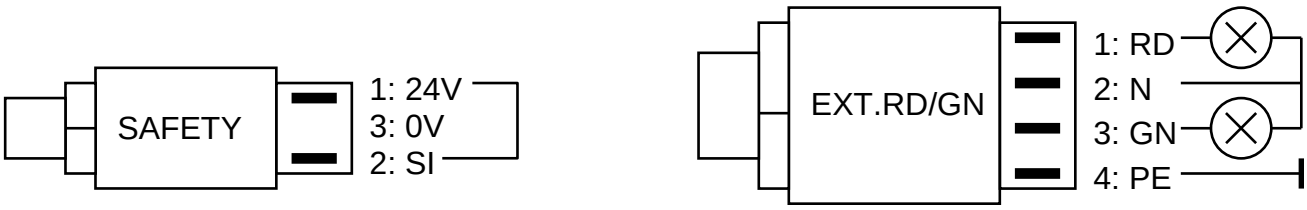


Figure 1: Safety / warning lights connector

During EMC-testing, utilising an external coupling-/decoupling network, the external interconnection lines and the device under test must be located within a safety test chamber to prevent any touching of the high-voltage leads. The interlock switch of the test chamber must be connected to the safety loop of the generator. Opening the test chamber must open the safety loop, thus shutting down the test generator.

During component testing the test samples should be confined by a protective cover equipped with a ground-switch interlock. The protective cover interlock must be connected in series with the external interlock, e.g. HILO-TEST Type PA 503 / PA 505. Lifting of the protective cover causes the generator to shut down, thus allowing the test fixtures to be safely installed or replaced. Special test fixtures are available upon request.
Suitable fixtures are available as accessories, eg. Typ PA 504, see Option 2.

ATTENTION: The earthing screw provided on the rear panel of the generator must be firmly attached to the earthing point of the power supply system and the earthing connection point of the test set-up.

3.2 USB Output

A standard USB interface provides the ability to save a summary of the test parameters whilst testing is being carried out.
Any USB storage device can be connected to the USB bush which is located on the front panel.

3.3 Trigger Input / Trigger Output

Generation of high-voltage output tests with selected parameters can be triggered by applying a switch to the BNC-connector ‘TRIG-IN’. This action replaces manual operation of the touch display and allows generation of output pulses at a defined time point.

During manual operation a 10V trigger signal appears at the BNC-connector TRIG-OUT whilst the high-voltage output pulse is generated.

3.4 Remote Control

All generator functions may be computer controlled via the isolated optical interface. Control commands and reply signals, are transferred by a light guide ring.

The software program allows full remote control of the test generator, as well as documentation and evaluation of test results.

For further information please refer to the software instruction manual.

3.5 Input/output connectors on the rear panel

ATTENTION: The unit must be operated with a fixed earth connection.

230Vac Power supply connector for the generator
SAFETY Safety interlock connector
HV-OUT direct output of combination wave generator PG 24-2500

Ext.Sync (option) Input for external synchronisation from CDN power supply

U_M monitor output for surge voltage, ratio 2000:1
I_M monitor output for surge current, resistance 1 mΩ

Monitor outputs for surge voltage (U_M) and surge current (I_M) are available, and permit external measurement of the high-voltage pulses generated. The monitor outputs are located on the rear panel.

Securing of the test set is up to the operator!

Without protective cover:

The high-voltage output connectors outputs are located on the rear panel.

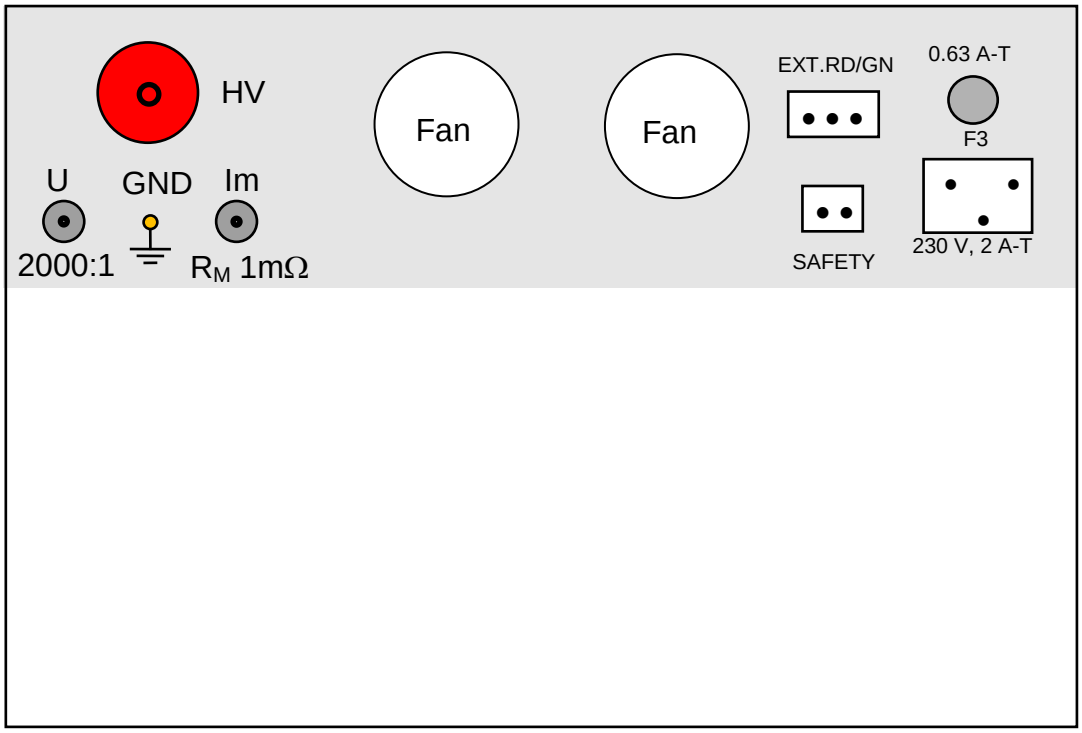


Figure 2: Location of the input/output connectors on the rear panel, without protective cover

With protective cover:

The high-voltage output connectors outputs are located on the top.

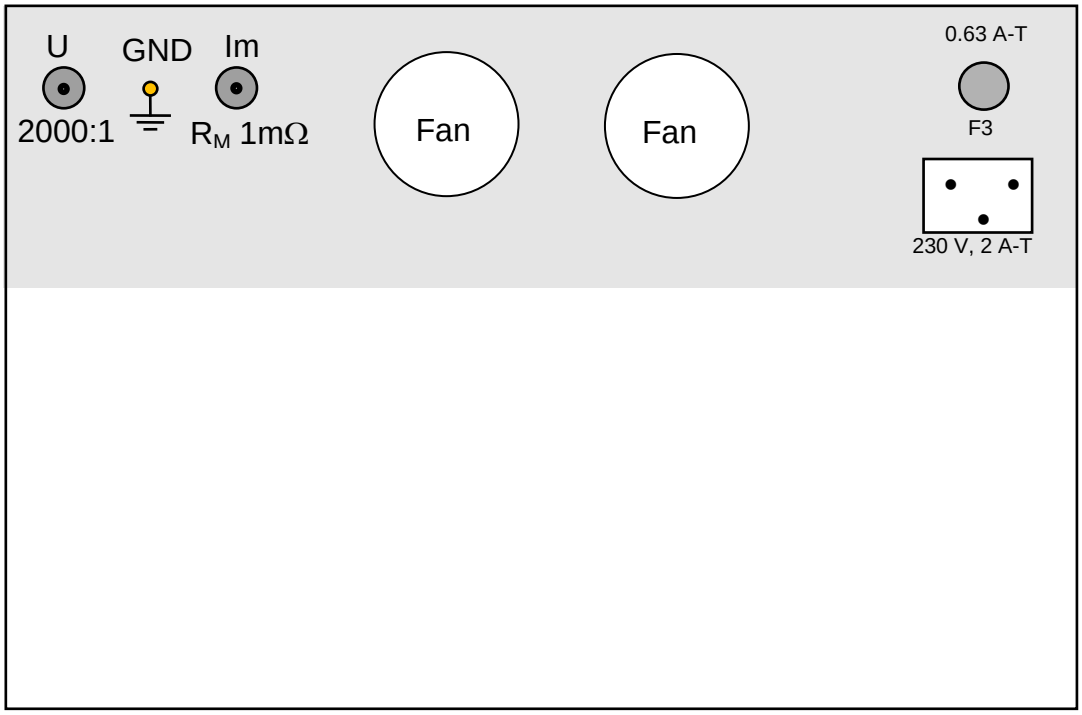


Figure 3: Location of the input/output connectors on the rear panel, with protective cover

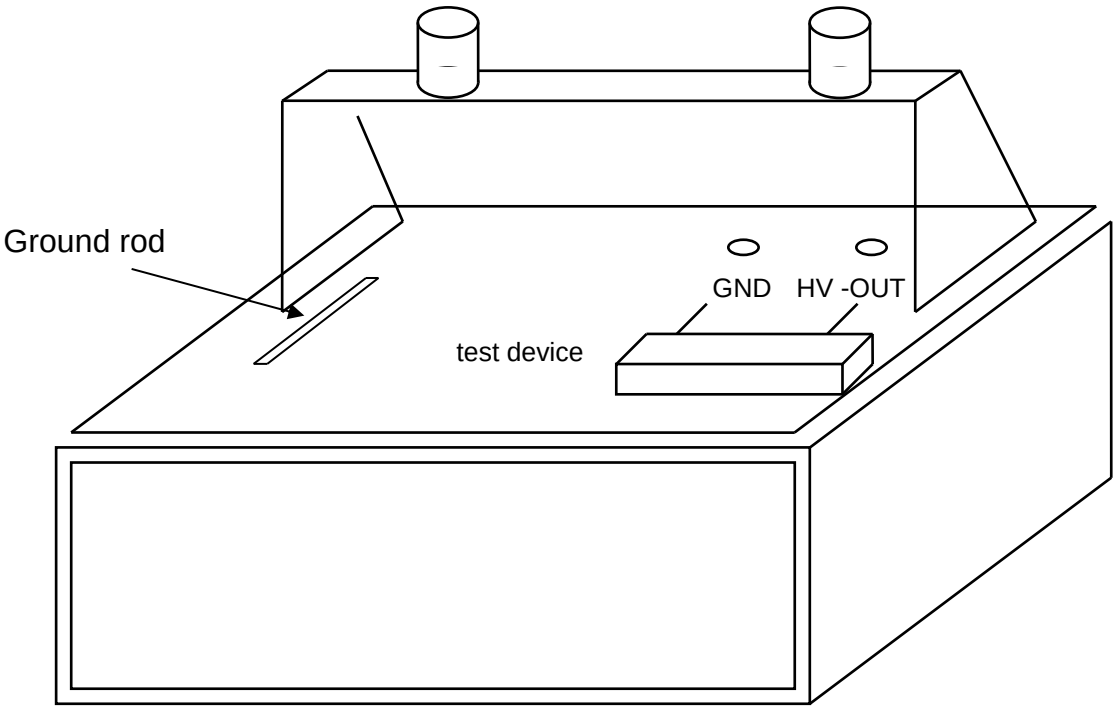


Figure 4: Location of the input/output connectors on the top (schematically)

4. Operation

The PG24-2500 features a microprocessor controlled touch display for ease of use. The test parameters, which are shown on the built-in display, are easily selected and can simply be adjusted by use of the touch function of the display.
The task menu is organised in a hierarchical structure. Selecting one of the function keys will lead to the next lower menu level. Operating the key ‘exit’ or ‘back’ leads back to the next higher level.

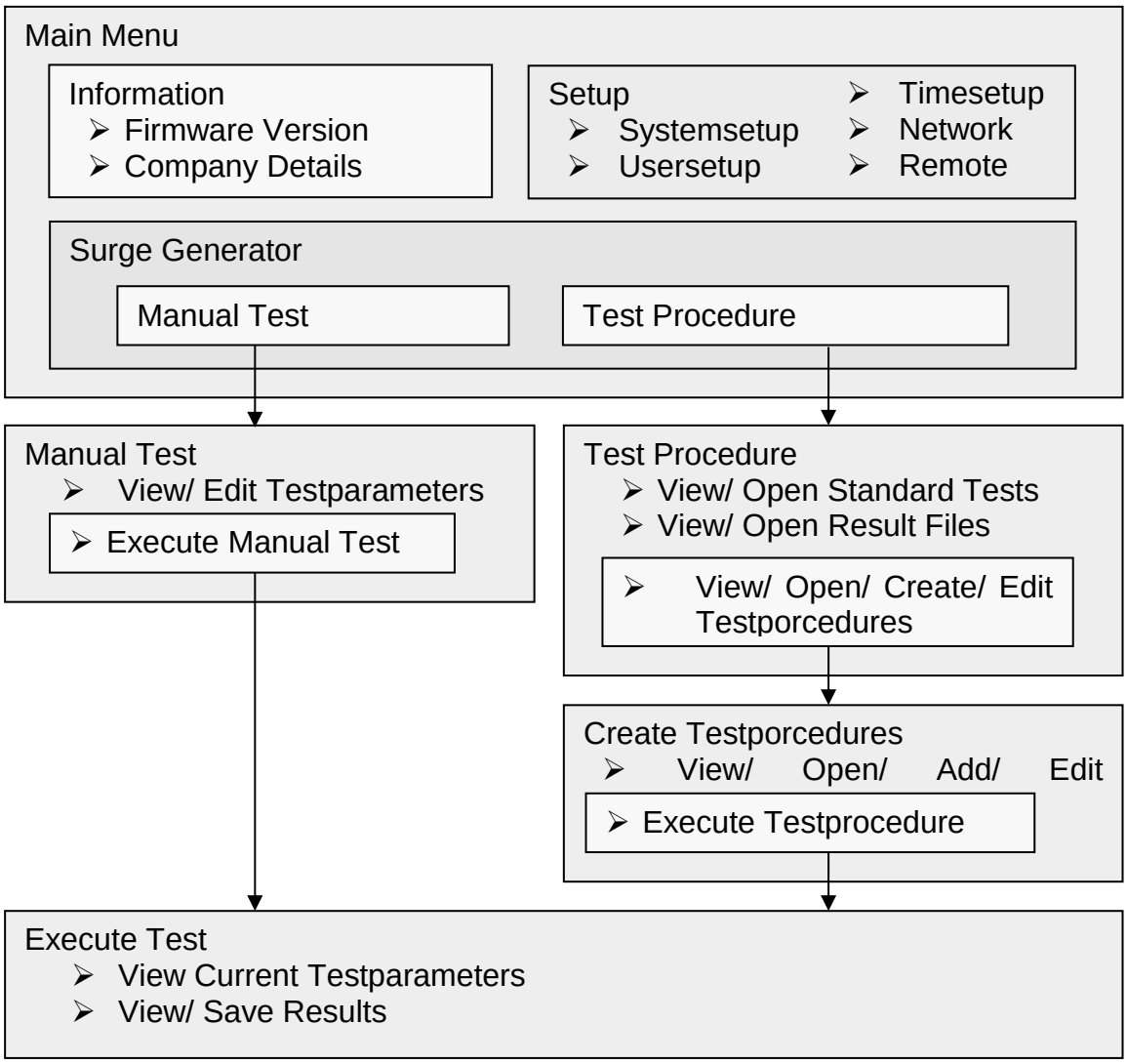


Figure 5: Menu in hierarchical structure

4.1 Turn-key Switch

Upon operating the turn-key switch on the front panel, the generator is energised and ready for use within 20 seconds.

Remove the key to prevent unauthorized use of the generator.

4.2 Main menu

After starting the PG, the *Main Menu* appears. Here you have the choice between the *Manual Test*, *Test Procedure*, *Info* and the *Setup*. The desired function must be selected by pressing the according touch button.

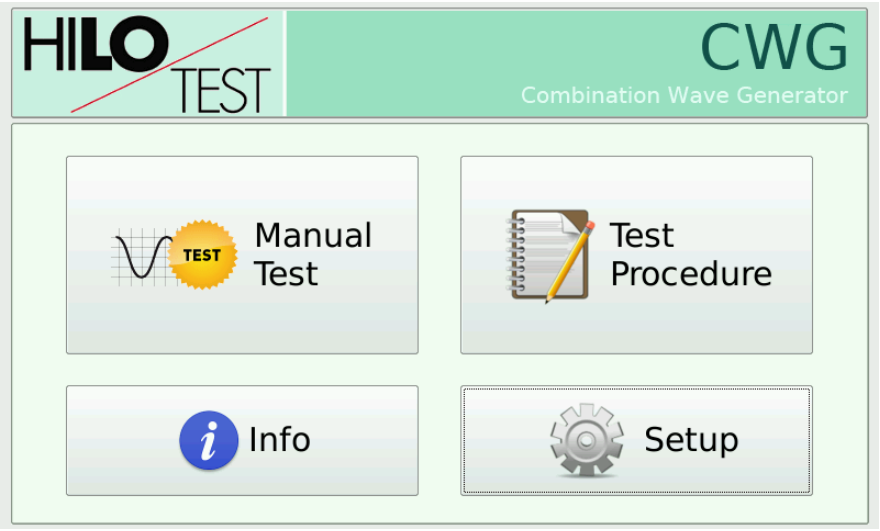


Figure 6: main menu

The Manual Test allows to operate the generator manually.
By operating Test Procedure, it is possible to add, change or execute a predefined test procedure or to list and save test results.

4.3 Setup

The function 'Setup' shows the configurations of the PGs.

Figure 7: setup

4.3.1 General Setup

- **Display Results**
  Permits to display or not the results after each test. These results can be saved on a USB device.

- **Sound**
  Permits to activate or deactivate the sound emitted by controlling the generator as well as by executing tests.

- **Manual Supply**
  Allows to control manually the equipment under test. By choosing “off”, the E.U.T. voltage is put on at beginning of the test but switched off at the end of the test.

- **Triggerdelay offset**
  Defines a global trigger delay, which is added to the parameter trigger delay, specified in all surge tests.

- **Connected CDN**
  Allows to set up an external CDN for advanced couplings.

4.3.2 User Setup

Allows to insert information about the device under test and the test laboratory which are shown on the head of the saved test results.

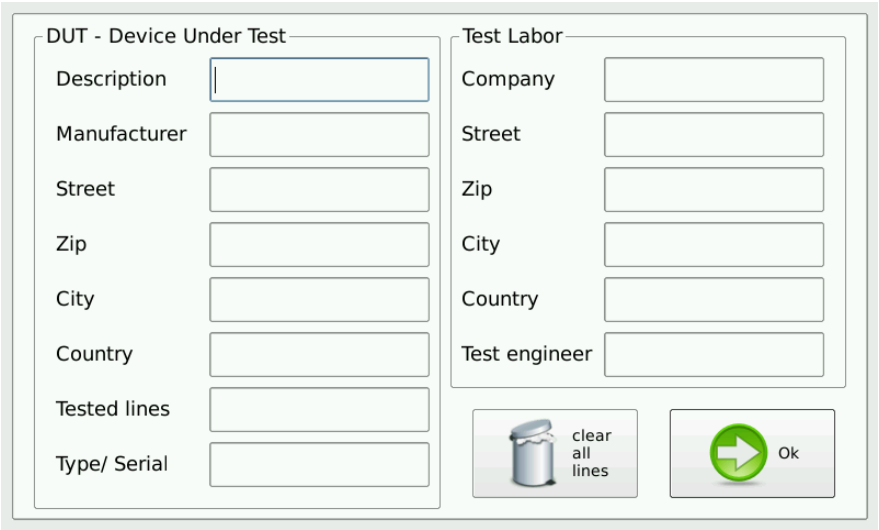


Figure 8: Setup / User Setup

4.3.3 Date/ Time

Permits to adjust the date as well as the time.
The selected parameter is displayed in colour and can be modified by pressing ‘plus’ or ‘minus’. By pressing the disk button, the changes are saved. To exit without saving, press the red stop button.

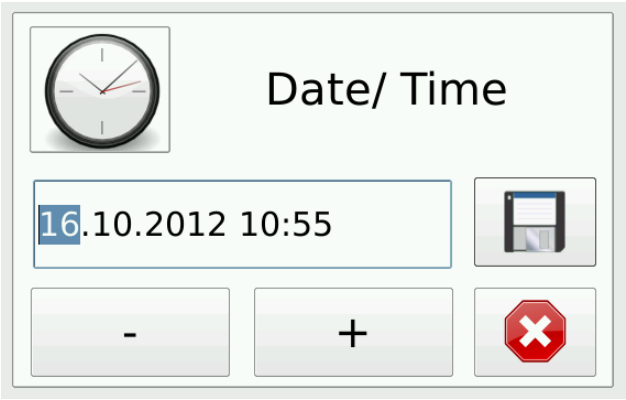


Figure 9: Setup / Clock

4.3.4 Netzwerk

Allows to change the network settings of the generator.

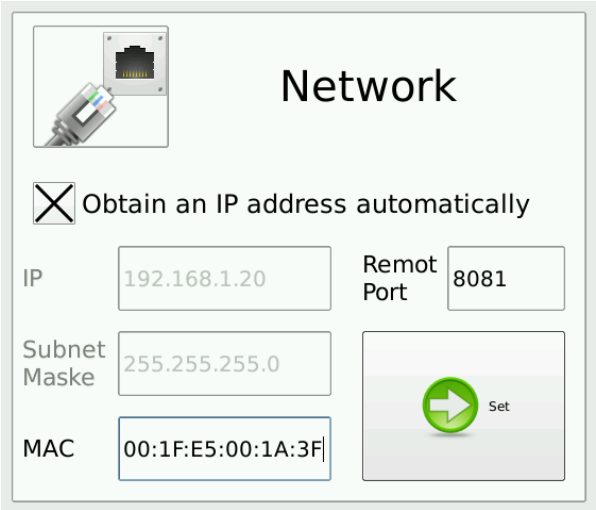


Figure 10: Setup / Network

By selecting "*obtain an IP address automatically*", the generator gets an IP address and subnet mask by DHCP. If it is not selected, manual values can be entered.

The MAC address cannot be changed as it is a unique identifier assigned to network interfaces for communications on the physical network segment.
The *remote port* permits to connect the generator with the HILO-Remote software on a personal computer.

With the *set button* all changed values get saved.

4.3.5 Remote Mode

This mode enables the control of the generator via the built-in computer interface. This mode will be activated automatically when a valid command was received.

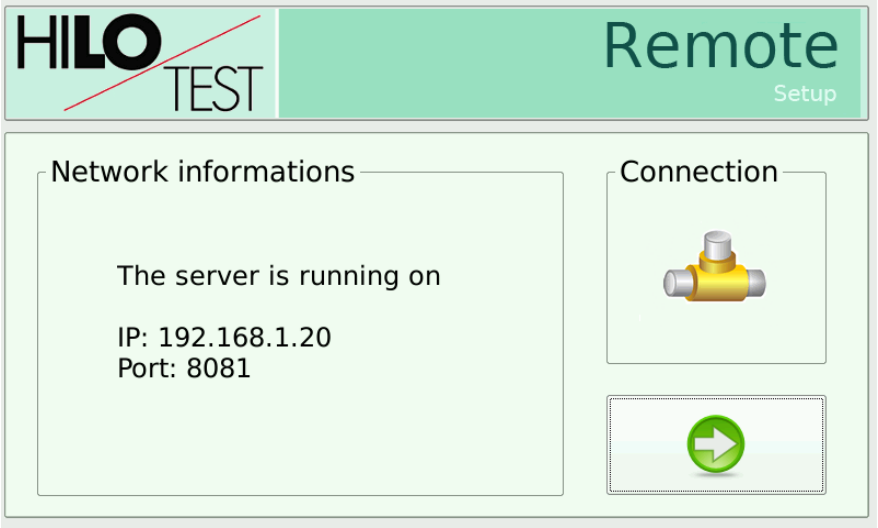


Figure 11: Setup / Remote Modus

In 'Remote' the generator functions are remotely controlled by the software “HILO-remote” running on an external computer via the built-in optically isolated computer interface.
On the left are displayed the network information.
The generator is successfully connected to remote control as shown in Figure 12, the connection is broken as shown in Figure 13.

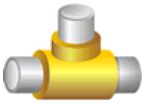


Figure 12: remote connected

Figure 13: remote not connected

The remote control mode is terminated by selecting the arrow button leading back to the last menu.

For more information, please refer to the software instruction manual.

4.4 Information and firmware update

By selection “Information” in the main menu, general information will appear.

The firmware version is displayed on the top. A firmware update function is also available. Other information as our company address / contact and disc space are displayed.

Instructions for the firmware update:

- copy the new firmware file to the root directory of a USB stick
- Insert the stick into the front of the generator and press “*update via usb stick*”.
- follow the instructions

The generator will automatically restart after a successful update.

4.5 Manual Test

By selecting ‘Manual Test’, all Surge parameters can be adjusted.

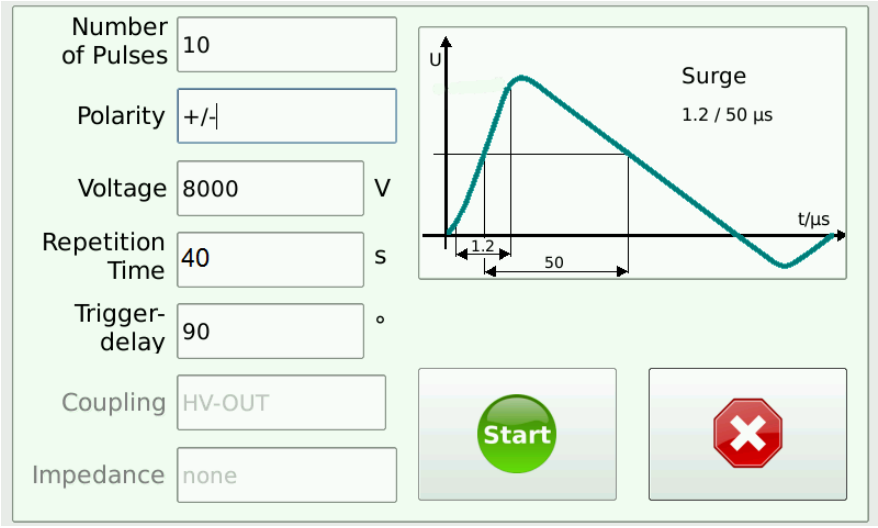


Figure 15: main menu / manual test

The parameters can be adjusted by entering new values in the input mask.

Detailed possibilities:

		PG24-2500
Number of Pulses	min	1
	max	1000
	inc	1
Polarity	possible states	+ / ± / -
Voltage	min	500 V
	max	24 kV
	inc	1V
Repetition Time	min	40s
	max	1000s
	inc	1s
Trigger Delay	min	0°
	max	360°
	inc	1°

4.5.1 Start Manual Test

DANGER By pressing ‘Start’, the manual test is executed and the defined parameters are displayed.

The energy storage capacitor is charged up to the desired voltage. If more than one pulse was selected, triggering of the high-voltage switch is accomplished automatically synchronous to the mains, including the “Tdelay” that was set in the setup, after the pre-selected charging voltage is reached.
If only one pulse is selected, triggering of the high-voltage switch is accomplished by operating the key ‘Trigger’ shown in Figure 16 or by applying a 10V trigger signal to the ‘TRIG-IN’ connector.

Figure 16: main menu / manual test / manual trigger button

Moreover, during charging of the energy storage capacitor, the charging voltage is displayed in the progress bar (Figure 17). After triggering the high-voltage switch, the peak values of the output voltage and the output current are displayed in panel ‘Control’. When the set “I * t limit” is not exceeded, the evaluation window shows “pass”, otherwise “fail”.
If the ‘Status’ panel is blinking red, then the testing is active; otherwise it is grey.

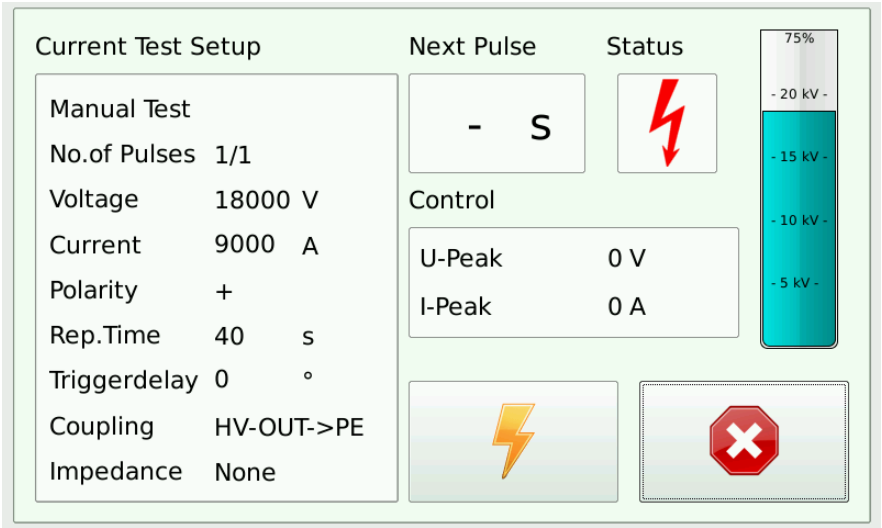


Figure 17: manual test / execution

The ‘Pause’ button interrupts the test.
By pushing the ‘Start’ button again, the test will continue.
By operating “Stop” the automatic test can be stopped at any time.
If ‘Display Results’ was activated in the ‘Setup’ menu, a test result listing is generated and ready to be saved as *.csv on a USB device (Figure 18). If ‘Display Results’ was deactivated, the current test is just carried out and can be restart immediately

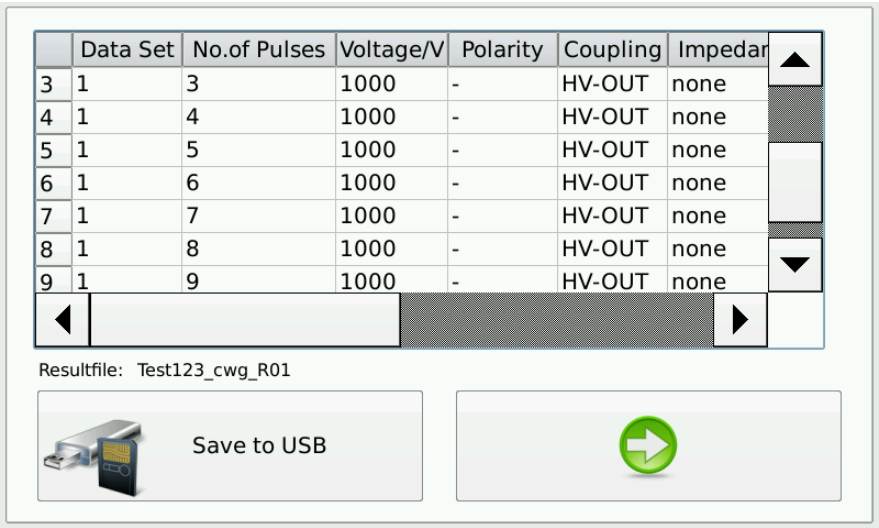


Figure 18: manual test / list result

4.5.2 Create Test Procedure

By operating 'Test Procedure' in the main menu of the generator, the database appears (Figure 19). Here it is possible to open or delete a test procedure or a result file.

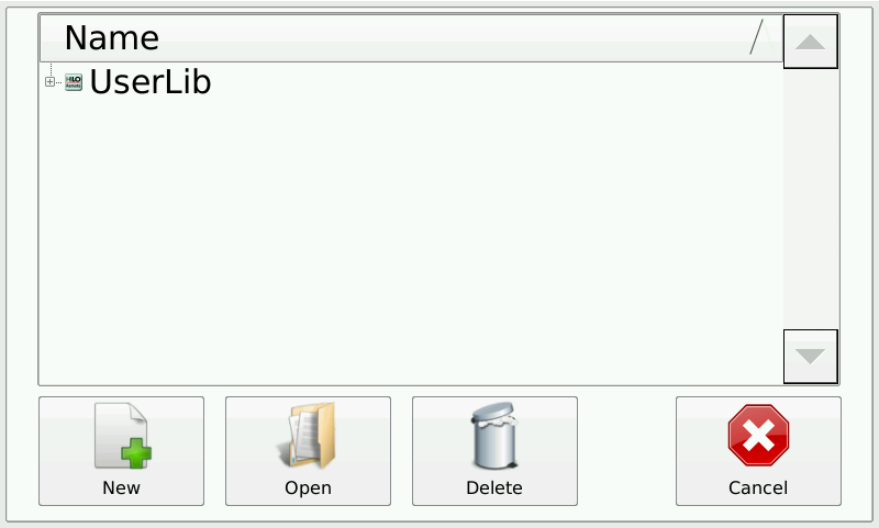


Figure 19: test procedure

Pressing 'New' allows to define a new test procedure and the data sets are displayed (Figure 20).

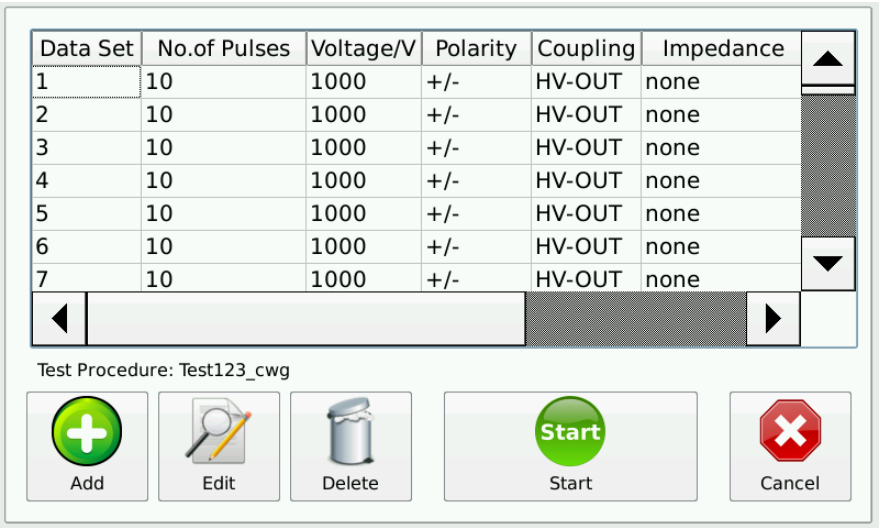


Figure 20: test procedure / data sets

‘Add’ allows to add a new data set.
‘Edit’ allows to change parameters of a selected data set.
‘Delete’ allows to delete the selected data set.
‘Start’ allows the execution of a test run with the selected parameters.
‘Cancel’ permits the interruption of the test at any time.

By pressing ‘Add’ or ‘Edit’ the parameters of the data set are displayed :

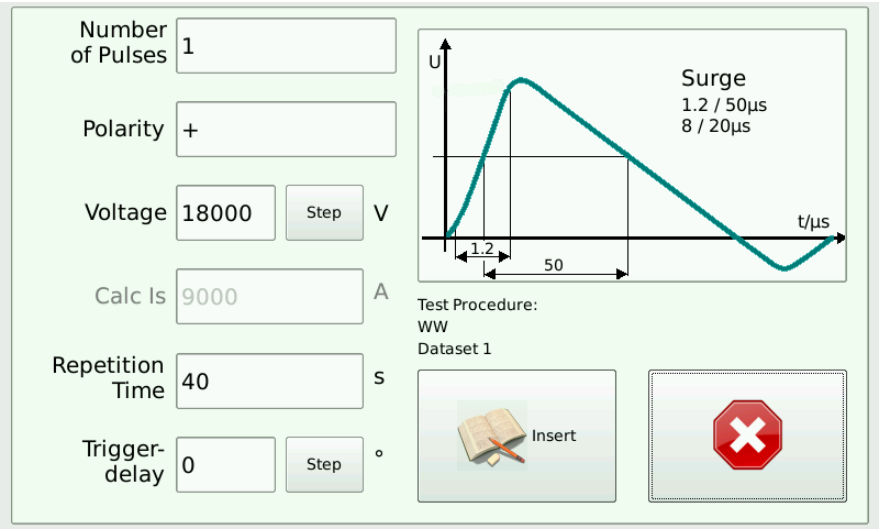


Figure 21: test procedure / data sets / manual

4.5.3 Variation of test parameters

The parameter voltage can be gradually changed by pressing the ‘Step’ button. The ‘Step Setup’ menu appears:

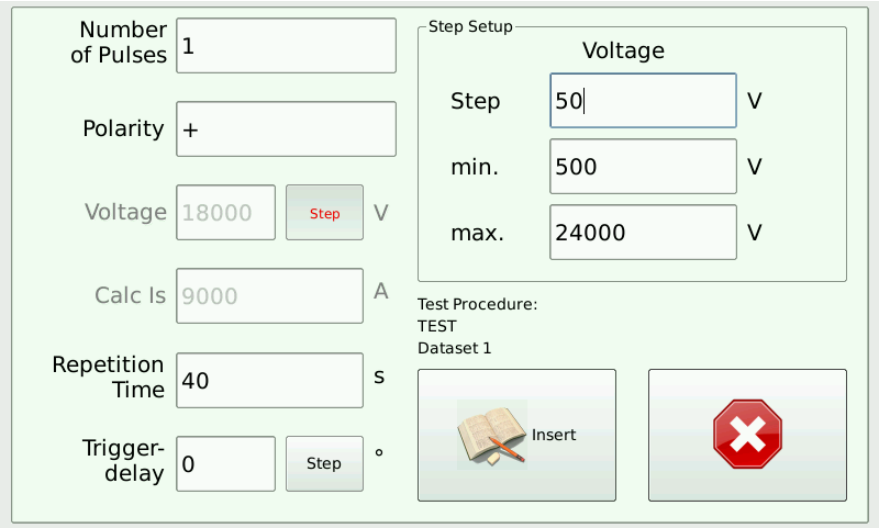


Figure 22: test procedure / data sets / manual / variation of parameters

The step, minimum and maximum values of each parameter can be inserted.
Operating ‘insert’ permits to create data sets for every step value.

4.5.4 Start test procedure

Pressing ‘start’ allows to execute the test procedure and the test parameters are displayed.

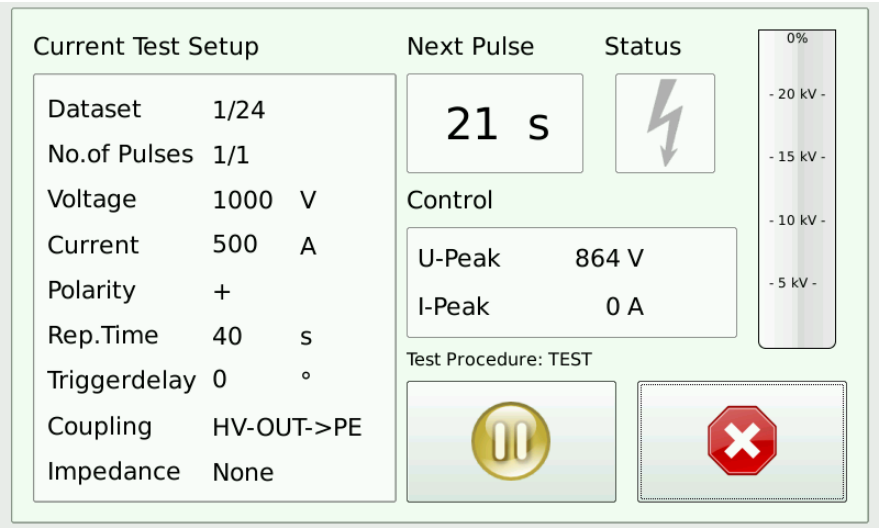


Figure 23: test procedure / data sets / execution

Moreover, during charging of the energy storage capacitor, the charging voltage is displayed in the progress bar. After triggering the high-voltage switch, the peak values of the output voltage and output current are displayed in panel “Control “.

If the “Status” panel is blinking red, then the testing is active; otherwise it is grey.

By pressing ‘Pause’ the test can be interrupted and started again later.

By operating “Stop” the test procedure can be interrupted at any time.

If ‘Display Results’ was activated in the Set-up menu, a test result listing is generated and ready to be saved on a USB device. If ‘Display Results’ was deactivated, the current test is just carried out and can be restarted immediately.

4.5.5 Open a result file

Each test started, creates a result file with consecutive numbering. The resulting file can be opened in the "Test Procedure" menu. The left part of the window shows the test procedures within the "UserLib", the right side lists the corresponding result files.

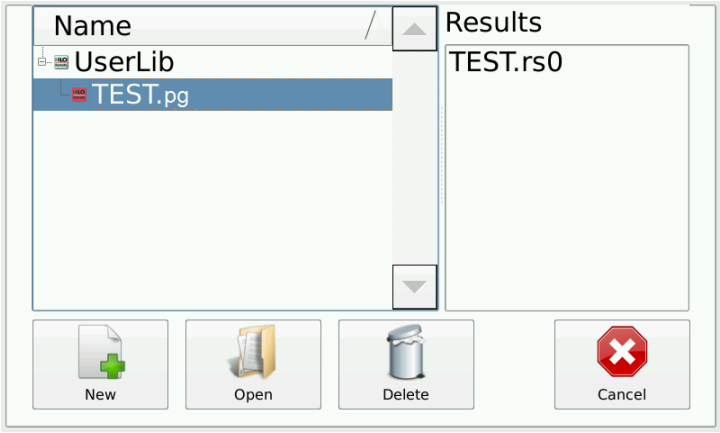


Figure 24: Test procedure

With the selection of a result file and select "Open", it opens.

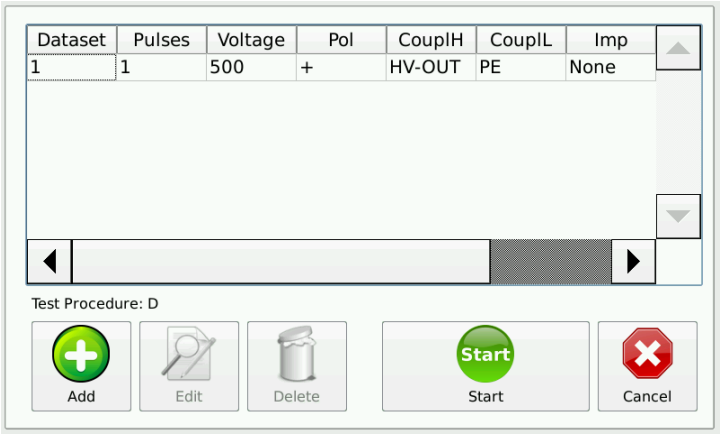


Figure 25: manual test / list result

The file can now be stored on a USB flash drive. As a *.csv file.

5 Environment Conditions

The generator is designed to be used under the following environment conditions:

- Indoor use
- Height up to 2000 m above sea level
- Temperature range 5°C - 40 °C
- Maximum relative humidity 80% for temperature up to 31°C, decreasing linearly to 50% at 40°C
- Voltage variation of power supply voltage: ±10% of nominal value.
- Transient over voltages according to class II
- In order to meet all requirements of EMC-directive this unit may be operated only inside a screened room supplied with a power line filte

ATTENTION: The unit must be operated with a fixed earth connection.

6. Technical specification PG 24-2500

Technical specification:	PG 24-2500
Mainframe, control unit:	
Microprocessor controlled touch panel	5”, 800X480, 24 bit
Optical Ethernet Interface for remote control of the generator	optional
Interface for saving reports	USB
External Trigger input	10 V an 1 kΩ
Connector for external safety interlock loop	24 V =
and external red and green warning lamps acc. to VDE 0104	230 V, 60W
Mains power supply	230 V , 50/60 Hz
Dimensions: 19"-cabinet, W * H * D	556*620*800 mm^3
Weight	115 kg
HV-impulse generator:	
Peak value of the open-circuit output voltage	0.5 - 24 kV ± 10 %
Wave form acc. to IEC 60, VDE 0433	1.2 / 50 µs ± 30 %/±20 %
Peak value of the short-circuit output current	0.2 - 12 kA ± 10 %
Wave form acc. to IEC 60, VDE 0433	8 / 20 µs ± 20 %
Polarity of surge output voltage / output current	pos/neg/alt selectable
max. stored energy	2500 Joule
Charging time at max. charging voltage	< 40s
HV-output: High current terminals on the rear panel	HV-OUT
Mains synchronous triggering: Phase shifting, digitally selectable	0 - 360 °, step 1°
Display of peak values of impulse voltage and impulse current	build in
Monitor output for impulse voltage	2000 : 1 ± 5 %
Monitor output for impulse current	12V ≡ 12 kA ± 5 %
Ground rod, for manual security earthing of the HV output	build in
Option:	
Software PG-Remote for remote control 5 m fibre-optic cable and PC-interface	
Option :	
Safety test cover PA 504 mounted on the top Limit switch connected to the safety interlock loop Test space: W*H*D	430*280*500 mm

7. Final Testing PG24-2500

7.1 Function test:

• FW-Version	V 5.8
• Manual Test: LEV1, LEV2, LEV3, LEV4, LEVx	OK [x]
• Timing test: Repetition Time, Trigger Delay	OK [x]
• USB transfer:	OK [x]
• Remote control	OK [x]
• Waveform check at the HV-OUT connector	OK [x]

7.2 ESD-TEST acc. to IEC 1000-4-2, Level 3

no malfunction OK [x]

7.3 EFT-TEST acc. to IEC 1000-4-4, Level 3

no malfunction OK [x]

7.4 CWG-TEST acc. to IEC 1000-4-5, Level 3

no malfunction OK [x]

7.5 Safety test

Resistance of protective earth	[0,11] Ω
Isolation resistance	[> 20] MΩ
Equivalent leakage current	[0,44] mA
max. supply current	[1,63] A
metal contact areas are potential free	OK [x]

7.6 Enclosures (in paperform)

- Waveform test certificate
- Declaration of conformity

Kalibrierschein
Calibration certificate

Kalibrierzeichen *Calibration mark*	**1804052** **CAL** ISO 9001 **2020.02**

Gegenstand *Object*	**EMC Test Generator**
Hersteller *Manufacturer*	**Hilo- Test GmbH**
Typ *Type*	**PG24-2500**
Serien-Nr. *Serial number*	**1804052**
Auftraggeber *Customer*	**Xx** **Xx** **Xx**
Auftragsnummer *Order number*	**EPC/0051/18/PI**
Anzahl der Seiten *Number of pages*	**5**
Datum der Kalibrierung *Date of calibration*	**21.08.2018**

Die Kalibrierergebnisse beziehen sich ausschließlich auf den genannten Kalibriergegenstand. Die Kalibrierung erfüllt die Anforderungen nach DIN EN ISO 9001 oder vergleichbarer QM-Richtlinien. Das Qualitätsmanagement der HILO-TEST GmbH ist gemäß DIN EN ISO/ IEC 9001 zertifiziert. Dieser Kalibrierschein dokumentiert die Rückführbarkeit auf nationale Normale des DKD (Deutscher Kalibrierdienst) bzw. PTB (Physikalisch-Technische Bundesanstalt) oder anderer nationaler Normale zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem internationalen Einheitensystem (SI).

Für die Einhaltung der Intervalle der Kalibrierung ist der Benutzer verantwortlich.

The calibration results refer exclusively to the object. The calibration satisfies the requirements of DIN EN ISO 9001 or equivalent QM guidelines. The quality management of HILO-TEST GmbH is accredited in accordance to DIN EN ISO/ IEC9001. This calibration certificate documents the traceability to national standards maintained by the DKD (Deutscher Kalibrierdienst), the PTB (Physikalisch-Technische Bundesanstalt) or other national standards, which realize the physical units of measurement according to the international System od Units (SI).

The user is obliged to have the object recalibrated at appropriate intervals.

Datum *Date*	Leiter des Kalibrierlaboratoriums *Head of the calibration laboratory*	Bearbeiter *Person in charge*

Kalibrierzeichen *Calibration mark*	**1804052** **CAL** ISO 9001 **2020.02**

1. Kalibriergenestand / *Calibration device*
PG24-2500

2.* Kalibrieranweisung / *Calibration method
Das Kalibrierverfahren ist in AW_calib.docx dokumentiert.
The calibration procedure is documented in AW_calib.docx.

3.* Umgebungsbedingungen / *Calibration conditions
Umgebungstemperatur / *Ambient temperature*: (25 ± 2) °C
Relative Luftfeuchte / *Relative humidity*: (51 ± 20) %

4.* Messbedingungen / *Measurement conditions
Anschlussfeld / *Connector panel:* Front-+ Rückseite / *front+ back panel*
Starteinstellungen / *Start-up conditions:* keine / *none*
Messwerterfassung / *Measurement value acquisition:* automatisiert / *automated*

5. Messunsicherheiten / *Measurement uncertainty*
Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsichheit durch Multiplikation mit dem Erweiterungsfaktor k = 2 ergibt. Sie setzt sich aus den Messunsicherheiten der Messgeräte und dem des Kalibrierverfahrens während der Kalibrierung zusammen. Ein Anteil für die Langzeitstabilität des Kalibriergegenstandes ist nicht erhalten. Der gemessene Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall. Dimensionslose Messunsicherheiten beziehen sich auf den Kalibrierwert.
The measurement uncertainty is made of standard uncertainty multiplied with a coverage factor k = 2. It consists of the uncertainty of measurement equipment and the uncertainty of the calibration method during the calibration. There is no long-term stability included. The measured data is with 95% probability in range. Non-dimensional measurement uncertainty are related to measured data.

Uncertainty of measurements (Surge / Voltage)	
Open circuit peak voltage	2,74 %
Risetime /tr	3,89 %
Pulsewidth /th	3,72 %

Uncertainty of measurements (Surge / Current)		
	PSM10-2	PSM40-1
Short circuit peak current	2,23 %	1,93 %
Risetime /tr	3,08 %	3,12 %
Pulsewidth /th	2,96 %	3,05 %

6. Durchgeführte Zusatzarbeiten / *Additional work*

☐ Reparatur / *Repair* ☐ Reinigung / *Cleanup* ☐ Abgleich / *Adjustment*

7. Konformitätsaussage (Auslieferung) / *Statement of compliance (outgoing)*

Die ermittelten Messwerte liegen / *The measurement results show*

☐ innerhalb der Spezifikationen / *conformity*

☐ außerhalb der Spezifikation / *out of specifications*

8. Rückführbarkeit der verwendeten Messeinrichtungen / Traceability of measurement systems

Mesurement device	**Type**	**Hilo-Test Inventory-No.**	**DAKKS No.**	**Calibration date**	**Calibration valid to**
Messgerät	**Type**	**Hilo-Test Inventar-Nr**	**DAKKS Nr.**	**Kalibrier Datum**	**Kalibrier gültig bis**
Digital Voltmeter, 5 ½ Digit	HP 34401a	# 490039	D-K-15180-01-00	02.08.2018	02.08.2019
Oszilloscope	RTE1102	# 410256	D-K-15180-01-00	30.07.2018	30.07.2019
Hilo-Test Pulse Current Shunt	PSM 40-1	# 480080	D-K-15180-01-00	11.08.2016	11.08.2019
Microohmmeter	MR300-C-A	# 410246	D-K-17543-01-00	03.06.2017	03.06.2019
Voltage divider	HVT20-RCR	# 410253	D-K-15070-01-01	13.08.2018	13.08.2019

9. Wave form test:

Voltage waveform: HV-OUT
High-voltage divider HVT20RCR connected to the output terminals of the generator.
Waveform measured with the Oscilloscope.

Positive Voltage:

Generator Output Voltage	LEV 1 0.5 kV	LEV 2 1.0 kV	LEV 3 2.0 kV	LEV 4 4.0 kV	LEV 5 10 kV	LEV x 24 kV	Um Monitor out	
rise time(1.2µs±30%):	1,33	1,20	1,15	1,14	1,14	1,19	1,19	µs
tail time (50µs±20%):	55,2	54,0	53,0	52,3	51,9	50,4	50,0	µs
amplitude(±10%):	510	1000	2000	4036	10040	24060	23960	V

Negative Voltage:

Generator Output Voltage	LEV 1 0.5 kV	LEV 2 1.0 kV	LEV 3 2.0 kV	LEV 4 4.0 kV	LEV 5 10 kV	LEV x 24 kV	Um Monitor out	
rise time(1.2µs±30%):	1,31	1,24	1,17	1,14	1,16	1,19	1,23	µs
tail time (50µs±20%):	53,7	52,7	52,5	51,6	51,2	51,0	50,3	µs
amplitude(±10%):	512	1000	2018	4000	10010	24060	23985	V

Current waveform: **HV-OUT**
Impulse current shunt PSM 40-1 (1mΩ), connected to the HV-OUT and GND terminals of the generator.
Current signal measured from the shunt with the Oscilloscope.
Monitor output: measured with Shunt PSM 10-1 Nr. 19, Rm = 1.0016 mΩ

Positive Voltage:

Generator Output Current	LEV 1 0.5 kV	LEV 2 1.0 kV	LEV 3 2.0 kV	LEV 4 4.0 kV	LEV 5 10 kV	LEV x 24 kV	Im Monitor out	
rise time(8.0µs±20%):	7,17	7,12	7,06	6,94	7,00	6,93	6,95	µs
tail time (20µs±20%):	21,00	20,98	20,91	20,89	20,77	20,67	20,67	µs
amplitude(±10%):	250	494	979	1950	4900	11690	11530	A

Negative Voltage:

Generator Output Current	LEV 1 0.5 kV	LEV 2 1.0 kV	LEV 3 2.0 kV	LEV 4 4.0 kV	LEV 5 10 kV	LEV x 24 kV	Im Monitor out	
rise time(8.0µs±20%):	7,14	7,12	7,01	7,01	7,01	6,92	6,94	µs
tail time (20µs±20%):	21,00	20,92	20,96	20,80	20,78	20,76	20,71	µs
amplitude(±10%):	250	495	975	1943	4882	11660	11730	A

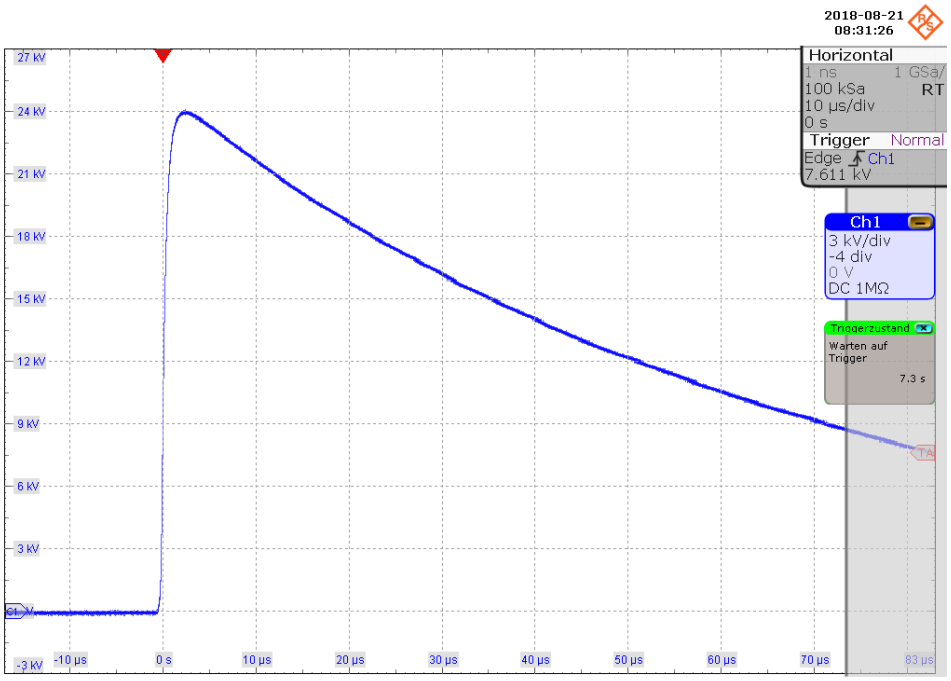
Monitor out Um:
IMPULSE VOLTAGE DIVIDER: 100 kΩ / 50 Ω, ratio = 2000:1
Reference: Digital Voltmeter: HP 34401a , 5 ½ Digit, # 490039

PVD 10 #	Serial No.:	R2/Ω	(R1+R2)/kΩ	ratio	Error
Um	245	50,143	100,99	2014,04	+0,70%

Monitor out Im:
IMPULSE CURRENT SHUNT: R_M= 1mΩ
Reference: Microohmmeter MR300-C-A, #410246

PSM #	Serial No.:	R_X / mΩ	Error
Im	17	1,0027	+0,27%

Voltage waveform 24kV, measured with HVT20RCR (1000:1)



Current waveform 24kV, measured with PSM40-1 (1mΩ)