INSTRUCTION MANUAL

HV – Impulse generator
PG 20-100

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

Inhaltsverzeichnis:

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 interference to other electrical devices when making these tests in a given installation. Operating the generator inside a screened room and additional filtering of the mains power supply may be necessary. People with heart pacemaker or any other device likely to be influenced, should be excluded from those tests.

- It is the responsibility of the operator to ensure that adequate precautions are taken to ensure that no human contact to the live parts of the output terminals, the cascaded test-object or associated leads is possible. Before energising the generator, the operator must assure that all safety precautions are complete and fully operational.

- The device must only be operated by professionally trained and educated personnel. Safety regulations according to EN50191 (VDE 0104), VBG 4 or specific national safety codes must be obeyed.

- The generator must only be operated from properly installed mains with protective earth. Interruption or isolation of the protective earth connector is not allowed. Cabinet, chassis and grounded parts of the coaxial measuring and output voltage connectors possess equal potential and are connected with protective earth of the mains.

- If safe operation of the device is obviously not possible, the generator must be shut down and secured against improper use. For example, this applies when the device exhibits external damage, contains loose parts or components, no longer operates according to its technical specifications or has been stored under adverse conditions.

- There are no serviceable parts inside the generator. Calibration and service of the generator without cabinet must only be conducted by professionally educated personnel which is aware of the inherent high-voltage hazards.

- Unauthorised modification or any use in contrary to the instructions contained in this manual, will invalidate the warranty and relieve the manufacturer of any further liability or responsibility.

- 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. A reproduction or unauthorised use of the information contained herein is expressly prohibited.

2 Introduction

The HV-Pulse generator PG20-100 is used for impulse voltage tests of solar modules (photovoltaic panels) with the standard surge voltage waveform 1.2/50 µs according to IEC 60060-1/2 up to 10 kV acc. to. IEC 61730-1/2 / EN 61730-1.

For the surge voltage tests of solar modules, these are enveloped with a copper foil as described in the relative above standard. After that the connections of the solar modules are tested with surge voltage against the copper foils. The tight copper foil envelope required by the standard results in comparatively high capacitances of approx. 10 - 183 nF, which is switched in parallel to the output of the impulse generator.

Therefore, a special impulse voltage generator is required for this standard specified test, which can generate the specified impulse wave shapes for the different EUT-capacitances, which are a result of the varying dimension of the solar modules to be tested.

The high voltage Pulse Generator comprises 7 different pulse forming networks, which allow to generate the requested wave shapes fully complying with the tolerances specified in the standard for the different EUT capacitances

The output peak voltage can be preset continuously from 2 –20kV. A built-in voltage divider allows monitoring of the output voltage wave form during testing.

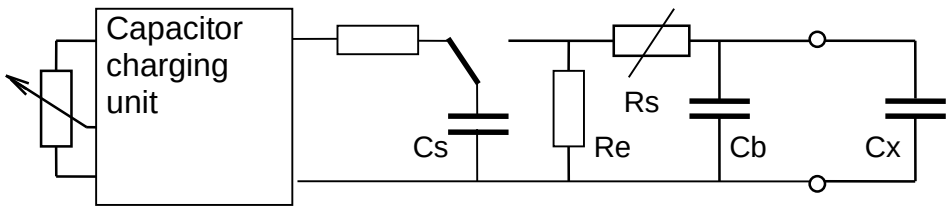


Figure 1: Principle of operation

The high-voltage output terminals are located on the rear of the generator.

The pulse generator PG 20-100 features a microprocessor controlled user interface and 5" touch screen display unit for ease of use. The microprocessor allows the user to either execute 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.
Moreover all generator functions may be computer controlled via the isolated optical interface. The software program PGC-REMOTE allows full remote control of the test generator via Ethernet light guide as well as documentation and evaluation of test results, accordingly to the IEC 17025. To record definite impulses with an oscilloscope, it is equipped with an Impulse Recording Function (IRF)

The generator excels by its compact design, simple handling and precise reproducibility of test pulses.

The generator uses maintenance-free semiconductor switches for surge current generation.

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.

Before touching the test samples, the high-voltage terminals and all parts of the test sample must be discharged with a ground rod. Now the test samples can be safely installed or replaced.

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, EN50191 (VDE 0104) or specific national safety codes.

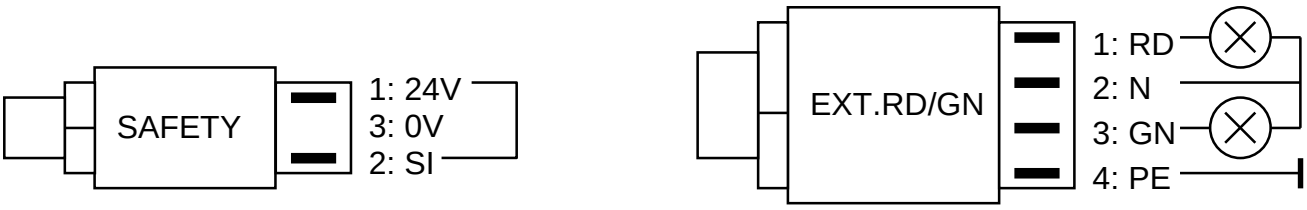


Figure 2: Safety / warning lights connector

During EMC-testing utilizing the built-in 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 501/PA 502. 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.

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 (3V to Ground) 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 Connectors of PG20-100

230Vac	Power supply connector for the generator
EXT.RD/GN	Connector for external warning lamps
SAFETY	Safety interlock connector
HV-OUT	direct output of combination wave generator PG 10-504
Um	monitor output for surge voltage, ratio 1000:1

The test object is connected between the output HV-OUT and the earth connector.

The monitor output connector Um delivers a voltage signal proportional to the output voltage which can be used for monitoring the waveform and amplitude of the output voltage by use of an external scope.

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

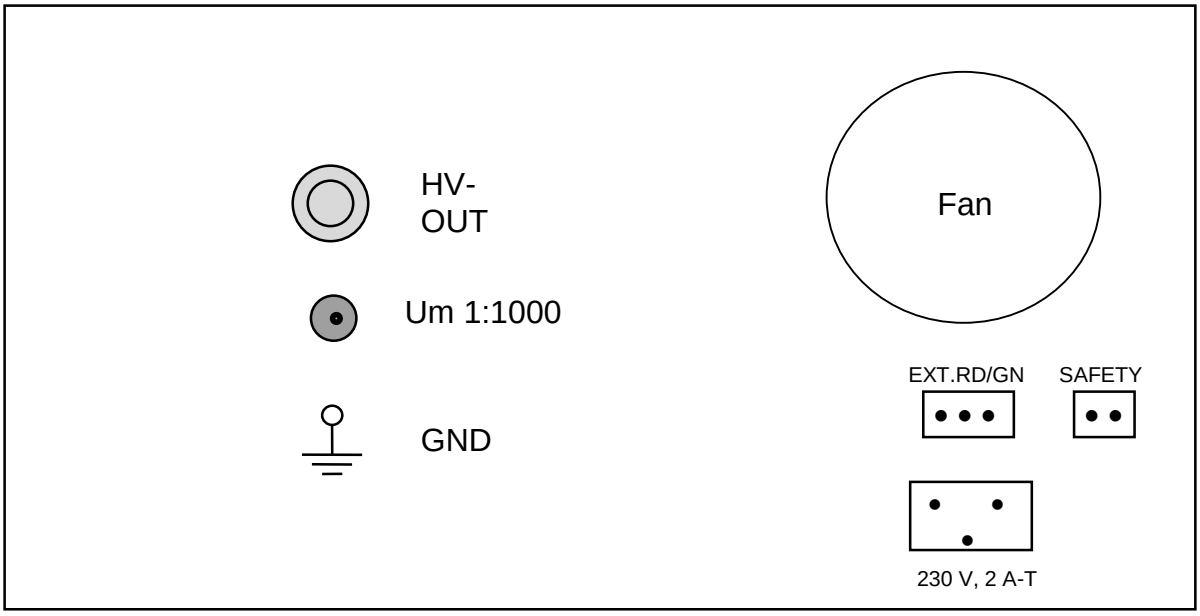


Figure 3: Location of the input/output connectors on the rear panel

4 Operation

Der PG wird durch ein mikroprozessorgesteuertes 7“ Touchscreen, als Bedien- und Anzeigeeinheit gesteuert. Der Benutzer kann Prüfabläufe aufrufen oder eigene Prüfabläufe selbst definieren, er kann gespeicherte Prüfabläufe automatisch ausführen oder den Generator manuell bedienen.

Die Menüs sind hierarchisch strukturiert. Durch die Wahl einer Funktionstaste wird man ins darunter befindende Menü geleitet. Mit „Exit” oder „Back” gelangt man in die nächst höhere Menüebene zurück:

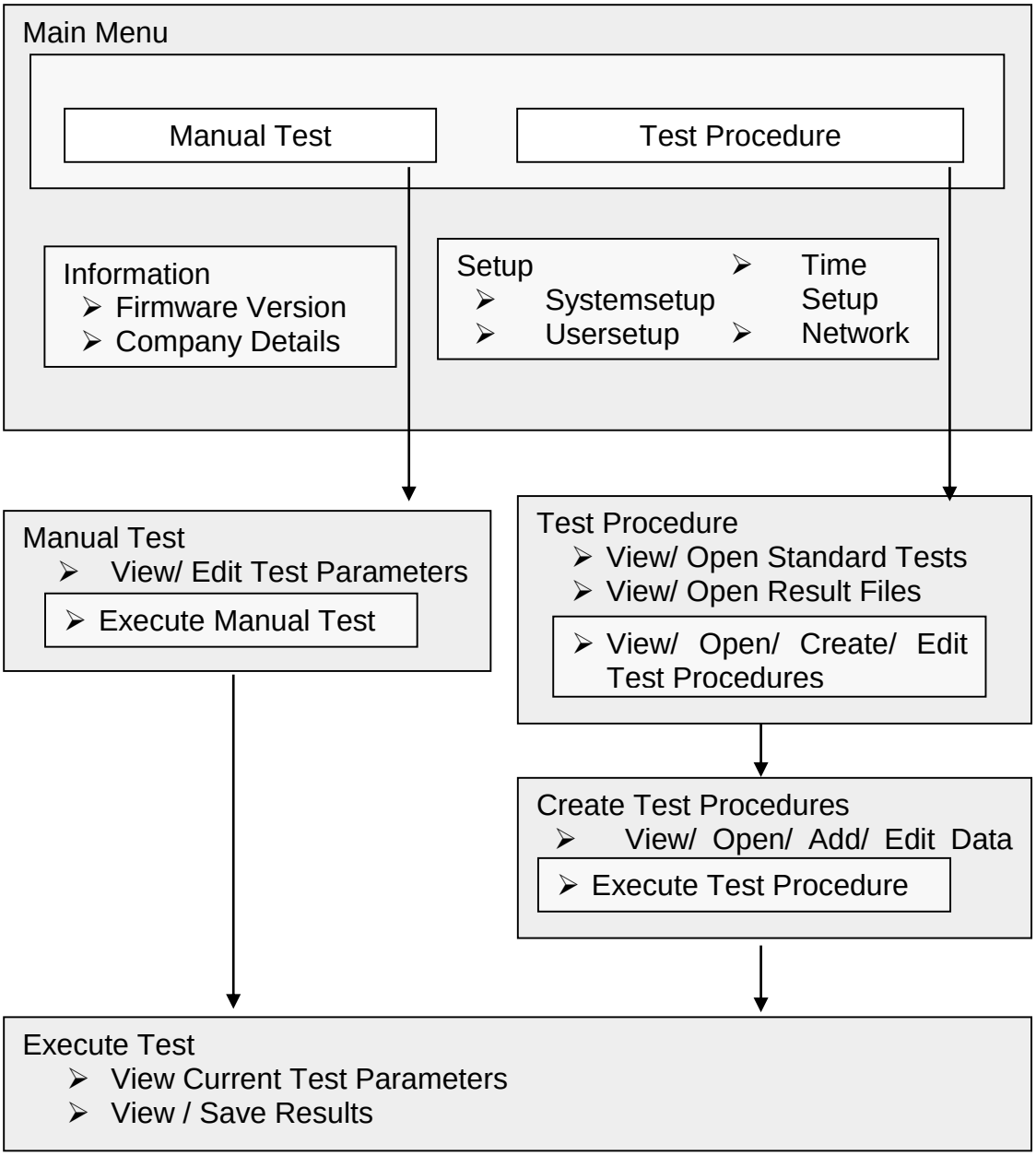


Figure 4: Menu in hierarchical structure

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.

Removing the key prevent from unauthorised use of the generator.

4.2 Main menu

After starting the PG20-100, the 'Main Menu' appears.

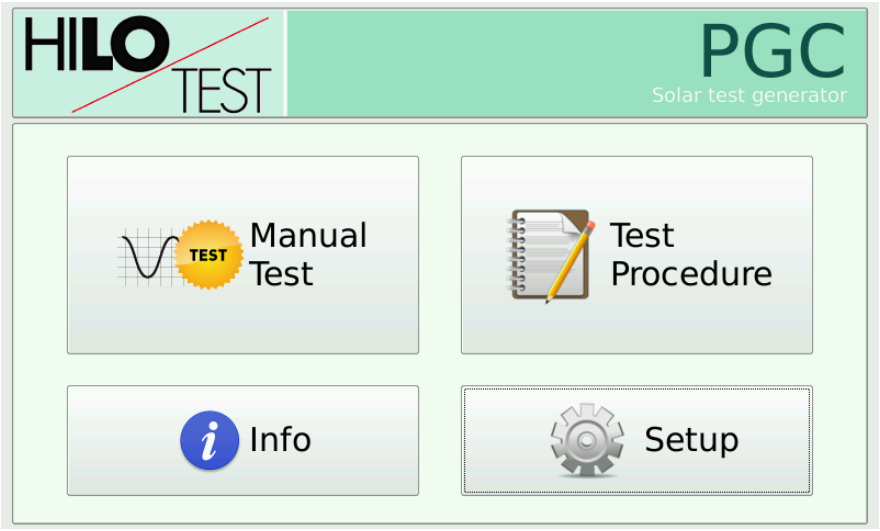


Figure 5: Main menu

You can choose between 'Manual Test', 'Test Procedure', the 'Setup' menu or 'Informations'.

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 PG20-100.

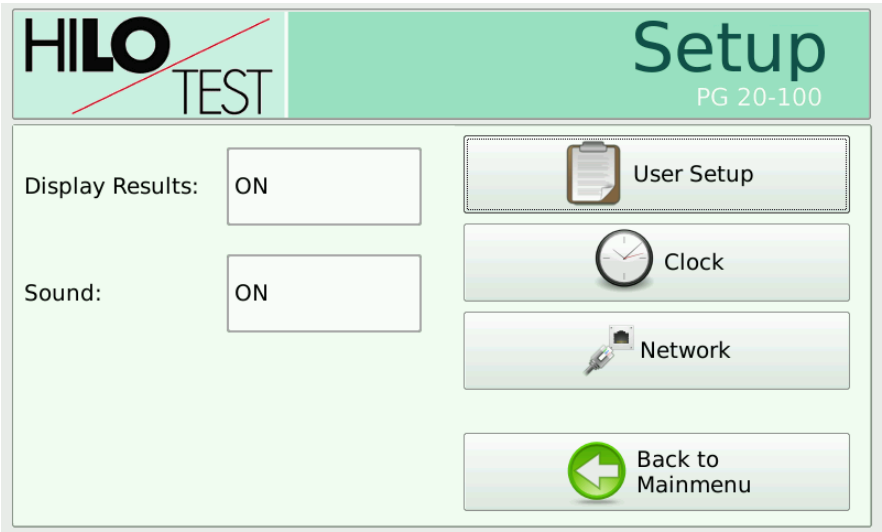


Figure 6: Setup

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.

4.3.1 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.

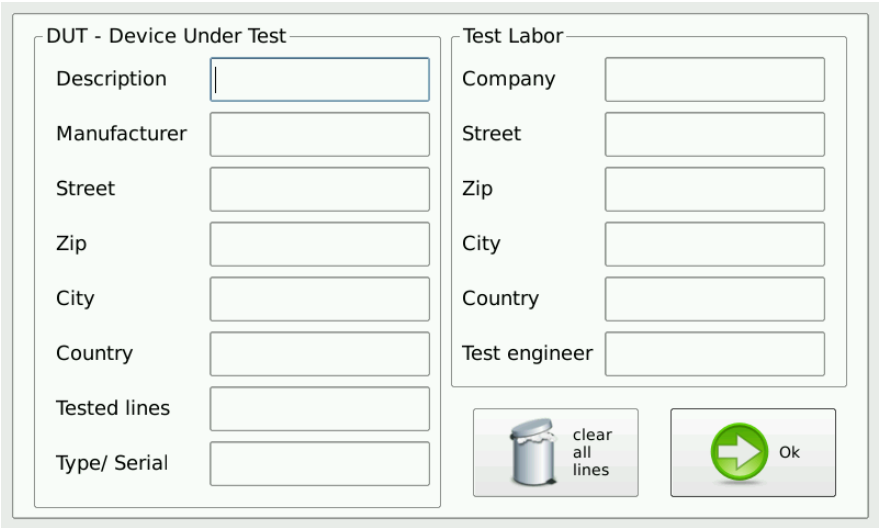


Figure 7: Setup / User setup

4.3.2 Date/ Time

Permits to adjust the date as well as the time.
The selected parameter is displayed in color 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.

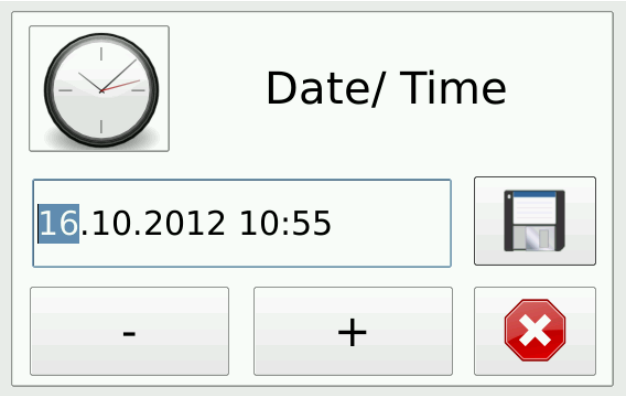


Figure 8: Setup / Clock

4.3.3 Network

Allows to change the network settings of the generator.

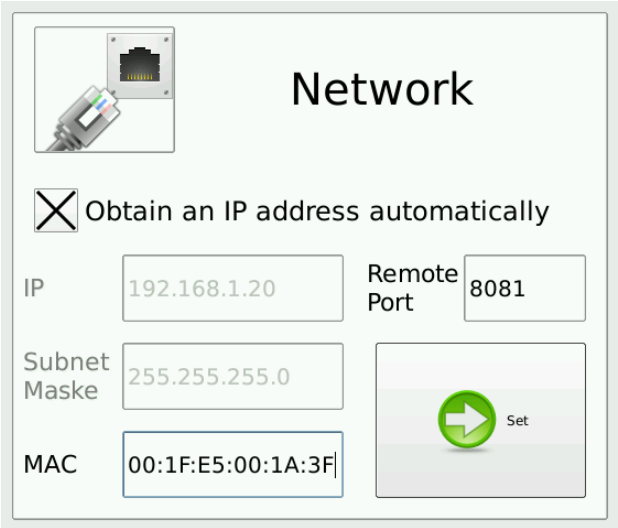


Figure 9: Setup / Network

By selecting “obtain a 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.

4.3.4 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.

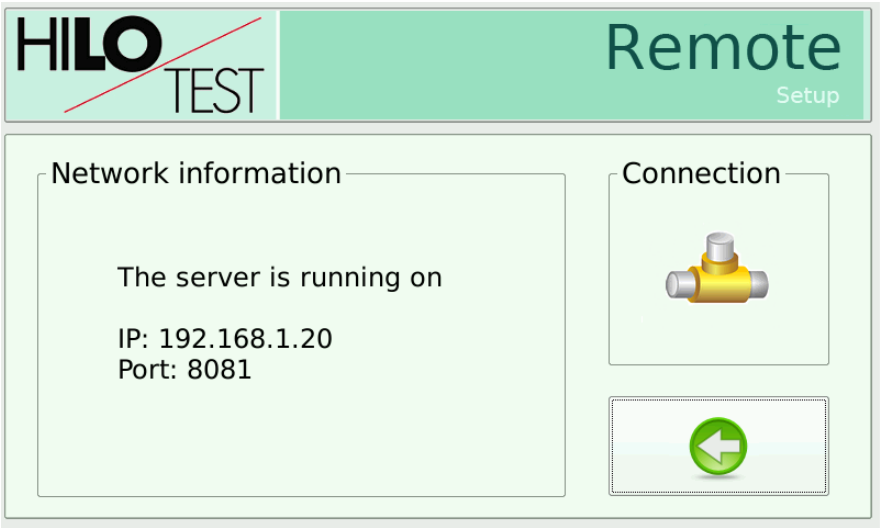


Figure 10: Setup / Remote mode

Upon selecting 'Remote', the generator functions are remotely controlled by the software "HILO-remote" running on an external computer and controlling 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 11: Remote connected, the connection is broken as shown in Figure 12: Remote not connected.

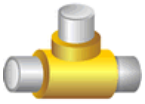


Figure 11: Remote connected

Figure 12: Remote not connected

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

Figure 13: Information

The firmware version is displayed on the top. A firmware update function is also available. Next to it are further information about the generator and the actual date and time.

Other information as our company address / contact and disc space are displayed.

Instructions for the firmware update:

- copy the new firmwarefile to the root directory of a USB stick
  (make sure, that there is no other HILO Firmware on the 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.

5 Manual Test

The ‘Manual Test’ allows to operate the generator manually.

DANGER

Push button ‘START’ from the Manual Test Menu will start execution of a test run with the parameters selected.
By operating ‘Test Procedure’, it is possible to add, change or execute a predefined test procedure or to list and save test results.

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

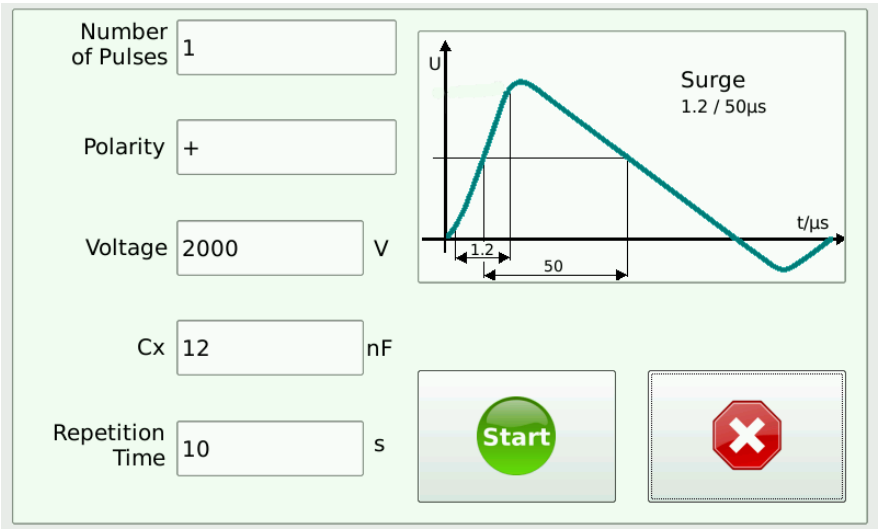


Figure 14: PGC / manual test

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

		PG20-100
Number of Pulses	Minimalwert	1
	Maximalwert	1000
	Schrittweite	1
Polarity	Auswahlmöglichkeiten	+ / ± / -
Voltage	Minimalwert	2000V
	Maximalwert	20000kV
	Schrittweite	1V
Repetition Time	Minimalwert	10s
	Maximalwert	1000s
	Schrittweite	1s
Cx	Auswahlmöglichkeiten	12,22,33,47,68,100,150nF

5.1 Start Manual Test

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 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 15: SURGE CWG / manual trigger button or by applying a switch to the ‘TRIG-IN’ connector.

Figure 15: SURGE CWG / manual trigger button

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 a sparkover was detected, the status window shows „FAIL“, otherwise it shows „PASS“.

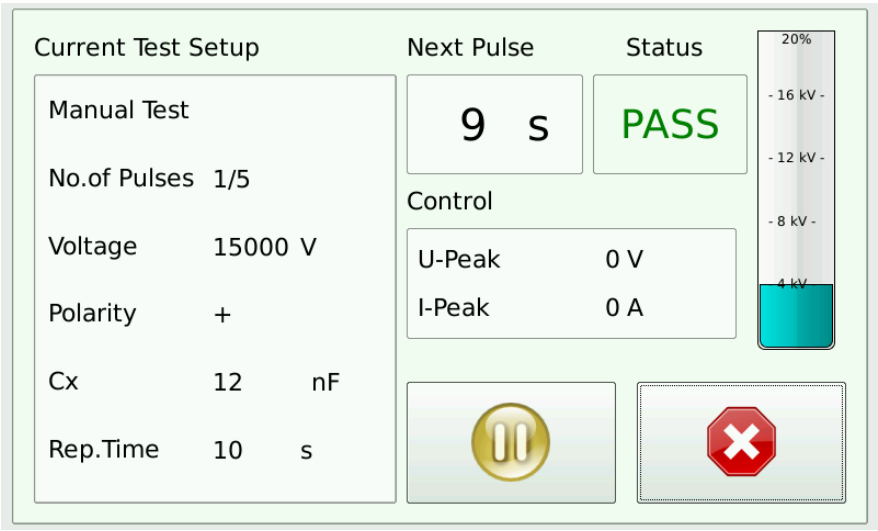


Figure 16: PGC / manual test / execution

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 on a USB device. If ‘Display Results’ was deactivated, the current test is just carried out and can be restart immediately.

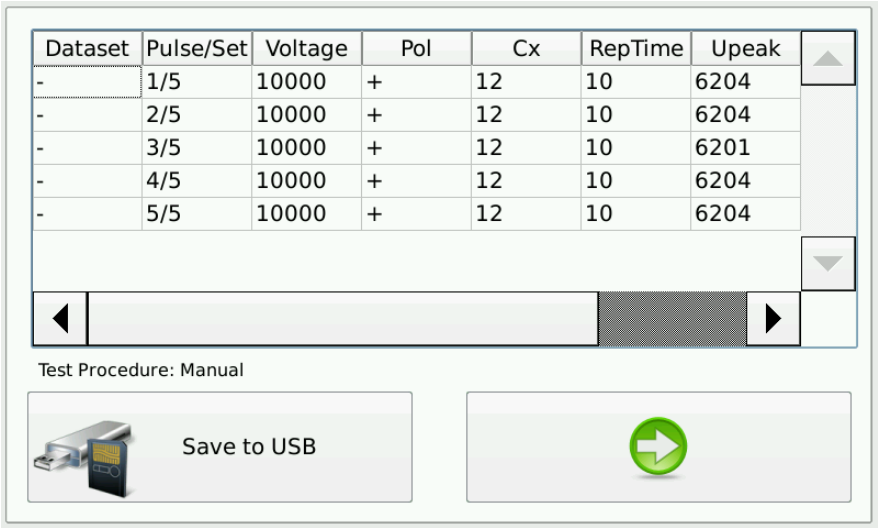


Figure 17: PGC / manual test / execution / list result

5.2 Create Test Procedure

By operating ‘Test Procedure’ in the menu of the generator, the database appears. The folder ‘UserLib’ holds all created test procedures.
Here it is possible to open or delete a test procedure and a result file.

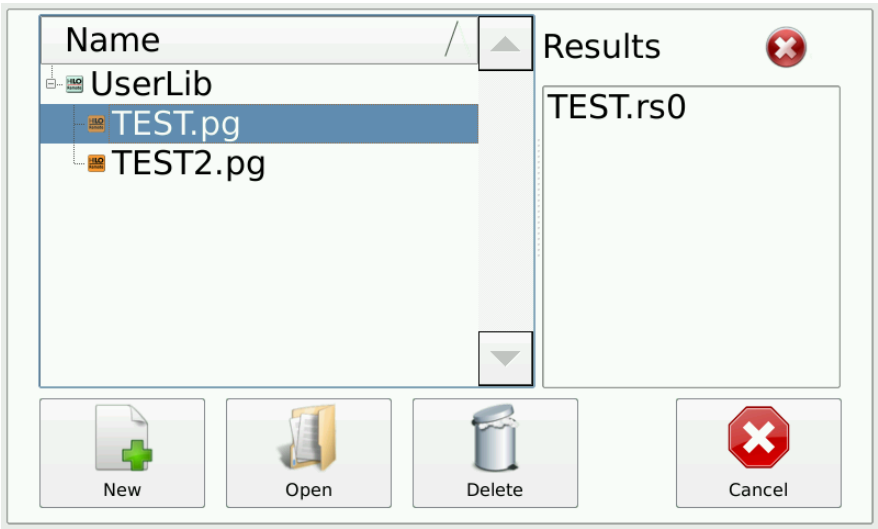


Figure 18: PGC / test procedure

Each test started, creates a result file with consecutive numbering. The right side lists the corresponding result files.
Is a result file marked (ending “.rs”), and you press open, then it will be displayed and you can store it on a USB device.

Pressing ‘New’ allows to define a new test procedure and the data sets are displayed.

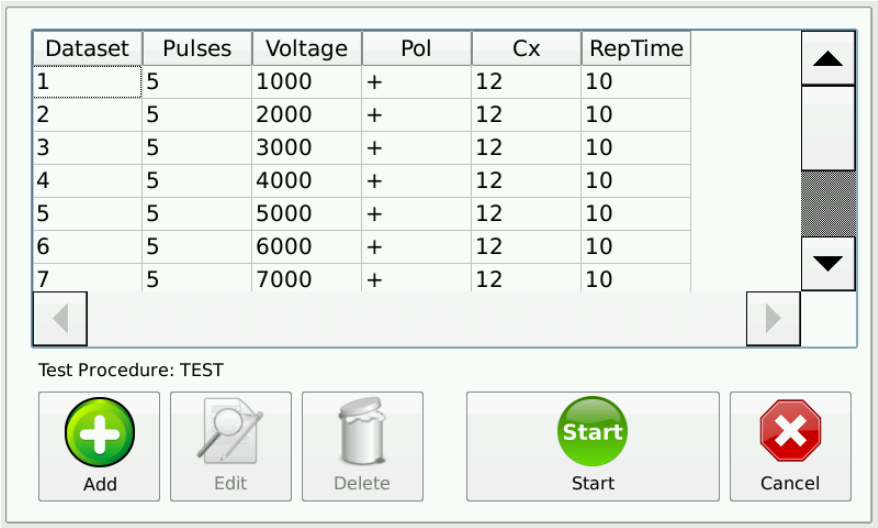


Figure 19: PGC / test procedure / data sets

‘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

DANGER Operating key ‘START’ from the Manual Test Menu will start execution of a test run with the parameters selected.

‘Cancel’ permits the interruption of the test at any time

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

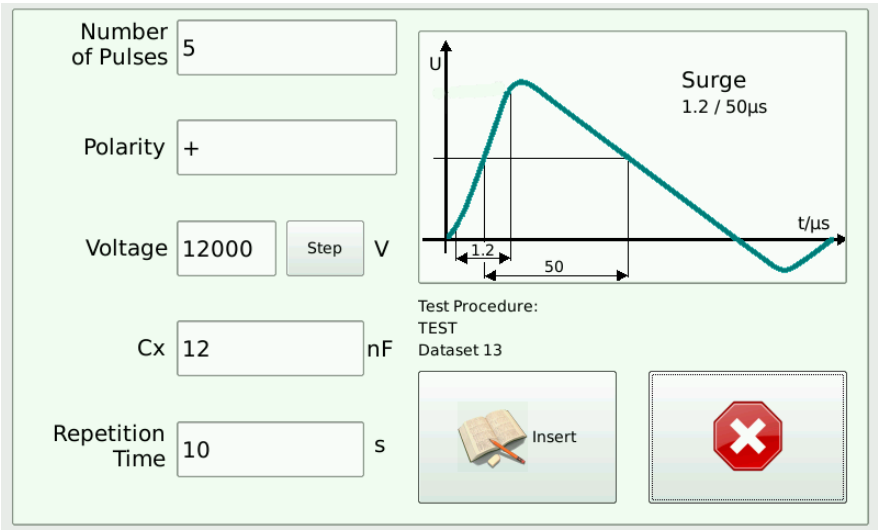


Figure 20: PGC / test procedure / database / data sets / manual

5.3 Variation of test parameters

The parameters voltage and trigger delay can be gradually changed by pressing the ‘Step’ button. The ‘Step Setup’ menu appears:

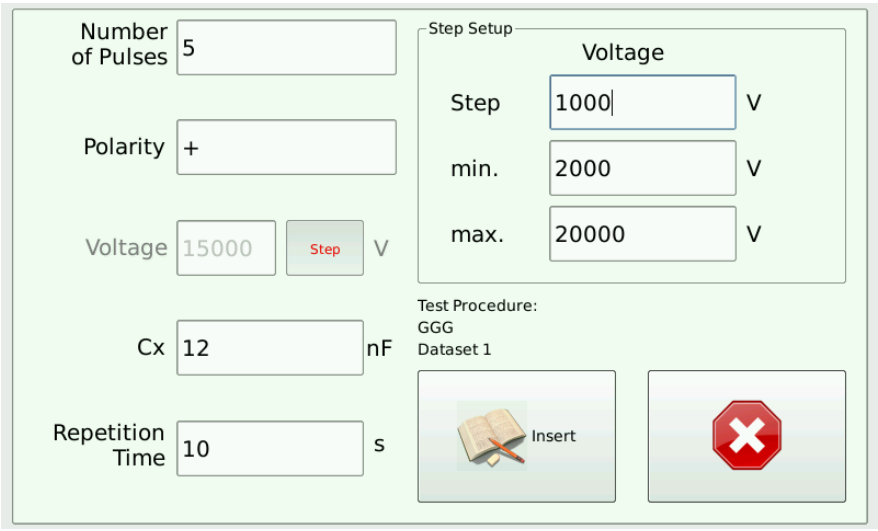


Figure 21: PGC / test procedure / database / data sets / manual / variation of parameters

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

5.4 Start test procedure

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

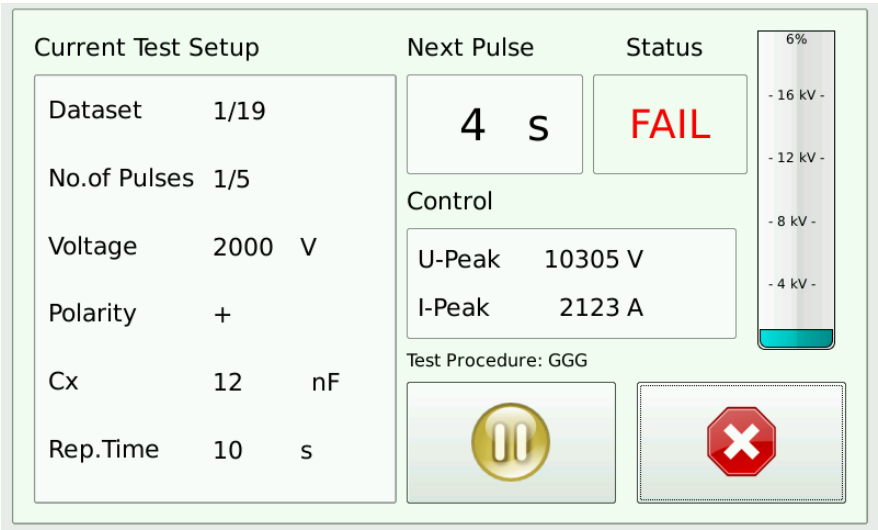


Figure 22: PGC / test procedure / database / data sets / execution

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 restart immediately.

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.

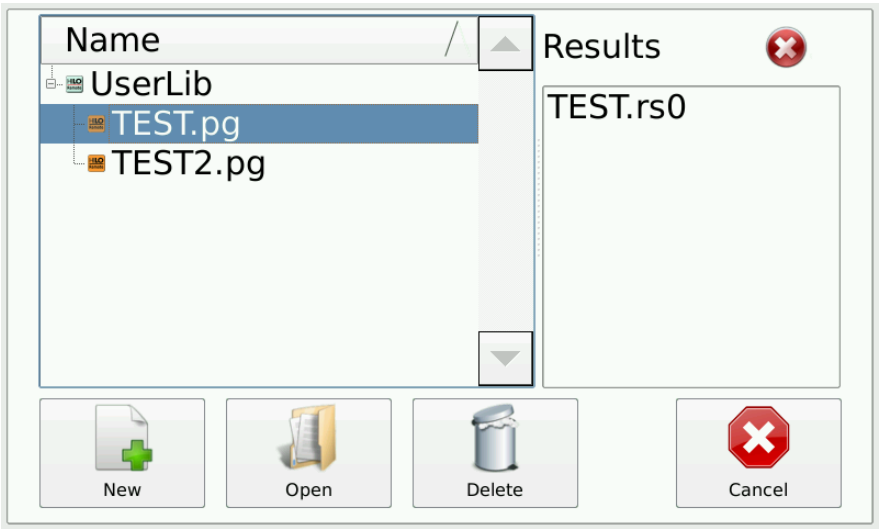


Figure 23: test procedure

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

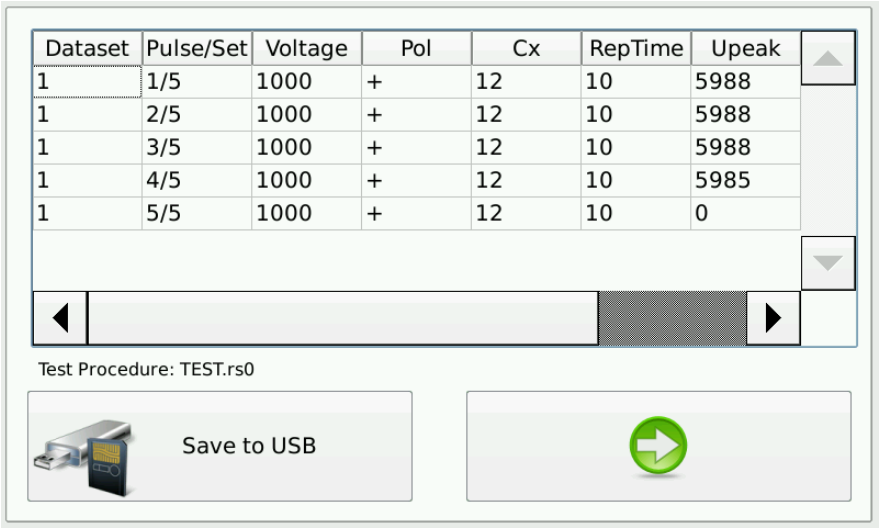


Figure 24: manual test / list result

The file can now be stored on a USB flash drive. As a *.csv file.
Mit der Auswahl einer Ergebnisdatei und „Open“, wird diese geöffnet.

6 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 : ±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 filter

ATTENTION: The unit must be operated with a fixed earth connection. The unit cannot be used in power supply networks which are protected by residual current switches.

7 TECHNICAL SPECIFICATIONS

	PG 20-100
Mainframe	
Microprocessor controlled touch panel	7”, capacitive
Optical Ethernet Interface for remote control of the generator	optional
Interface for saving reports	USB
External trigger input/ output	Switch/ 10 V
Connector for external safety interlock loop	24 V =
External red and green warning lamps	230 V, 60W
Mains power	90V - 264V, 50/60 Hz
Dimensions of desk top case W * H * D	450*330*500 mm^3
Weight	30 kg
High- Voltage Pulse Generator acc. to IEC 61720-2	
Impulse output voltage, adjustable	2.0 - 20 kV (±5%)
Waveform of Impulse output voltage	1.2 / 50 µs (±30% / ±20%)
Polarity, selectable per software (no plugs necessary)	pos./neg.
Maximum stored energy Cs	100J
Charging time for max. charging voltage	approx. 10s
Interior load capacitance Cp	10 nF (± 10%)

Pulse forming networks to test solar modules:		**Cp = 10 - 183nF**
selectable per software (no plugs necessary)		
Area	EUT capacitances nominal	Range of EUT capacitances
1	12 nF	10 - 16 nF
2	22 nF	16 - 27 nF
3	33 nF	27 - 40 nF
4	47 nF	40 - 57 nF
5	68 nF	57 - 83 nF
6	100 nF	83 - 122 nF
7	150 nF	122 - 183 nF
Spark-over detection:		PASS / FAIL
Impulse current output: on the generator’s rear panel		HV conector
Impulse high voltage dividers to observe the impulse wave shape		built-in
Ratio		1000 : 1 ±2%

Accessories
mains cable, key, HV-connection cable, operation instructions

Options	**PG 20-100**
Software PG-REMOTE, for remote control	
With Impulse Recording Function (IRF)	
(XP, WIN7, WIN10) incl. 5 m fibre optic cable and PC Ethernet interface	
Capacitor- calibration- kit	**CCK 20**
Calibration capacities:	23nF, 33nF, 50nF, 73nF,100nF, 156nF (±3%)

Fabr. Nr.: [1704037]

8.1 Functional test :

• FW-Version	V 5.0
• Manual test: Test voltage 0% - 100%	OK [x]
• Timing test: Repetition rate, Pulse counter	OK [x]
• USB Transfer:	OK [x]
• Remote control	OK [-]
• Waveform check at the generator output	OK [x]
• Waveform check at the monitor output	OK [x]

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

no malfunction OK [x]

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

no malfunction OK [x]

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

no malfunction OK [x]

8.5 Safety test

Resistance of protective earth	[0,07] Ω
Isolation resistance	[> 20] MΩ
Equivalent leakage current	[0,49] mA
max. supply current	[0,49] A
metal contact areas are potential free	OK [x]

8.6 Enclosures

- Calibration certificate:
- Declaration of conformity

Kalibrierschein
Calibration certificate

Kalibrierzeichen *Calibration mark*	
	1704037
	CAL ISO 9001
	2020.02

Gegenstand *Object*	**EMC** **Test Generator**
Hersteller *Manufacturer*	**Hilo- Test GmbH**
Typ *Type*	**PG20-100**
Serien-Nr. *Serial number*	**1704037**
Auftraggeber *Customer*	**UL LLC** 2191 Zanker Rd San Jose, CA 95131 United States
Auftragsnummer *Order number*	**1246**
Anzahl der Seiten *Number of pages*	**6**
Datum der Kalibrierung *Date of calibration*	**19.05.2017**

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*	**1704037** **CAL** ISO 9001 **2020.02**

1. Kalibriergenestand / *Calibration device*
PG20-100

2.* Kalibrierverfahren / *Calibration method
Das Kalibrierverfahren ist in AW_calib.docx übereinstimmend mit der IEC 61730-1/2 und IEC 60060-1 dokumentiert.
The calibration procedure is documented in AW_calib.docx consistent with the IEC 61730-1/2 and IEC 60060-1.

3.* Umgebungsbedingungen / *Calibration conditions
Umgebungstemperatur / *Ambient temperature*: (21 ± 2) °C
Relative Luftfeuchte / *Relative humidity*: (38 ± 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)	
Open circuit peak voltage	2,70 %
Risetime /tr	3,88 %
Pulsewidth /th	3,71 %

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 (X)*

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	04.07.2016	04.07.2017
Oszilloscope	DPO 3054	# 490042	D-K-15180-01-00	15.05.2017	15.05.2018
Voltage divider	HVT20-RCR	# 410253	D-K-15070-01-01	19.06.2016	19.06.2017
Hilo-Test Pulse Current Shunt	PSM 10-2	# 480070	D-K-15180-01-00	08.03.2016	08.03.2018

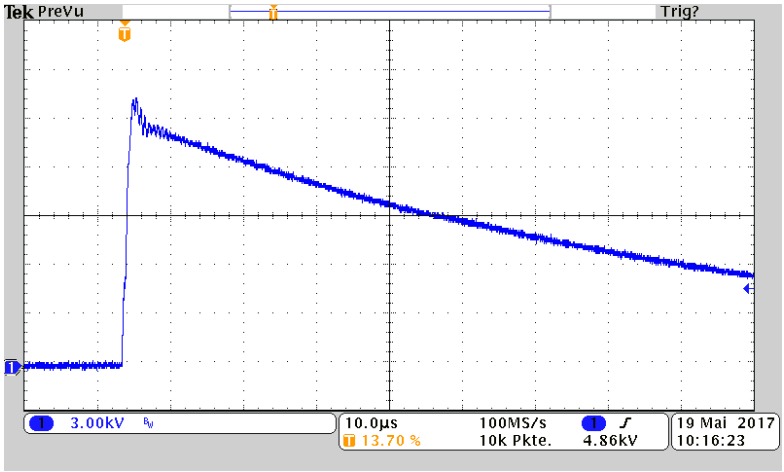
9. Messwerte / *Measurement results*

Cx-range: 68 nF, Test Objekt : Cx = 73 nF CCK(#1704038)

Polarity	Voltage setting	Output voltage/kV ± 5%	Front time 1.2µs±30% (30%-90%)*1.67	Tail time 50µs±20%	within tolerance
+	2kV	2,04	1,25	49,1	OK
-	2kV	2,03	1,24	48,7	OK
+	4kV	4,0	1,31	54,4	OK
-	4kV	3,97	1,39	54,8	OK
+	10kV	10,03	1,24	52,8	OK
-	10kV	9,96	1,27	52,9	OK
+	16kV	16,03	1,27	52,0	OK
-	16kV	16,07	1,25	52,7	OK
+	20kV	19,4	1,26	52,6	OK
-	20kV	19,4	1,23	52,9	OK
Monitor output Um					
+	20kV	19,6	1,23	52,0	OK
-	20kV	19,6	1,22	52,0	OK

Tolerance IEC 60060-1

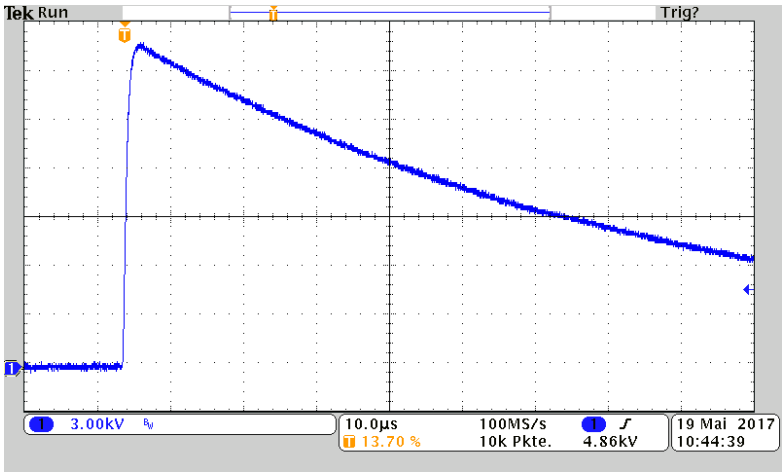
Output wave form: 20kV; Cx=73nF:



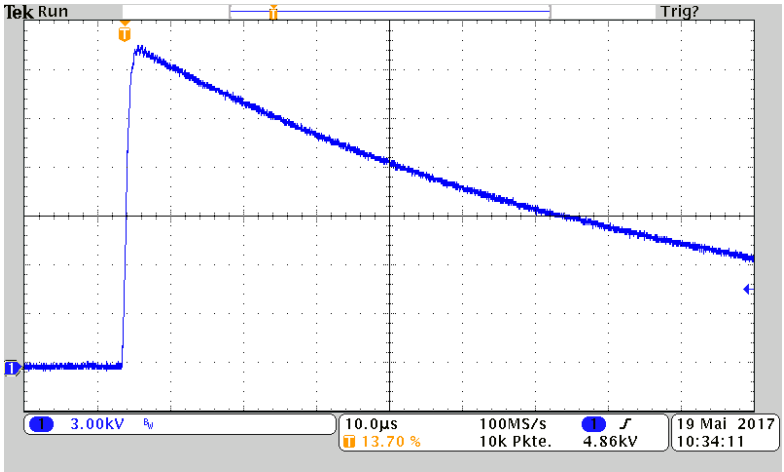
Output wave form with CCK20. #1704038

Cx-Range	Cx/nF	Vout / kV	Tr / µs	Tf / µs	OK
12 nF	12 (extern)	19,75	1,29	55,8	OK
22 nF	23	19,7	1,22	55,4	OK
33 nF	33	19,456	1,23	55,3	OK
47 nF	50	19,35	1,27	51,9	OK
68 nF	73	19,4	1,26	52,6	OK
100 nF	100	19,41	1,16	50,0	OK
150 nF	157	19,43	1,32	48,4	OK

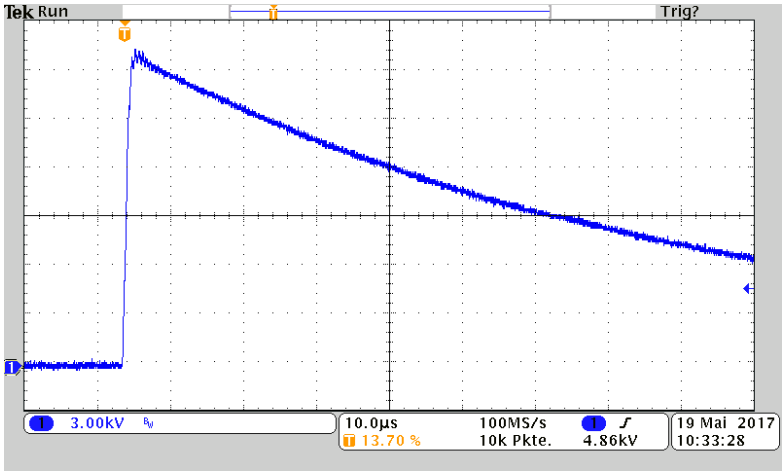
Cx = 12nF; 20kV



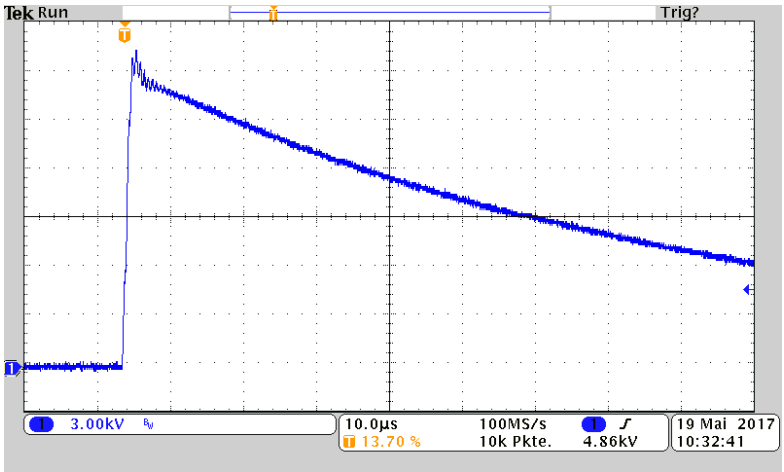
Cx = 23nF; 20kV



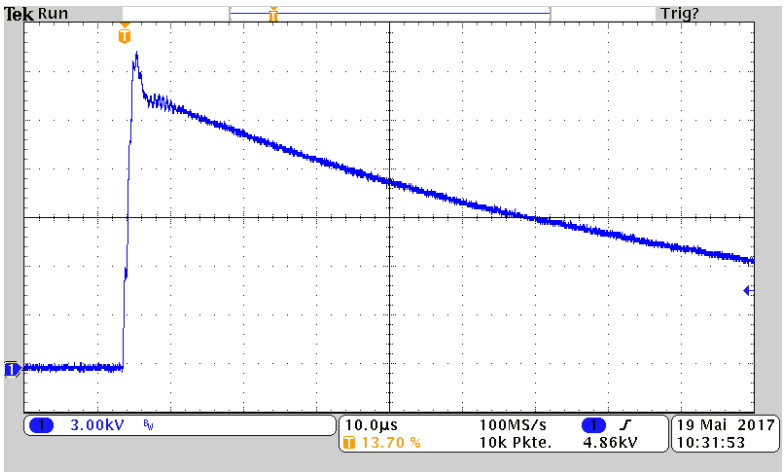
Cx = 33nF; 20kV



Cx = 50nF; 20kV



Cx = 100nF; 20kV



Cx = 150nF; 20kV