CONTENTS

1   Introduction

The High Energy Pulse Generator type NSG 650 produces hybrid pulses of the shape 1.2/50 μs (open circuit) and 8/20 μs (short circuit) as well as a 0.5μs/100 kHz damped oscillation. The unit thus complies with the standards and recommendations IEC 801-5 (1991), ANSI-IEEE C62.41, IEEE 587, VDE 0109 etc.

All the functions of the instrument are controlled and monitored by a micropro-cessor. Instead of using operating elements mounted on the front panel, the NSG 650 is operated via a personal computer (IBM XT, AT or compatible). Alternatively the user can integrate the generator into an existing automatic test environment.

The PC operating software supplied provides unique features which are other-wise not possible via front panel controls. This includes freely programmable test sequences which can be stored for further or repetitive use and the test par-ameters of which can be filed together with the test results obtained.

The menu structure of the user-program guides the user in a logical manner through the development of a test sequence.

Test parameters may be defined in four different modes:

      Single pulse

      Incremental voltage sequence

      Incremental phase angle sequence

      User-defined sequence of test profiles

During the test the actual pulse peak values (Vp and Ip) at the generator output are measured and displayed on the monitor screen. All the test parameters, measured values and the status of the test object (EUT) are recorded and can be printed in the form of a table.

Optionally a digital I/O-board can be fitted to incorporate the control of associated coupling networks or other elements in the automatic test rig to which the generator is connected.

Matching coupling networks are available to couple the pulses into supply lines or into data or signal lines.

In addition, a range of accessories such as test enclosures, warning lamps, etc. is available to help the user assemble a test rig both easily and safely.

Considerable attention has been paid to the matter of personnel protection. Software checks are backed by visual and audible alerts and by interlocked circuitry to prevent any erroneous operation.

CONTENTS

2   Safety considerations

The NSG 650 generator produces high voltage pulses having a high energy level.

Incorrect or careless operation can be lethal!

Neither Schaffner Elektronik AG, Luterbach, Switzerland, nor any of the associated sales organisations can accept any responsibility for personal injury or for material or consequential damage that results through irresponsible operation of this instrument.

The construction of the instrument conforms to the safety requirements called for in VDE 100 and provides all the prerequisites for safe and reliable operation.

Strict and responsible observance of the following safety measures and recommendations is a must at all times.

Safety measures

These operating instructions form an integral part of the equipment and must be carefully studied before putting the equipment into operation and be available to the operating personnel at all times.

The equipment may only be used by trained personnel.

Personnel fitted with a heart pacemaker must not operate the instrument nor remain in the test vicinity when the generator is in operation.

The instrument is only to be used in dry rooms. In the event of any condensation occurring, this must be allowed to evaporate before the instrument is put into service.

The construction of the instrument is not designed for use in an explosive atmosphere.

The test rig is to be set up in conformity with the relevant safety standards (e.g. VDE 104).

The instrumentation may only be used with appropriate mains plugs connected to a **mains supply with a protective earth.** In addition, a duplicated protection

earth connection is necessary. This requirement can be met by making a reliable connection directly between the earth terminal and the fixed installation (not via a mains distributor or similar items).

To ensure safe operation, only approved accessories, plugs, adapters, etc. are to be used.

The test rig must offer insulation protection against a voltage of at least 10 kV.

The pulse voltage must not be able to find its way to unearthed metallic objects even if the item under test (EUT) is faulty or fails.

The EUT must be tested only inside a protective cage or hood that provides protection against flying debris, fire and electric shock.

Depending on the type of test object (EUT) and especially on the cabling to it, a considerable amount of interference can be radiated which could affect nearby systems and radio communication. These interference effects on the surroundings are to be kept under control by the user through the use of suitable measures such as a Faraday cage, shielded cable runs, etc.

The instrument must never be left unattended while in operation. When not in use, the key should be removed and be put in a safe place.

The instrument housing must not be opened. Any repair or service work and any internal adjustments must only be carried out by appropriately qualified service personnel.

3   Concept of the instrument

3.1   Block diagram
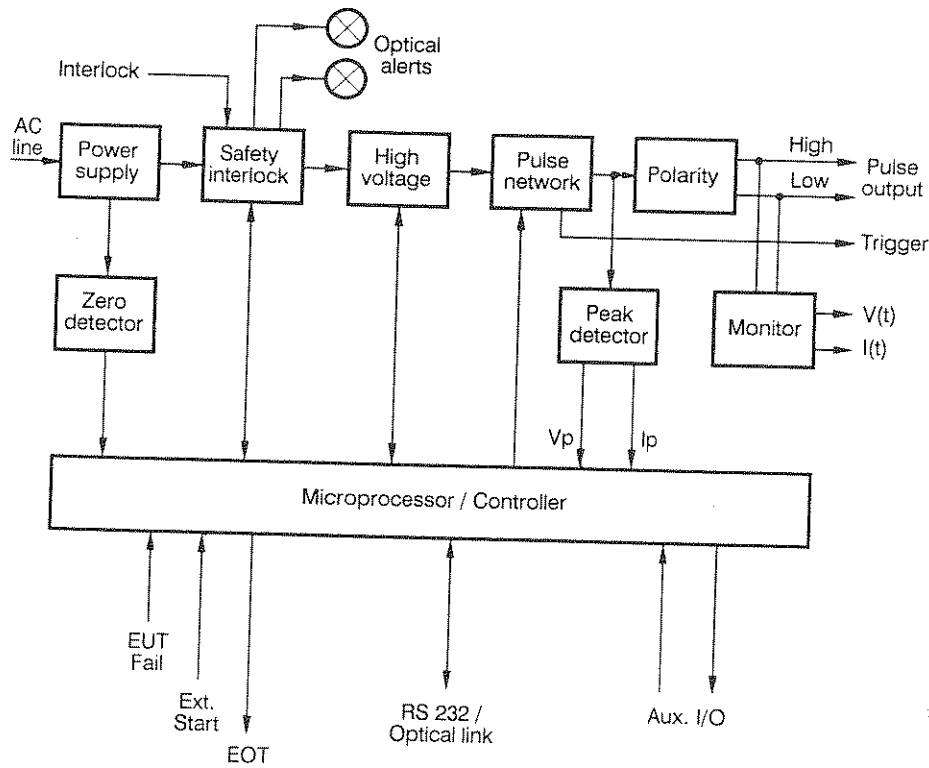
3.2   Principle of operation

The widespread acceptance of personal computers and the reasonable price of the equipment makes it realistic to create test equipment for laboratory and production purposes that are simply user-interfaces to such PCs.

In so doing, the power of a local computer such as that for calculation purposes, program and data storage, file handling, application-orientated screen presentations, print-outs of protocols and lists, networking and communications possibilities with other parts of the plant, etc. can be made available to a test rig and its operation.

Such a concept demands that the test equipment itself incorporates the necessary processor intelligence in order to be able to carry out all the specific tasks and real-time procedures and to be able to understand the PC software as an integral part of the product.

The NSG 650 generator contains a high performance microprocessor as the controlling element. This controls and monitors all the functions of the instrument, regulates the time-dependent generation of the pulses, secures and checks the statuses of switching elements, collects the results of the measurements taken and constantly monitors the safety elements in the test set-up. In addition, the microprocessor handles the communications through the computer port together with other inputs and outputs as well as checking all the entries for validity and plausibility.

As can be seen from the block diagram, the energy part of the instrument is made up of several sub-systems as described below.

A mains-driven power unit supplies both the control section and the high voltage generator with stabilised dc.

The zero-crossing detector produces reference signals so that the pulses can be superimposed on the mains supply to the EUT at the programmed phase angle.

Safety circuits combine and interlock the status signals from the key-switch, the microprocessor, coupler and external protective gear to ensure that the demand for 'safety first' is met under all operating situations and abnormal conditions.

The high voltage supply charges the capacitors in the discharge network to the required voltage and then ensures that a constant charge is maintained until a pulse is triggered.

The pulse network function block contains the components necessary to produce four different types of output pulse:

Surge LZ	1.2 / 50 μs surge pulse with 2 Ω internal dynamic impedance
Surge HZ	1.2 / 50 μs surge pulse with 12 Ω internal dynamic impedance
Ring LZ	0.5 μs / 100 kHz damped oscillation with 12 Ω internal dynamic impedance
Ring HZ	0.5 μs / 100 kHz damped oscillation with 30 Ω internal dynamic impedance

The pulse triggering mechanism controlled by the microprocessor also belongs to this part of the instrument.

The polarity switching facility determines the polarity of the pulses appearing at the HIGH output referred to HF-ground and the protective earth.

Two detectors measure the peak voltage and the peak current of the pulse at the output of the generator and pass the values obtained on to the micro-processor for digital treatment.

Elaborate measuring circuits in the monitor section enable the pulse forms occurring at the EUT to be observed via normal oscilloscope inputs instead of having to use the symmetrical high voltage probes that would otherwise be necessary.

3.3   Operating elements and connections
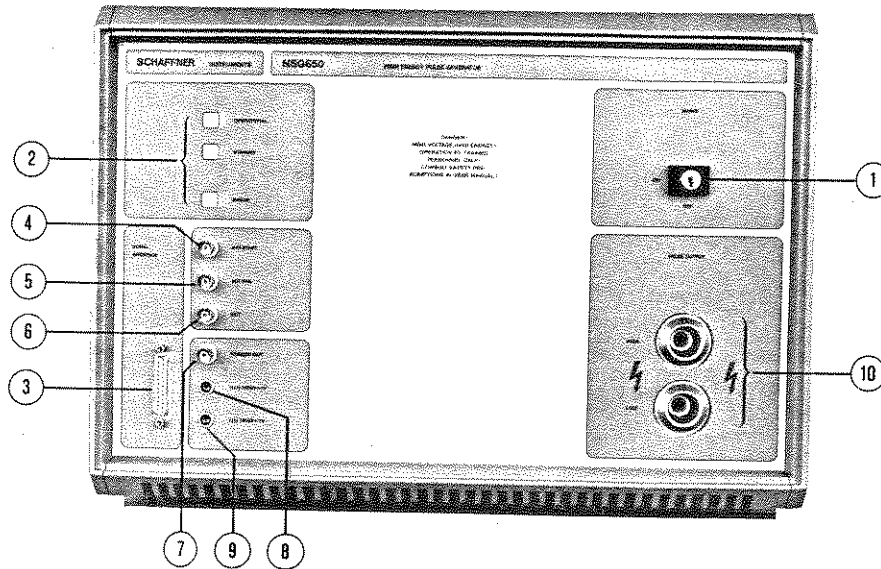
1   MAINS   Safety key-switch and mains on/off switch. The generator can hence only be activated by authorized personnel. The key can only be extracted in the OFF position. When it is switched ON, the generator goes into the STANDBY state while safety circuits prevent high voltage generation.

2   Generator status   Display field showing the status of the generator.

     OPERATIONAL   The generator has been switched to the active state. High voltage generation has been activated; i.e. pulses can be triggered. This state can only be attained through the TEST program menu.

     STANDBY   The generator is switched on and can communicate with the operating program. HV generation is not active.

                     The signals for these two indicators are also available in parallel at the interlock connector **12** for external warning lamps.

     ERROR   Indicates that the internal microprocessor has detected faulty operation in the instrument. A status message with error information also appears on the monitor screen.

3 SER. INTERFACE Socket (Cannon, 25p, neg.) for RS 232C connecting cable to the PC or another control computer. The NSG 650 is wired as a DCE so that a conventional RS 232C cable can be used. (25p to 25p or 9p to 25p, depending on the type of computer used). A dummy modem is not required.

In order to prevent disturbances from interfering with communications between the computer and the generator, a fiber-optic (opto-link) can be used instead of a cable.

Further information regarding the opto-link and the connector pin-out can be found in Section 4.2 and 8.2.

4 EXT. START BNC socket for the input of an external Start signal. This input has to be firstly activated in the PARAMETER SETUP menu.

The Start command for pulse generation or a whole sequence is triggered by applying a logic 0 signal. The input can hence be driven by either TTL or CMOS logic as well as by a mechanical contact.

5 EUT FAIL BNC socket for a status message concerning the EUT. If the EUT is capable of producing a suitable signal in the event of a failure occurring, that signal can be applied to this input to terminate the current test sequence. "nok" appears on the monitor screen (and in the print-out). See also Sections 4.7.3 and 4.7.5.

The function is activated by applying a logic 0 signal. The input can hence be driven by either TTL or CMOS logic as well as by a mechanical contact.

6 EOT End of test signal. The electrically isolated contact closes briefly once the chosen test has been completed.

Automatic batch testing can be achieved by making use of the EXT. START, EUT FAIL and EOT connections.

7 TRIGGER OUT BNC connector. Output for triggering an oscilloscope at the beginning of a pulse.

Accuracy:	$< 1\,\mu s$
Pulse width:	2 to $4\,\mu s$
V_p:	3 to 5 V
Load impedance:	> 10 kΩ

8   V MONITOR

Measurement output for the pulse voltage. The measuring circuit is electrically isolated from the pulse output and delivers a signal that is attenuated by a factor of 1:1000. The measurement is taken at the pulse output of the generator. A normal, asymmetric, high impedance CRO input can be connected to this output directly by means of the cable supplied.

9   I MONITOR

Measurement output for the pulse current. The measuring circuit is electrically isolated from the pulse output and delivers a proportional signal in the ratio of 1000 A = 1 V. The measurement is taken at the pulse output of the generator. A normal, asymmetric, high impedance CRO input can be connected to this output directly by means of the cable supplied.

10 PULSE OUTPUT

High voltage coaxial socket at which the pulse is output. Symmetrical, floating HIGH and LOW outputs via the inner conductors while the protective earth connection is via the screen.

The mating connecting plugs are component parts of the coupling networks (CDN 110, CDN 116 etc.). Plugs and cables are available as accessories for component tests, etc. (see Section 12).
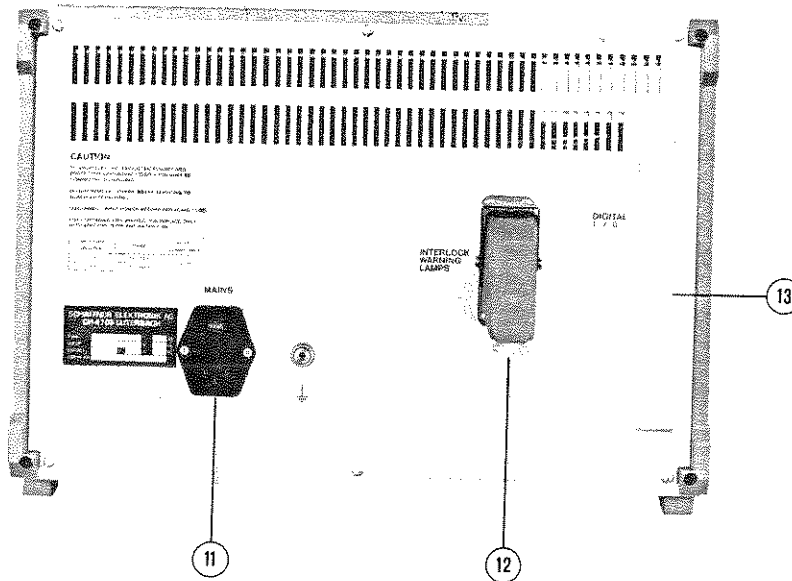
11 Mains input   Mains connector for powering the generator. A voltage selector for 115/230 Vac and a fuse are incorporated.
Fuse ratings: 115 Vac 2 A slow-blow
                 230 Vac 2 A slow-blow

12 Interlock   Plug and socket for the wiring of safety contacts and warning lights. The plug supplied with the instrument has a wire link inserted in the safety circuit. This has to be replaced by the actual safety contact in the final test rig (test hood, test enclosure, etc.).

When a coupling network is connected, this connector is needed for the extension of the safety circuit through the network. The NSG 650 will not work without the safety connector. See Section 8.5 for the connector pin-out.

13 Digital I/O   Cut-out for the optional circuit board with digital inputs and outputs. See Section 8.6 for a function description and technical details.

4   Operating concept

4.1   NSG 650 PC program

The software to run on the personal computer is a prerequisite for the operation of the NSG 650 and is hence considered to be an integral part of the instrument.

In place of a front panel with a wealth of control elements, the user is presented instead with a an operating surface on the computer screen which provides a considerably greater range of possibilities than knobs, buttons, switches and so on ever could, while enabling the test conditions and sequences to be input in a clear, unambiguous and error-free manner.

The NSG 650 PC program sends commands and parameters to the processor in the generator via the serial link and receives the results of measurements, status messages, etc. in return. The program supports and supervises the dialogue with the user. Non-valid parameter data and combinations of values are not accepted and erroneous operation is largely prevented.

The PC program does not have any direct control over the actual generation and triggering of the pulse itself. This is entirely the responsibility of the on-board microprocessor in the NSG 650. In this way, any faulty operation in the PC or disturbances on the data transmission link cannot lead to incorrect or dangerous operation on the part of the generator.

The programs

> NSG 650 OPERATING SOFTWARE and
> NSG 650 TRAINING SOFTWARE

supplied on the diskettes are for exclusive use with the SCHAFFNER NSG 650 Generator. It is forbidden to copy and give them to a third party for other purposes. The copyright is in the hands of SCHAFFNER ELEKTRONIK AG, in Luterbach, Switzerland.

The diskettes may be copied for backup purposes in connection with the operation of the generator. The diskettes are not copy-protected.

4.2   Hardware requirement

The following hardware must be available on the PC side for generator operation:

IBM PC (XT or AT) or a compatible computer
640 kB memory minimum
1 or 2 floppy drives or 1 floppy drive + 1 hard-disk
monochrome or colour monitor
keyboard
serial port, COM 1
printer (for protocol print-out)
operating system, DOS version 2.2 or later

The NSG 650 PC software has been structured in such a way that it will run perfectly satisfactorily even on the simplest system configuration without any limitations. Initialisation and the establishment of the display happens more quickly with an AT and the availability of a hard-disk adds to the general convenience but this does not otherwise affect the work with the generator at all. Use of only operating system routines for inputs/outputs, etc. has been strictly observed to ensure that the program will run on all 'compatibles', but especially on lap-tops.

The program is available on two different diskette formats:

5¼", DS/DD, 360 kB
3½", DS/DD, 720 kB

When the program is started, it investigates the screen driver that has been installed and then automatically sets up the corresponding b/w or colour presentation.

Command and data inputs for operating the generator are entered via the keyboard. A mouse is not supported.

The standard serial I/O port, COM 1, is used for the link to the NSG 650; all the necessary connections being made through any commercially available RS 232 cable. (The NSG 650 is set up as a DCE and hence a dummy modem is not required). The program automatically sets the COM 1 port to the correct settings (Baud-rate, parity, stop-bits, etc.).
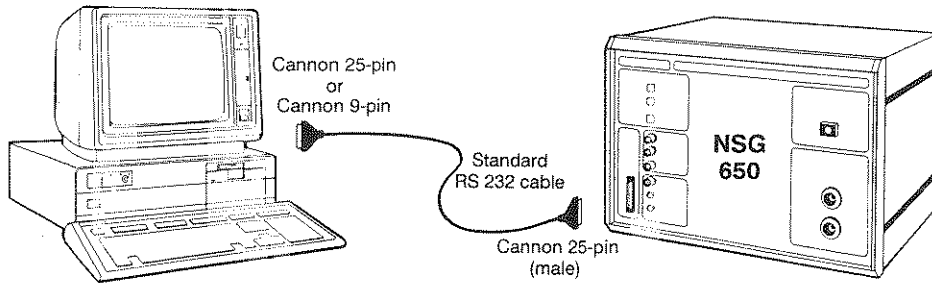
An optical link to the PC can also be used to prevent disturbances on the transmission path and hence in the computer system caused by pulse voltages in the test rig.

The opto-link type INA 301 electrically isolates the PC system from the test rig. Power for the electro-optical converter is obtained directly from the data lines in this model so that no supplementary power pack is necessary.
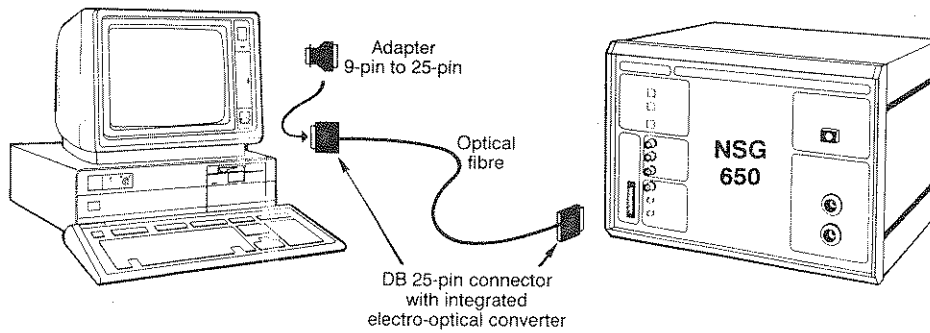
Some PCs, especially some of the lap-tops, do not supply enough power at the serial port to feed the converter as well. In such cases an opto link type INA 303 or INA 304 has to be used which is equipped with an external power supply unit at the PC end. The NSG 650 supplies power for these models via the 25-pin connector.
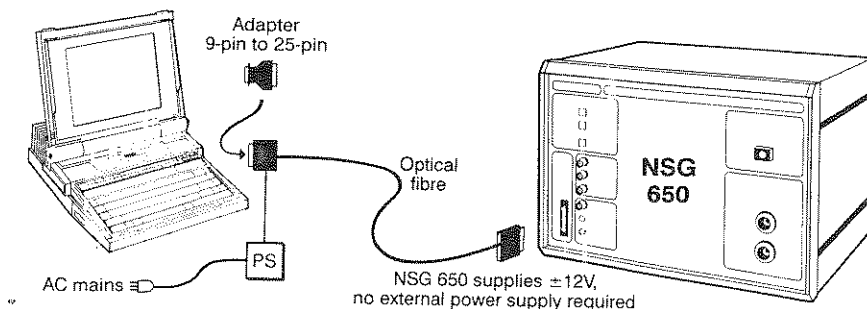
Operation of the opto-link with a computer having only a 9-pin COM 1 connector requires the use of a conventional adapter as shown on the right:

Technical details concerning the port can be found in Section 7.
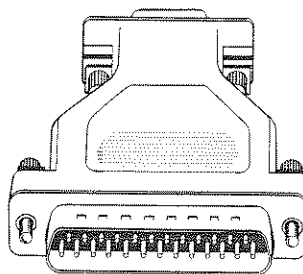
A printer is necessary to print out the test programs and data. The NSG 650 PC program utilises the DOS-routines as a printer driver; the print-out presentation conforming to the default settings of the printer concerned.

4.3   Training software

The instrument is delivered with two program packages on 5¼" as well as on 3½" diskettes:

NSG 650 TRAINING SOFTWARE
NSG 650 OPERATING SOFTWARE

The training software enables operation of the NSG 650 Generator to be simulated without the need for the instrument to be present or having to be connected. Responses from the instrument, status signals and measured data are replaced by calculated standard values. In all other respects the program behaves just as the operating software would do so far as operation and reactions are concerned.

This enables the user to practice working with the generator but without producing the high voltage pulses or having to have a safe test rig at his disposal.

The program can, however, be of even greater assistance. All the test sequences and files that are created have the same structure as those produced by the actual operating program. This means that test programs, protocol forms, test sequences, etc. can be created off-line in an office for subsequent transfer to the system proper by means of a diskette for example. Conversely, test result protocols can be handed back to the office for further processing.

This complete compatibility between the TRAINING SOFTWARE (off-line) and the OPERATING SOFTWARE (on-line) offers the additional advantage that the test programs can be created by specialists for use on the factory floor by operatives who only need to be instructed in the safety aspects and a few simple operations to start and stop a test procedure.

4.4   Operating software

The NSG 650 OPERATING SOFTWARE is the operating program for the generator itself. All of the functions that concern the NSG 650 are only able to work if the generator is correctly connected to the PC and is switched on at both the mains and the key switch. (Otherwise the program finds that responses and communications signals are missing which would lead to error messages being produced.

Attention: This program should only be started and be put into use if all the necessary safety precautions for the operation of the generator have been taken.

4.5   Installation

This section details the procedure for installing the program on the relevant computer system. Other forms of installation are also possible, depending on the need and to suit specific working methods. Further information can be found in the DOS manual for the PC concerned in such cases.

> *Caution:*   To prevent data loss, file corruption and, above all, the introduction of a virus, the write-protect sticker should never be removed from the original diskettes.

Installation on a system with two floppy drives:

- Prepare a work-copy of both the original diskettes (NSG 650 TRAINING SOFTWARE and NSG 650 OPERATING SOFTWARE), e.g. with:

        A:> **diskcopy a: b:**

or, if the two diskettes have differing formats:

        A:> **copy a:*.* b:**

- Carry on working only with the work-copies. Besides the programs themselves (NSG650TR.EXE and NSG650.EXE), these diskettes will also carry all the files with the standard values for the parameters, protocol inputs, etc.

- The programs are started with the call:

        A:> **nsg650tr**   for the TRAINING version, or

        A:> **nsg650**   for the OPERATING version

Installation on a system with a hard-disk:

- If both the training software and the operating software are to be installed on the same hard-disk, it is advisable to store them in two different directories since only the main programs (NSG650TR.EXE and NSG650.EXE) differ from one another not, however, the rest of the files which are present on both diskettes.

- Hence, create the directory C:\TRAIN by typing:

    C:> md train

and copy the complete content of the NSG650 TRAINING SOFTWARE diskette into this directory with:

    C:\TRAIN> copy a:*.* c:

- Create another directory, e.g. C:\NSG650 by typing:

    C:> md nsg650

and copy the complete content of the NSG650 OPERATING SOFTWARE diskette into this directory with:

    C:\NSG650> copy a:*.* c:

- Starting from the correct directory, the respective programs are started with the commands:

    C:\TRAIN> **nsg650tr**　　for the TRAINING version, or
    C:\NSG650 **nsg650**　　for the OPERATING version.

Note:　Refer to the DOS manual to find how batch files can be created to call the programs directly from the operating system.

The program automatically configures the COM 1 port each time the program is started and adapts to the display and printer-drivers that are present.

Some lap-tops emulate colour displays by means of a range of grey-scales but with rather poor contrast. In such cases, the system command:

    > MODE BW80

often gives a better black/white presentation. This command can be incorporated in the batch file.

4.6   General operation

The training and preparation program NSG 650 TRAINING SOFTWARE and the operating program NSG 650 OPERATING SOFTWARE behave identically as far as the way that they are used and the screen displays are concerned. The following description thus applies to both programs.

The NSG 650 PC program is configured on a menu-driven structure. The various screen masks are based on a uniform concept for both presentation and use.

Typical screen presentation:
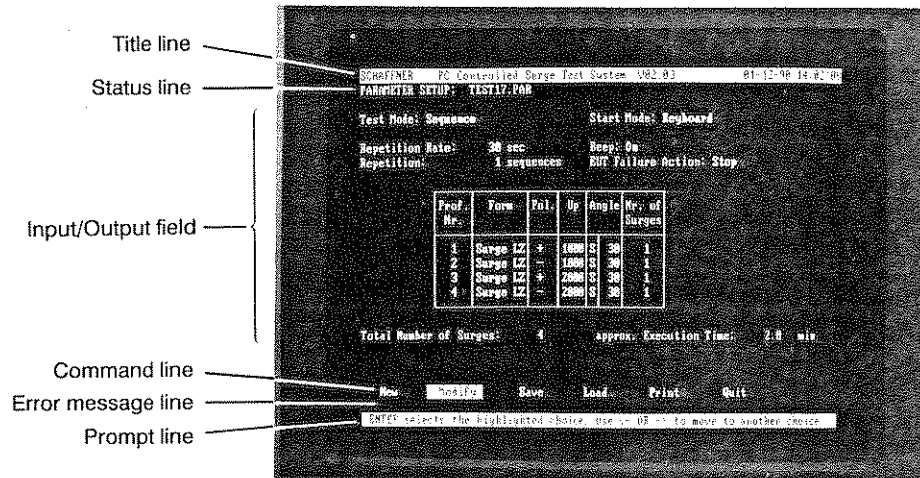
Title line:	Program name and version number
	Current date and time (taken from the system)
Status line:	Active menu
	File name
	Generator status message
I/O field:	Fields for inputting commands
	Display of the value that has been set, or measured value
Command line:	Summary of commands applicable to the current menu
Error line:	Shows any system errors
Prompt line:	Informs about the input possibilities corresponding to the position of the cursor.

Keyboard inputs

The various input fields accept only entries that are meaningful to them, e.g. only the keys from 0 to 9 for numerical fields and only the switching function with the 'SPACE' bar for selection fields.

Selected menus, commands, toggle fields and data fields are highlighted. The prompt line gives information about logical keyboard entries for the relevant field in each case.

Key-functions

Cursor keys PgUp/PgDn TAB	< / > / ∧ / ∨	Move the cursor from field to field Page up / Page down
Enter key	ENTER or CR	Executes the selected menu or the command selected in the command line
Space bar	SPACE	Toggling or scrolling in the corresponding fields through the range of possibilities offered (e.g. Test mode single → Increment voltage → Increment angle → Sequence → Single)
Escape	ESC	To leave the input/output field and return to the command line
Number keys	0...9	To input numerical values in the foreseen fields
Letter keys / special characters		Only accepted in editing fields (e.g. giving a file name, text fields in the JOURNAL menu)

Further key-functions that are only active in special cases are described in the corresponding menus.

4.7   Menus

4.7.1 Structure

When started, the NSG 650 PC software is loaded into the memory of the computer and reports on the screen with a start-display. The menu-structure of the program is displayed when the ENTER key is pressed.
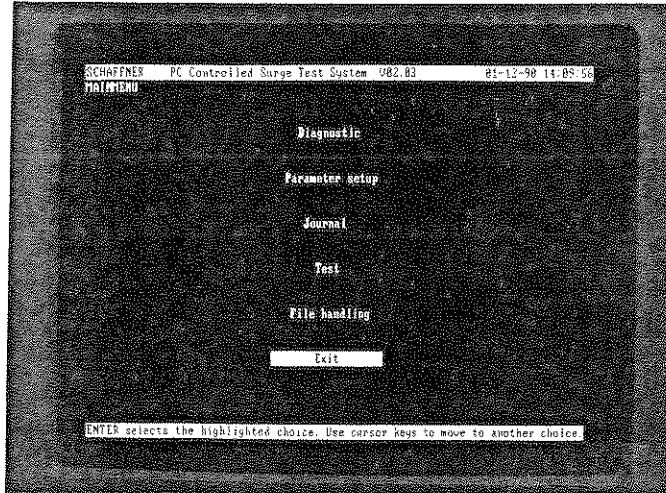
Branches can be made from this main menu into the sub-menus and from these back into the main menu again to select the next menu item.

Selection of the individual menus is made by using the cursor keys with the execution of the choice being performed by the ENTER key. Alternatively, the initial letter of the sub-menu can be entered to execute it.

The sub-menus are listed in the order in which they are normally required although they are hierarchically all on one level and the observance of a particular order is not necessary.

The EXIT command closes the program properly and returns the computer to the DOS level.

4.7.2   Diagnostics

A self-test on the NSG 650 Generator can be carried out at any time through the DIAGNOSTIC menu.

The self-test mainly checks the integrity of the processor part of the generator together with its memory.

In normal cases the status line reports: NSG 650 - Status **ok**

The instrument should be handed back to the responsible SCHAFFNER Service Centre in the event of a fault being reported instead.

The self-test also outputs statistical data. The number of times a pulse has been triggered is listed in groups according to the voltage range for the two pulse types. This information is taken from a non-volatile memory in the NSG 650 processor and indicates the total since the set-up of the instrument at the factory.

A jump back to the main menu can be made with **Quit**.

4.7.3 Parameters

The test or test sequence to be carried out is programmed in the Parameter menu.
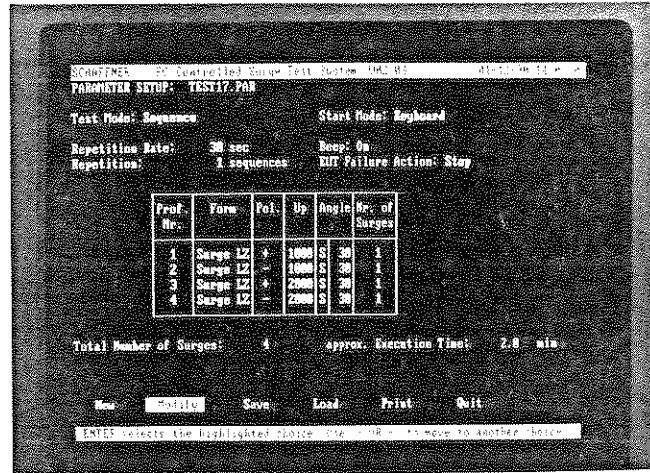
When this menu is called up, the computer automatically loads a default set of parameters: DEFAULT.PAR. (The values loaded are those that were last saved under this file name).

Selecting New in the command line causes the cursor to jump to the Input/Output field so that new test conditions can be set up in the "test mode" field. Use the space bar to scroll through the various modes possible, thus:

Single	Single test pulse
Increment voltage	Sequence with incremented test voltage
Increment angle	Sequence with incremented phase angle
Sequence	Freely programmable set of test profiles

The input masks change according to the mode that has been set. Input fields are only displayed if they are logical and usable in the selected mode.

An unacceptable entry is rejected by the program. A message line displayed at the bottom of the screen shows the range of possible values.

The cursor can be moved around amongst the other input fields by means of the cursor keys, thus:

Start mode

Flips between 'Keyboard' (pulse triggering via the keyboard of the PC) and 'External' (pulse triggering by means of an external contact).

Beep

Flips between 'On' (gives a warning tone before each pulse is triggered) and 'Off' (no acoustic warning).

EUT failure action

Defines the behaviour of the instrument in the event of a failure in the EUT. A choice of 'Stop' (breaks off the test) and 'Continue' (carry on with the test sequence) is provided.

Repetition rate

Numerical input in seconds to define the pulse repetition frequency (minimum = 10 secs., maximum = 10000).

Repetition

Numerical input defining the number of times that the entire sequence should be executed (minimum = 1, maximum = 1000).

Parameter input in "Single" mode
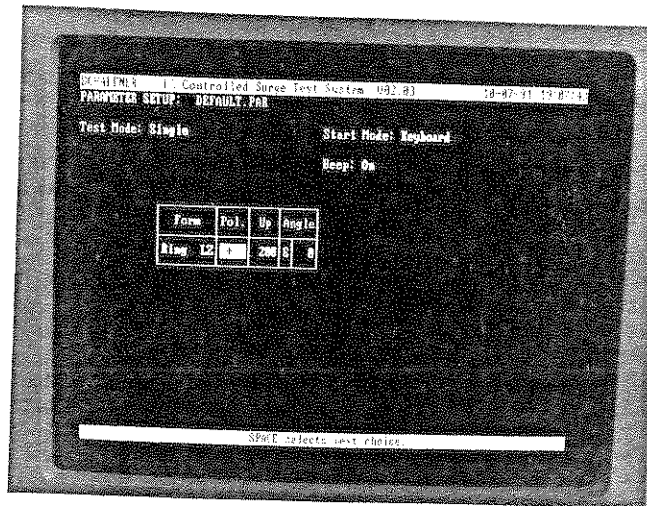
Form: Scrolls through the various pulse forms when the space bar is pressed:

Surge LZ 1.2/50 μs pulse with low dynamic impedance (2 Ω)

Surge HZ 1.2/50 μs pulse with raised dynamic impedance (12 Ω)

Ring LZ   0.5 μs/100 kHz damped oscillation
with low impedance (12 Ω)

Ring HZ   0.5 μs/100 kHz damped oscillation
with greater impedance (30 Ω)

Pol: Selected pulse polarity (+ / -)

Up: Numerical input for the peak pulse voltage
(minimum = 200 V, maximum = 6600 V)

Angle: Pulse injection phase angle relative to the zero-crossing point.
A/S selection field:

A : Asynchronous. True stochastic coupling.
S : Synchronous to the mains.
Data field : Numerical indication of the phase angle in degrees
(minimum = 0°, maximum = 359°)

Additional features in the "Increment voltage" mode:
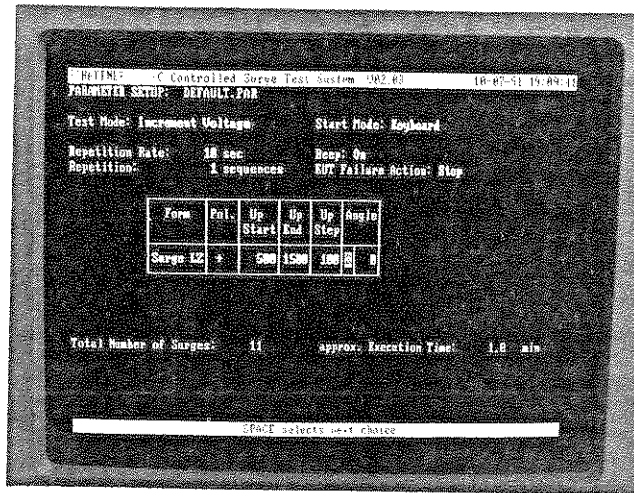
Up Start: Starting value of a test sequence with
                        increasing voltage.

Up End: Voltage at the end of the test sequence.

Up Step: Incremental step voltage.

                        If the 'Up Step' is not an integer divisor of the difference
                        Up End - Up Start, the test sequence is terminated after
                        the last integer increment of Up Step, i.e. Up End can
                        never be exceeded.

Total number of surges: Display field in which the computer writes the number
                        of test pulses derived from 'Up Start', 'Up End', 'Up Step'
                        and 'Repetition'.

Approx. execution time: Display field in which the computer writes the execution
                        time for the whole test sequence based on the 'Total
                        number of surges' and the 'Repetition rate'.

Additional features in the "Increment angle" mode:
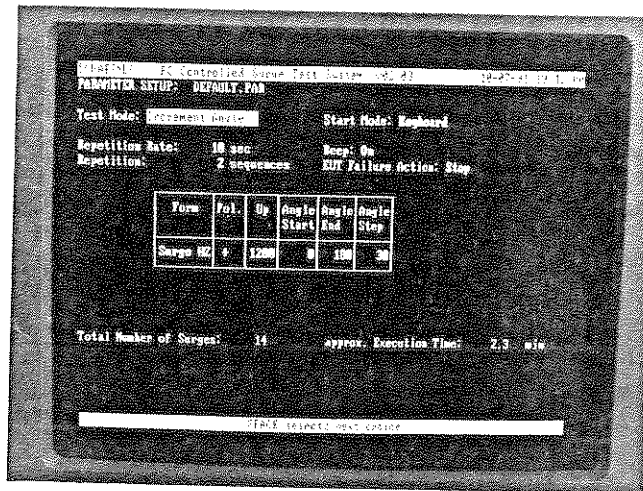
Angle Start: Starting value for a test sequence with a fixed test
                          voltage and increasing phase angle.

Angle End: Final value of the injection phase angle.

Angle Step: If the "Angle Step" is not an integer divisor of the
                          difference Angle End - Angle Start, the test sequence is
                          terminated after the last integer increment of Angle
                          Step, i.e. Angle End can never be exceeded.

Total number of surges: Display field in which the computer writes the number
                          of test pulses derived from "Angle Start", "Angle End",
                          "Angle Step" and "Repetition".

Approx. execution time: Display field in which the computer writes the execution
                          time for the whole test sequence based on the "Total
                          number of surges" and the "Repetition rate".

Additional features in the "Sequence" mode:
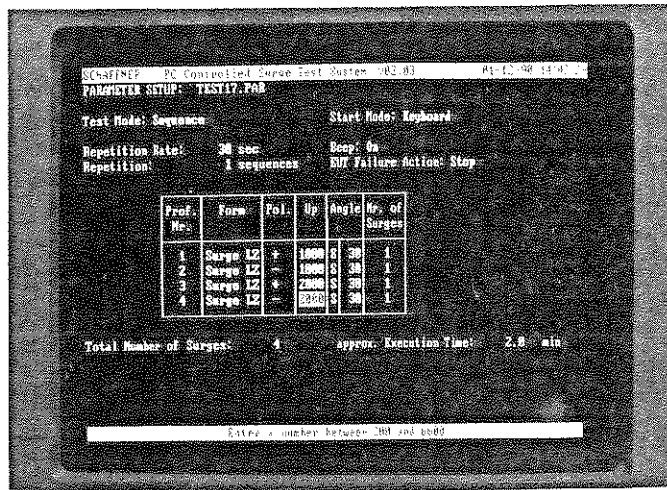
This operating mode enables arbitrary sequences of test pulses to be programmed with a wide variety of pulse types, polarity, voltage and injection angle.

The definition of a single pulse is referred to as a profile and the combination of various profiles gives the test sequence.

Prof. No.:   The various profiles are automatically numbered sequentially. (One line corresponds to a complete pulse profile).

Use the "INS" key to make way for a new profile between two existing ones or to start at the end of a new profile. In each case the values contained in the previous line are copied down into the new one where they can then be altered as required. This is a practical feature since, in the majority of cases, only one value changes from profile to profile, e.g. the polarity or voltage.

Use the "DEL" key to delete the line on which the cursor is positioned.

Moving the cursor around in the table and scrolling is achieved with the cursor and PgUp/PgDn keys.

No. of surges: The numerical entry made for each pulse profile defines how often that pulse is repeated before the program executes the next pulse profile.

Total number of surges: Display field in which the computer writes the total number of test pulses in the sequence derived from the number of profiles x the number of pulses per profile x "Repetition".

Approx. execution time: Display field in which the computer writes the execution time for the whole test sequence based on the "Repetition rate".

The input/output field is exited with "ESC" and the cursor jumps back to the command line.

The test program can be backed-up in the current directory by means of the Save command. The computer asks for a file name which, in keeping with DOS convention, can consist of up to eight characters. Special characters and spaces should not be used. The extension, .PAR, is added automatically by the software.

The current data-file can be printed out with the Print command. All the profiles are listed, of course, not just the four lines that are shown at any one time on the screen.

Load brings all the parameter data files in the current directory onto the screen. (Scrolling with the cursor or PgUp/PgDn keys). Pressing ENTER loads the chosen file which then becomes the active parameter set-up.

Use the Modify command to jump into the input/output field in order to alter an existing set-up. The manner in which it works is similar to New. The amended parameter settings can either be stored under the same name (by over-writing) or as a new file with a different name according to need.

A return to the main menu is made with Quit. The current parameter settings are maintained and are automatically transferred into the test menu.

4.7.4 Journal

The measurement report print-out is prepared in the journal menu. This menu item can be jumped over if no print-out is required.
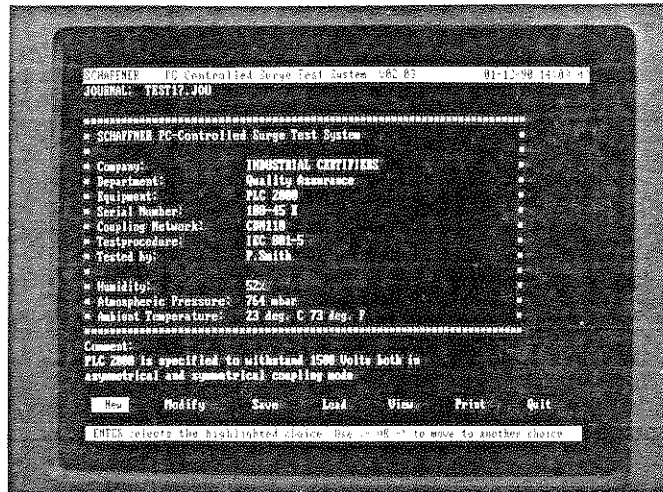
The print-out has a header that contains a number of pieces of information that describe the conditions under which the test has been carried out.

The leading frame contains a summary of information that belongs in the definition of a test report such as company identification, EUT, test procedure, ambient conditions, etc.

Below this is a field for remarks which can be used like a text editor or a text processor to add further details about the test to the report. The length of the remarks is limited only by the amount of memory space available.

A default screen (DEFAULT.JOU) is displayed by the computer when the menu is called up; the values given being those that were last stored under this name.

The cursor can be made to jump into the report frame by activating New in the command line after which the various predefined fields can be completed.

Use ESC to leave the input/output field and bring the cursor back into the command line. Executing the Save command stores the report text file in the current directory for which the computer requests a suitable file name. This can consist of up to 8 characters in keeping with the DOS-convention. Special characters and spaces should be avoided. The .JOU extension is added by the software automatically.

The current report can be printed out with the Print command. After a test run with data logging, the printout also contains the test data that has been stored.

The Load command brings a list of all the reports that are in the current directory onto the screen. Use the cursor keys or PgUp and PgDn to scroll through the list. Press ENTER to load the selected file which then becomes the current journal.

Use the Modify command to enter the input/output field to change an existing item. The function is similar to New. The modified text can either be stored under the same file name (over-writing) or be stored separately under a new name.

View brings the current journal onto the screen. This function shows the whole content of the report including data that has been recorded during one or more test runs. Use the cursor keys or PgUp and PgDn to scroll through the whole report. No text changes can be made in the View mode. If the current journal has not yet been put through a test run to have test result data added to it, a message saying "No measurements available" appears on the screen.

Use Quit to return to the main menu. The current journal is kept and is automatically transferred to the test menu.

Three different files relating to the journal are stored in the current directory automatically by the program. The three files all have the same, chosen name, (such as TEST1) but differ in the extension that is added by the program, thus:

TEST1. JOU	is the control-file for creating the journal
TEST1. JO1	contains the measurement data
TEST1. PRN	is a print-file which contains the whole journal,
	i.e. report header, text field and measurement data.

The files with the extension .JO1 and .PRN are pure ASCII files and can therefore be read and further treated in any editor program (under DOS or a utility program such as PC-Tools or Norton Commander) or, even better, in any text processing program (such as MS-Word, Framework, Wordstar, etc.). If a journal has to be removed from the data storage medium, care should be taken to delete all three files with the same name. The same remark applies to copying a journal to another directory or storage medium.

The special status of the journal-files DEFAULT.JOU, DEFAULT.JO1 and DEFAULT.PRN:

The DEFAULT files are needed by the system in order to start up correctly. DEFAULT.JOU is called by the JOURNAL menu upon each new start and remains active until another journal is loaded (Load) or until the initial journal is renamed. The DEFAULT file only ever stores the latest activity, however, i.e. the results of several test runs are not kept. The DEFAULT file should therefore **not** be used as a work-file. (Save with a new name after creating each New journal).

4.7.5 Test

The prepared test is run in the test menu. The pulse or pulse sequence defined
in the foregoing preparatory steps is sent with the correct timing to the generator
for execution. There is no way of altering the pulse or control parameters from
within the test menu.

At the top left the screen shows the name of the current parameter-file. This is
followed by the important basic settings and then, in the table, the parameters of
the first test pulse. The layout of the table corresponds to the operating mode
chosen in the parameter menu.

The cursor jumps to the "Journaling: Yes/No" field when Test is selected (Yes/No:
toggle function with the space bar). A decision can be taken here regarding
whether reporting is required or not. Even in the case of a correctly prepared
journal, prevention of the recording of pulse results can sometimes be useful
such as for checking out the test rig.

The name of the current journal is displayed. If necessary, another journal can be
called up in this field for the storage of the measurement data. The chosen journal
must, of course, exist and be available from the current drive. If this is not the case,
the test run cannot be started and an appropriate error message is displayed.

The settings for the test run are completed by setting the field "Do you want
to start the test" to "yes" (toggle with the space bar). Up to this moment the
generator is in the "Standby" state, that is, the high voltage circuit cannot in any
way be activated.

As a final safety measure, the input of the key combination CTRL-G is now requested. This then starts the test run or the automatic sequence of pulses. (Unless the "Start mode" has been set to "External" whereby the generator also waits for an external start command or the interlock safety circuit has not been closed in which case the test is prevented and a relevant error message appears on the screen).

Pressing **ANY KEY** stops the test immediately and sets the generator back to the "Standby" mode.

A test run can be interrupted with the key combination CTRL-I. Although this puts the generator back into the "Standby" state, the test routine can subsequently be continued again by entering CTRL-G. Opening the interlock safety circuit during a test run has the same effect as entering CTRL-I.

A return is made to the command line while inputting commands by means of ESC, by breaking off or terminating the test run according to the display by the program through pressing ENTER.

Use **Q**uit to return to the main menu.

4.7.6 File handling

The "File handling" menu enables the user to administer his files without having to leave the program to manipulate the files at the DOS level.

The functions available help to maintain order in the various test files and enables them to be copied to other directories or storage media for archiving purposes.

The first 15 of the files available in the current directory are shown on the screen. After executing a command from the command line and jumping into the data field, further files (provided that they are available) can be brought up on the screen by means of the cursor keys and PgUp/PgDn. The highlighted file is the one that is processed in each case.
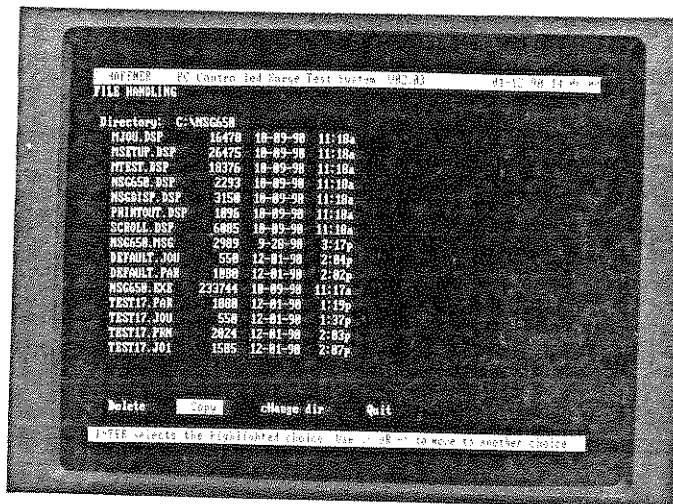
The following files, at least, are in the NSG 650 PC software:

NSG650	.EXE	NSG650 PC-program
MSETUP	.DSP	
MTEST	.DSP	
MJOU	.DSP	
SCROLL	.DSP	
MDIAG	.DSP	DSP files are needed by the program for
MFILE	.DSP	screen presentations.
NSGDISP	.DSP	
NSG650	.DSP	
PRINTOUT	.DSP	
NSG650	.MSG	Screen messages from the program
DEFAULT	.JOU	Start-file for the journal
DEFAULT	.PAR	Start-file for the parameter mask

All these files are needed by the program and must therefore not be deleted.

Files created by the user which can be manipulated as required (copying, renaming, deleting) carry the following extensions:

XXX .PAR   Parameter file
XXX .JOU   Journal control file
XXX .JO1   Measurement data for the journal
XXX .PRN   Print data for the journal

Delete   Deletes the specified file. Confirmation is requested for safety's sake.

Copy   Copies the specified file to another directory or drive, or duplicates the file under another name.

The instruction sequence that has to be given must follow the DOS-convention rigidly, i.e. drive, path, file name including the extension of the target file.

The greatest benefit of the copy function is to assemble parameter files and journal files that belong together onto a floppy disk that can then be stored separately.

cHange dir Enables a change to be made to another directory. The latter must be on the same drive as the NSG 650 program and must have been created previously. (It is not possible to change the drive).

The instruction sequence follows the DOS-convention strictly, i.e. the path must be defined as for the DOS "CHDIR" command.

To maintain order, it is recommended to create sub-directories for the acceptance of user-files and to change to the appropriate one immediately after starting the NSG 650 program. This prevents the system files from becoming mixed with the test program files. This operation can, of course, be accomplished automatically with a suitable batch file.

5   Measurement technique

5.1   General

High voltage pulse measurements fall into a specialist field which requires not just a fair amount of experience but also expensive equipment that is not commonly found in the average laboratory.

The NSG 650 generator contains measuring circuitry for comparative measurements which both relieves the user from the task and simplifies the whole matter.

Auxiliary equipment used in such tests and the test rig itself can, however, make the measurements only relative so that the measurement results cannot be taken as absolute values but rather necessitate a certain amount of interpretation.

Measurements of voltage and current are taken at the high voltage output of the instrument. Within the framework of the given measurement tolerance, these figures thus represent real values at the device under test assuming that this is connected to the pulse output in such a way that cable losses and other effects can be neglected.

Generally speaking, this is true for component tests (varistors, gas-filled surge suppressors, etc.).

If further elements, e.g. coupling networks and non-defined cabling, are installed between the generator and the device under test then the values measured can no longer be taken to be the actual values at the test object. The impedances of the coupling elements and stray losses will correspondingly affect the results.

In spite of this, the results obtained can nevertheless be accepted as relative values. They enable comparative measurements to be made between various test objects and, especially, they show quite unmistakably any critical thresholds and the behaviour of the test object. Surge tests typically show up effects such as an electrical breakdown or arcing at a particular test voltage.

5.2   Peak value measurements

The pulse peak values of voltage (V_p) and current (I_p) are measured at the output of the generator, digitized by the instrument itself and displayed as a numerical value on the computer screen during the test procedure as well as being logged in the test report.

Even with the generator output not connected to anything, a peak current value of several Ampères can be recorded which is due to pick-up disturbances in this high impedance situation. This disturbance is eliminated when a network and/or test object is connected and hence the measured value will not be falsified.

A current can be measured when operating the generator with a network, even if no test object is connected. This is a true, voltage-dependent current which is caused by the suppression elements in the mains filter. In principle, this open-circuit current should be subtracted from the value measured with the test object. In practice, however, the "error" is usually negligible.

5.3   Measurement monitor

The signals for the voltage and current monitors are taken from the pulse output but are electrically isolated by converters before being fed to the monitor outputs. These can be connected to the high impedance asymmetric inputs of an oscilloscope via the cables supplied which contain filtering elements.
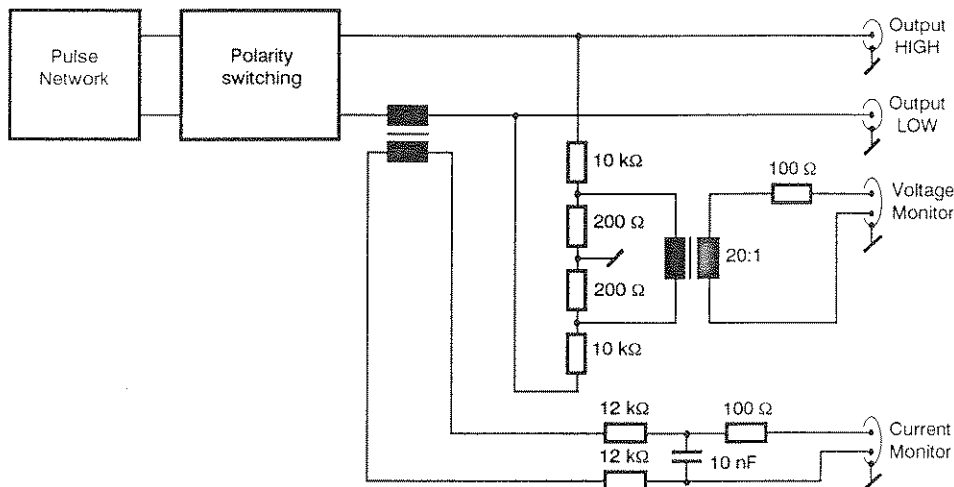
Technical specifications of the V MONITOR

Connection:	Use the cable supplied.
	BNC connector at the oscilloscope end
Attenuation:	1:1000
Accuracy:	± 5%
Load impedance:	> 10 kΩ

Technical specifications of the I MONITOR

Connection:	Use the cable supplied.
	BNC connector at the oscilloscope end
Attenuation:	1 V = 1000 A
Accuracy:	± 5%
Load impedance:	> 10 kΩ

A trigger is produced to synchronize the oscilloscope at the start of the pulse.
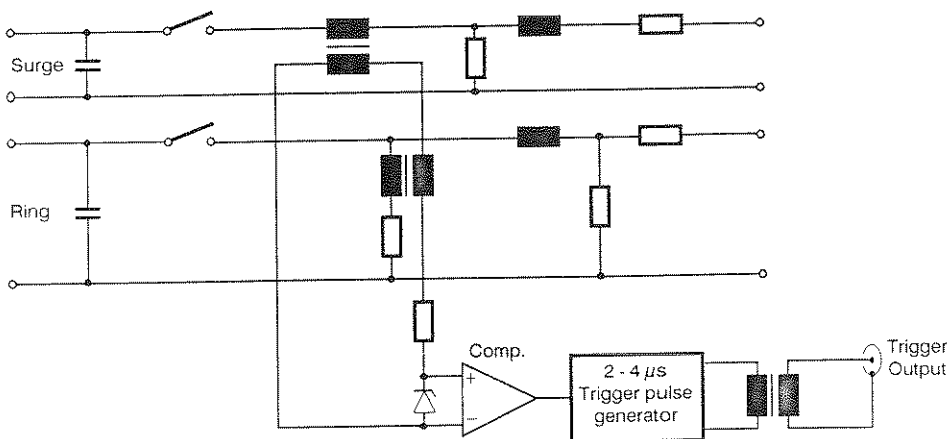
Technical specifications of the TRIGGER OUT

Connector:	BNC
Accuracy:	< 1 μs
Pulse width:	2 to 4 μs
V_H:	3 to 5 V
Load impedance:	> 10 kΩ

5.4 Phase angle

A phase-angle detector ensures that the pulse can be superimposed on the mains supply at the programmed phase angle. The mains input to the NSG 650 is taken as a reference so the supply to the equipment under test should be taken from the same phase.

The programmed phase angle represents an average value. The individual pulses are distributed about this value in a roughly Gaussian distribution with the following maximum spread:

SURGE	up to 4 kV:	± 15°
	over 4 kV:	± 25°
RING	up to 2 kV:	± 15°
	over 2 kV:	± 30°

An external reference input can be added to the NSG 650 if the phase of the EUT supply is not identical with that of the generator supply (and the difference cannot be compensated by the computer).

This modification may only be incorporated by a SCHAFFNER Service Center.

6 Operation

6.1 Installation

The following checks should be carried out before the instrument is installed for the first time or after it has been transported or had significant changes made to the associated test rig:

- Inspect the instrument as well as all the accessories and check for any transport damage. Any such damage that is found must be reported immediately to the transportation company.

- Check the setting of the voltage selector and the rated value of the fuse. Adjust the voltage selector if necessary to conform with the local mains supply:

- Set to 230 V: for mains supplies with a nominal value of between 220 Vac and 240 Vac, 50/60 Hz.
  Fuse: 2 A, slow-blow, 5 x 20 mm

- Set to 115 V: for mains supplies with a nominal value of between 100 Vac and 120 Vac, 50/60 Hz.
  Fuse: 2 A, slow-blow, 5 x 20 mm

- To change the fuse or to set the voltage selector, release the cover on the combi-connector with a screwdriver then hinge it out. Extract the drum of the voltage selector then replace it in the correct position.

- Allow the instrument to dry out thoroughly before installing it should any condensation have occurred.

- Operate the instrument only in a horizontal position

6.2 Operation

The safety measures given in Section 2 are to be rigidly observed when operating the generator type NSG 650 or any of its accessories. Particular attention is drawn once again to matters concerning personal safety, cabling, **earthing** and disturbance in nearby installations.

When using coupling networks and additional system components, the safety precautions contained in the relevant operating instructions must be followed.

Coupling networks and connections to test enclosures and similar items must be correctly connected before the generator is switched on.

Earth leakage circuit breakers cannot be used in the mains supply as they will trip immediately because of the additional leakage current in the coupling elements.

The requirements concerning the control computer, the installation of the software and the handling of the diskettes are all described in Section 4.1 onwards.

6.3   Tests

6.3.1 Component tests

Component tests are defined as those carried out on individual elements without the pulses being superimposed on a mains supply. The differential concept of the generator is not utilized for such work. For the sake of simplicity, the LOW output is short-circuited to earth and the component to be tested is connected between the core and screen of a coaxial cable.
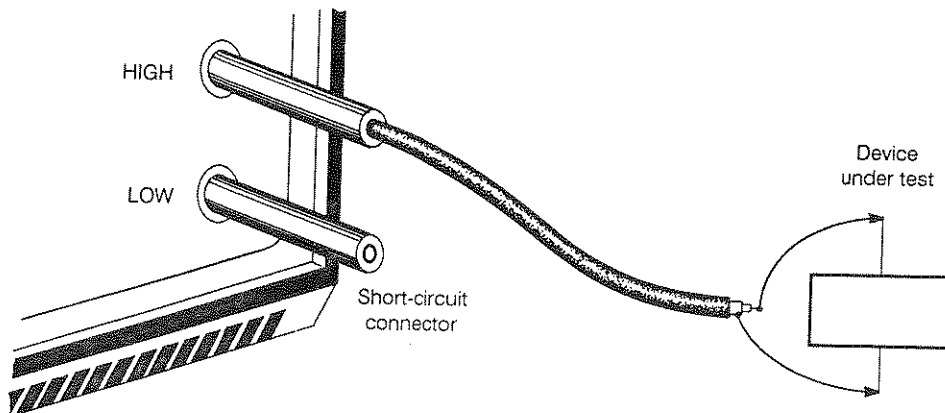
A certain amount of care is needed with the wiring of the HV connectors. Once the connector has been taken apart, the plastic safety cap has to be removed and put safely aside. Prepare the cable as shown in the diagram and make sure that the pre-tinned central conductor protrudes a few mm through the solder sleeve. Flow a sufficient amount of solder carefully into the sleeve to make a good connection to the core of the cable while preventing any solder from coating the outside of the

sleeve (otherwise the plastic cap cannot be re-mounted correctly). Trim the central conductor back so that it is flush with the edge of the insulating tube. Replace the plastic cap.

A short-circuit connector can be made by using a length of suitable diameter multi-strand wire soldered into place as above with its tail-end fanned out over the cone of the earthy outer sleeve.
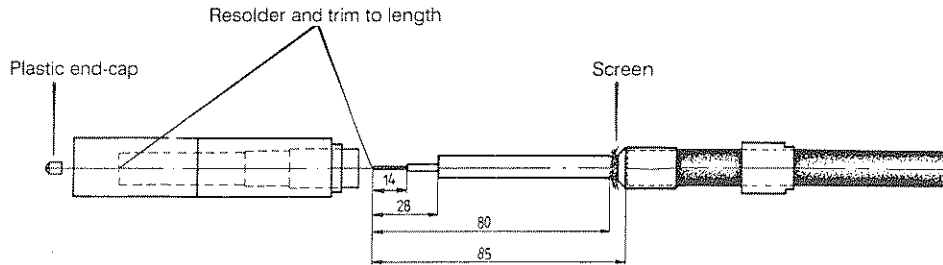
See Section 8.5 for details of the wiring of the interlock connector.

The construction of complete and safe test rigs is simplified by the use of accessories such as connectors, cables, test enclosures, warning lamps, etc. as listed in Section 12.

6.3.2 With coupling network CDN 110

The surge voltage coupling network type CDN 110 serves to inject the pulses into a mains feed for tests on instruments and systems. It conforms to the Standards and Recommendations IEC 801-5 (1991), prEN 50082, ANSI-IEEE C62.41, VDE 0109, etc.

The requisite coupling modes and test parameters can be found in the relevant standards and test specifications.

The CDN 110 is supplied with the matching connectors for connection to the NSG 650. All the cable links must be correctly connected before the test system is switched on.

The NSG 650 safety circuits are looped through the coupling network. After connecting the two units together, the interlock plug from the NSG 650 must be inserted in the socket on the CDN 110 to complete the circuit. Wiring of the safety contacts can be found in Section 8.5.

Further details can be found in the documentation relating to the CDN 110.

6.3.3 With coupling network CDN 116

The coupling network type CDN 116 enables surge voltage tests to be carried out on signal, data and control lines. It conforms to the requirements of IEC 801-5, prEN 50082-2, etc.

The CDN 116 is equipped to work with one pair of conductors. A number of CDN 116's can be linked together to cope with multi-core cables.

The pertinent test parameters can be found in the relevant standards and test specifications.

All the cables must be correctly connected before the test system is switched on.

Interconnection cables to mate with the NSG 650 and CDN 116 are available as accessories.

Further details can be found in the documentation relating to the CDN 116.

6.3.4 With other coupling arrangements

If the user's own coupling equipment is to be used this must be fitted with the correct connectors and cables. Suitable material is listed in Section 12.

Great attention must be paid to the wiring of the safety circuits in order to ensure that the safety philosophy implemented in the concept of the NSG 650 is not degraded in any way.

See Section 8.5 for the wiring of the safety contacts.

7   Communications-protocol

A user, who operates the generator with a PC and the software supplied, does not need to concern himself with the details of the information flow through the interface.

Knowledge of the communications-protocol is only necessary if:

> The NSG 650 is to be integrated software-wise into a whole system concept.

> Another, non PC-compatible control computer is to be used.

> Special software is to be written for a particular application.

> Single commands are to be transferred to the generator from an ASCII-terminal.

The specification of the protocol, the command structure, error messages, etc. can be found in a separate publication:

<div align="center">

NSG 650
Communications-protocol

</div>

8   Input /output connections

8.1   PULSE OUTPUT

NSG 650 housing   Switches shown in the idle position ⏚ PE
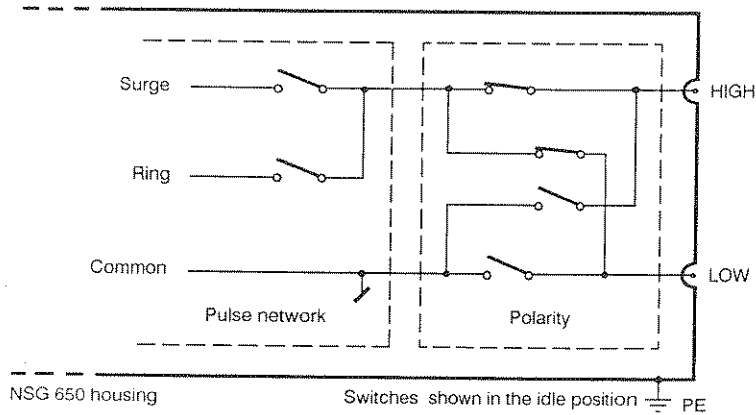
8.2   SERIAL INTERFACE

Instrument connector: Canon DB 25-pin, female

The NSG 650 is designed to run as a DCE so that a commercially available, 1:1 wired RS 232C cable can be utilized (25p-to-25p or 9p-to-25p depending on computer type used). A null-modem is not necessary.

Pin-out of the RS 232C port on the NSG 650:
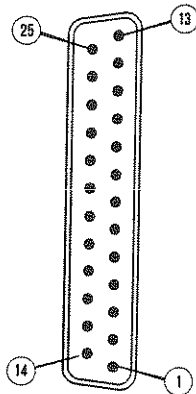
Pin No.	Function
1	Protective earth
2	TXD: Transmit data
3	RXD: Receive data
7	Signal earth
18	+ 12 V } Supply to the
25	− 12 V } opto-link

All the other connections are unused.

Technical specifications of the RS 232C interface:

* RS 232C
* Transmission rate: 9600 Baud
* Data bits: 8
* Parity: Even
* Stop bits: 1
* Control signal: None

8.3 EUT FAIL and EXT. START input

* Electrical isolation: Via opto-isolator
* Sink current: < 10 mA
* Input delay: 10 ms typ.
* Electric strength
  of the opto-isolator: 2000 V min.
* Operating mode: Control by transistor or contact to earth
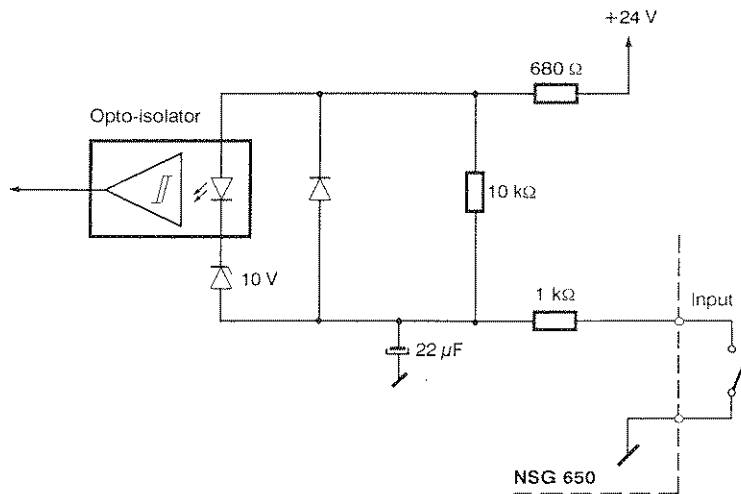
8.4   EOT

EOT output

*   Electrical isolation via relay
*   Normally open contact, switching capability 230 Vac / 1 A
*   Built-in contact protection
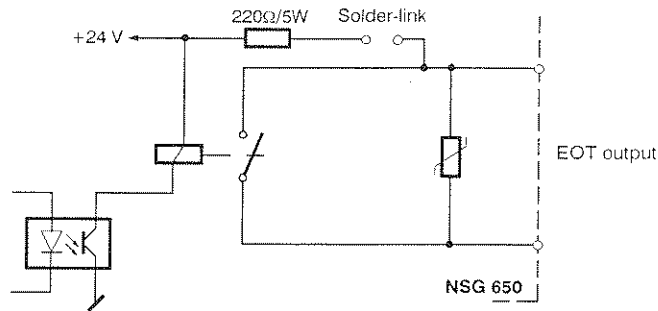
8.5   INTERLOCK

Wiring of the interlock connector
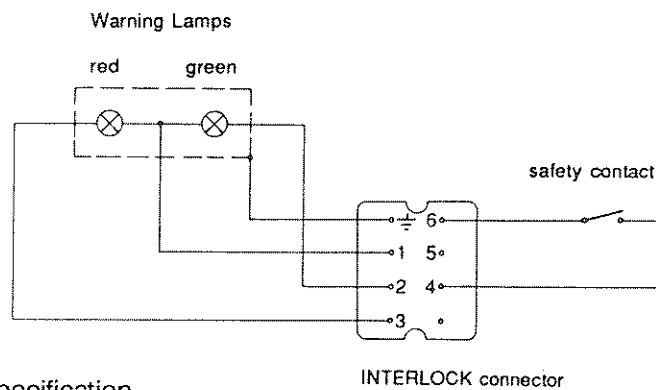
Technical specification

Supply to the warning lamps: 230 Vac, 60 W max.
Supply to the safety contacts: 230 Vac, 100 mA max.

The generator cannot be operated without the INTERLOCK connector. If no safety contact is included in the test rig, a wire link must be inserted in the connector to simulate the existence of such a contact (this is how the connector is wired upon delivery from the factory).

8.6   I/O extension

Optionally, an I/O-board (INA 650) with 8 digital inputs and 16 digital outputs can be inserted at the rear of the generator.

The extension facility is foreseen for widespread automation of the test procedure, e.g. for controlling coupling networks, component feeders or similar items.

The present NSG 650 program does not service these options. The relevant commands are, however, implemented in the NSG 650 communications protocol and are hence accessible for a specific control program (see also Section 7).
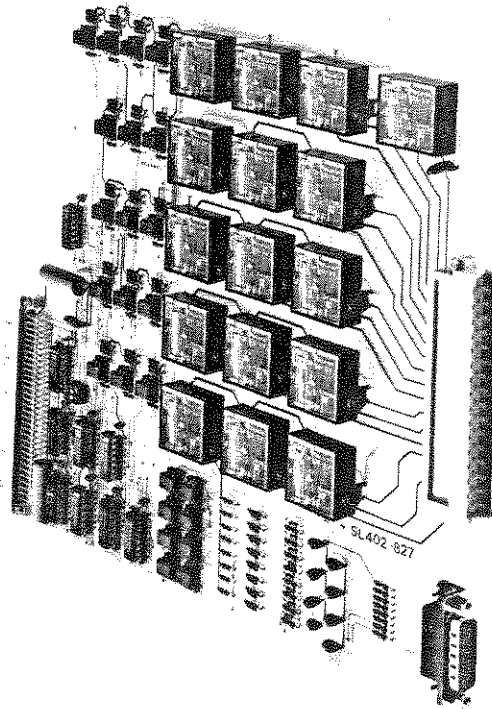
Technical specifications and wiring

Inputs:
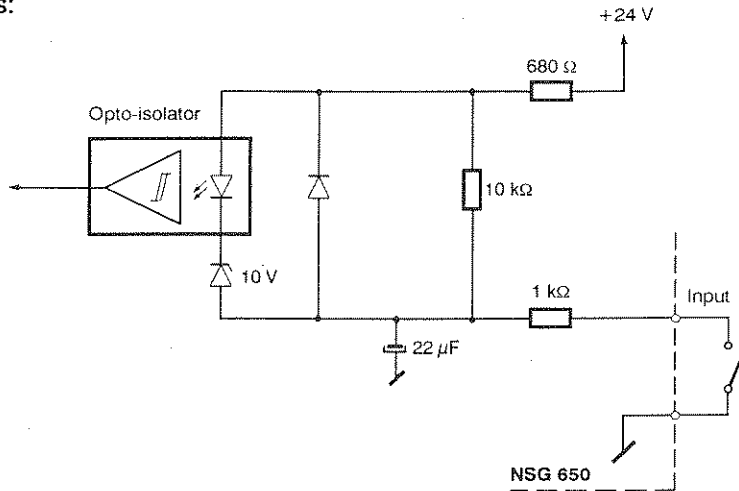
* Electrical isolation: Via opto-isolator
* Sink current: < 10 mA
* Input delay: 10 ms typ.
* Electric strength
  of the opto-isolator: 2000 V min.
* Operating mode: Control by transistor or contact to earth

Outputs:
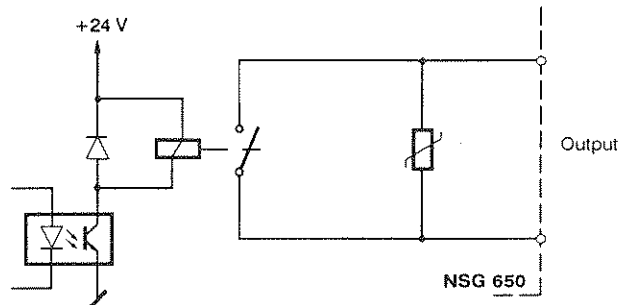
* Switching capability: 230 Vac / 1 A
* Built-in contact protection
* Normally open contact

9   Technical specifications

Instrument supply	115 or 230 Vac, +15% / -20% 50/60 Hz, 115 W approx.

Types of pulse:

Surge	1.2/50 μs (open circuit) 8/20 μs (short circuit) 200 V to 6.6 kV $\pm$ 10% up to 3.3 kA (at 6.6 kV) dynamic impedance: low 2 Ω high 12 Ω
Ring wave	0.5 μs/100 kHz 200 V to 6.6 kV up to 550 A (at 6.6 kV) dynamic impedance: low 12 Ω high 30 Ω
Polarity	+ / −
Pulse outputs	Floating
Controls	No front panel controls are provided. All functions are controlled via the PC with the NSG 650 operating software.
Type of PC Port	IBM-compatible with min. 640 kB of memory Serial, RS 232C (COM 1)
Program menus	Diagnostics Parameter set-up Journal Test File handling
Operating modes	Single pulse Increment voltage sequence Increment phase angle sequence User-defined test profile sequences

Parameters	Type of pulse:	Surge	(high imp.)
		Surge	(low imp.)
		Ring	(high imp.)
		Ring	(low imp.)

Voltage
Voltage step
Polarity
Synchronous / asynchronous
Phase angle (relative to line)
Phase angle step
Repetition rate
Number of surges
Number of sequences

Start trigger	Keyboard or externally applied signal
Peak detector	Vp and Ip measured at output and reported digitally to the result table
EUT failure	Stop or continue mode
Optional aux. I/O	8 inputs, 16 outputs, electrically isolated
Monitor outputs	V(t), I(t) for an oscilloscope
Test reports	Automatic recording of test setup and test results with user-definable header
Safety interlock	Hardware and software safety provisions
Self-diagnosis	On power-up or on request, reports statistics

Dimensions   Width: 449 mm (17.7")
             Height: 310 mm (12.2")
             Depth: 500 mm (19.7")
Weight   33.5 kg (73.8 lbs) approx.

10   Pulse form definitions

Idealized pulse specifications, as they appear in the corresponding Standards, are shown below by way of reference.

Further information and specifications regarding test procedures can be found in the relevant official documents.

Front time:
$T_1 = 1.67 \times T = 1.2\,\mu s \pm 30\%$
Time to half value:
$T_2 = 50\,\mu s \pm 20\%$

Open-circuit surge pulse as per IEC 801-5 or IEC 60-2

Front time:
$T_1 = 1.25 \times T = 8\,\mu s \pm 20\%$
Time to half value:
$T_2 = 20\,\mu s \pm 20\%$
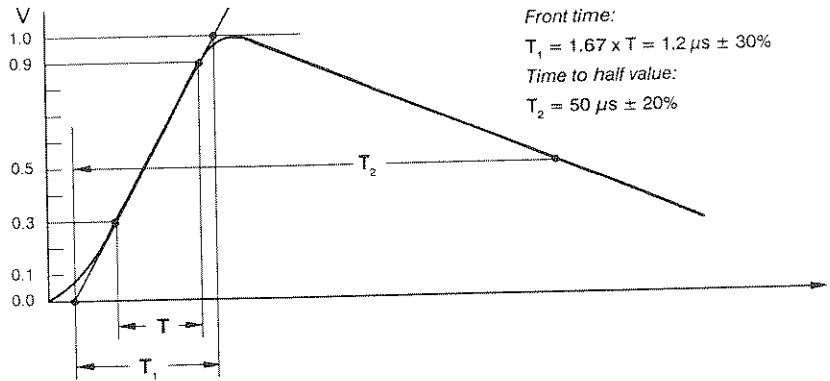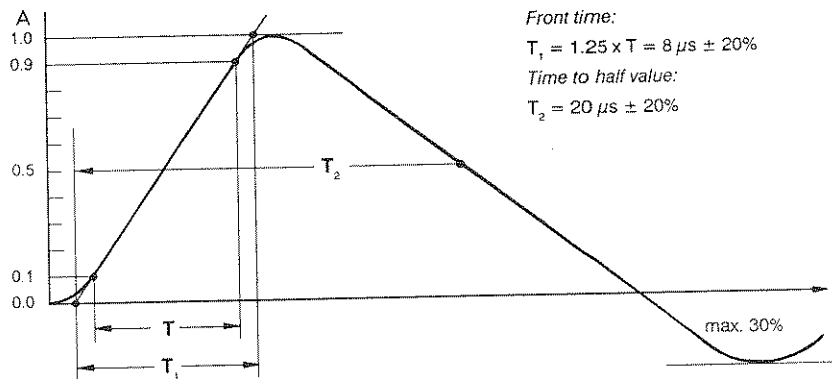
Short-circuit surge pulse as per IEC 801-5 or IEC 60-2

0.5 μs / 100 kHz ring wave as per ANSI-IEEE C62.41

VOLTAGE

T_r = Rise time (0.5 μs)

T = Oscillation period (10 μs)
    (f = 100 kHz)

TIME μs
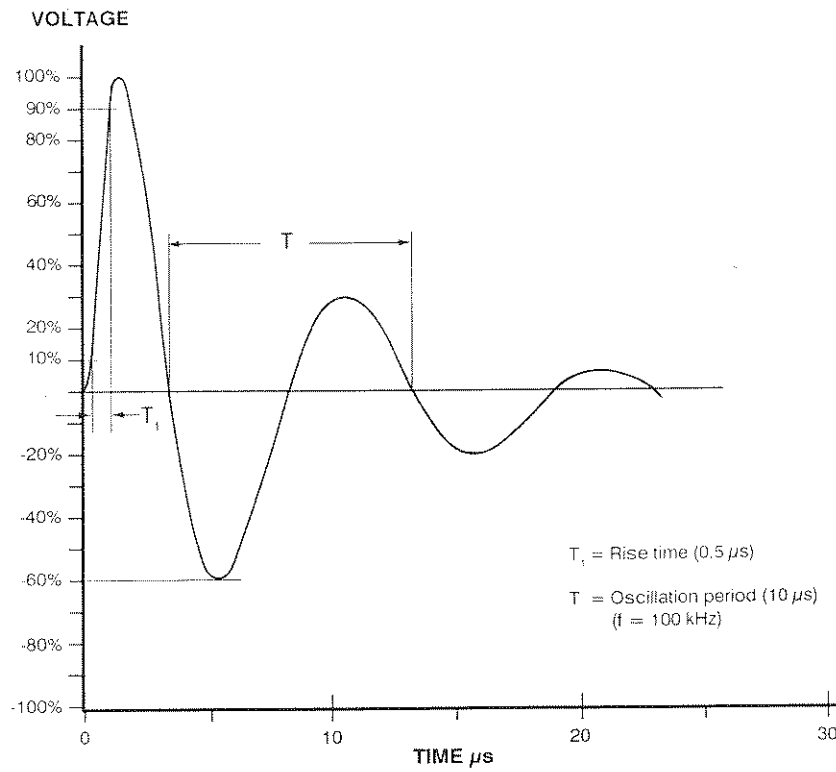
11   Maintenance and function check

There are no adjustable items inside the instrument, either for calibration or service purposes, that are accessible to the user.

The instrument housing must not be opened. In the event of any repair or adjustment work being necessary, the whole instrument should be returned to a SCHAFFNER Service Center accompanied by an order and/or a description of the fault.

Maintenance work by the user is confined to cleaning the exterior and carrying out a function check:

Cleaning

A damp cloth is usually sufficient to clean the housing. A mild, non-abrasive household cleanser may be used if necessary.

No chemicals should be used for cleaning purposes.

Switch the system off completely and disconnect the mains supply before any cleaning is undertaken.

Function check

> *Attention:* The safety measures already described must also
>   be strictly observed during a function check!

A function check is normally carried out automatically by the NSG 650 PC-program and reported by means of its status messages.

Once the system has been switched on, the generator goes into the STANDBY state (green LED) and the ERROR indicator (yellow LED) remains unlit. If this is not the case, check the mains connection, fuses and cabling taking all the usual precautions.

The NSG 650 starts to communicate with the computer once the program is started. (Check carried out with the 'Self-test' in the diagnostics menu).

If there is no reaction, check all the connections and the cable to the RS 232C port or the opto-link.

A check should also be made to ensure that the correct program package is being used, namely the NSG 650 OPERATING SOFTWARE. (The simulation program, NSG 650 TRAINING SOFTWARE, does not access the interface port).

The generator cannot switch to its active state (OPERATIONAL) if the safety contact connected to the interlock connector is open circuit.

Pulse generation can be observed on an oscilloscope by means of the special cables connected to the MONITOR sockets. This can usefully be employed as a function check but should *never* be interpreted as a reference or as a calibration measurement.

12   Ordering information

NSG 650   High Energy Pulse Generator
            The unit is supplied complete with the operating software, training
            software (both running on an IBM-PC or compatible), filtered monitor
            cables for an oscilloscope and is ready to be interconnected with the
            optional pulse coupling networks.

Optional accessories

CDN 110   Surge coupling network, single phase
CDN 116   Signal-line coupling network
INA 120   Test enclosure (L x W x H: 350 x 350 x 150 mm approx.)
INA 121   Component test box (L x W x H: 290 x 190 x 130 mm approx.)
INA 140   Warning lamps
INA 161   Brackets for mounting in a 19" rack
INA 301   Opto-link set, 10 m, powered from data-lines
INA 303   Opto-link set, 10 m, with 230 Vac power supply
INA 304   Opto-link set, 10 m, with 115 Vac power supply
150-828   HV coaxial connector (to use unit without CDN 110, e.g. for
            component testing) 2 off are needed
402-741   HV coaxial cable, 2m

11   Warranty

SCHAFFNER grants a guarantee of 1 year on this instrument, effective from the
date of purchase.

During this period, any defective component part will be repaired or replaced free
of charge or, if necessary, the instrument will be replaced by another of equivalent
value. The decision regarding the method of reinstating the functional capability
is at the sole discretion of SCHAFFNER.

Excluded from the guarantee are damage or consequential damage caused
through negligent operation or use as well as the replacement of parts subject to
degradation.

The guarantee is rendered invalid by any intervention on the part of the customer
or a third party.

The goods are to be returned in the original packing or other equivalent packing
suitable for the purpose of the foreseen means of transport. SCHAFFNER can
accept no responsibility for damage in transit.

Notes

Appendix A

Software version V 02.05

A1:   The programs are now delivered on   5¼", 1.2 MB and 3½" 1.44 MB
       HD diskettes which contain both the TRAINING SOFTWARE as well as the
       OPERATING SOFTWARE.

       The two programs are stored in the sub-directories TRAIN and OP
       respectively.

       The installation instructions given in Section 4.5 can still be used provided
       the relevant sub-directory is accessed with a an appropriate 'change
       directory' command.

A2:   **Expansion to include further ports**

       Until now, the COM1 port on the PC has been used exclusively by the
       earlier versions of the program. As from version V 02.05 the COM2 port
       can also be used and, if necessary, the COM3 and COM4 ports, too.

       Unless instructed otherwise, the program will continue to utilize COM1 (the
       default setting).

       A batch instruction is necessary for communication via COM2. An
       appropriate batch-file (NSGCOM2.BAT) can be found ready prepared on
       the diskette. In this case the program call is effected via the batch-file, e.g.
       C:\OP>NSGCOM2

       COM3 and COM4 are not specifically defined in the DOS convention. It is
       possible that problems may be encountered concerning addresses and
       interrupts with certain computer configurations. Batch instructions can be
       created for these ports as well by using the information given in Section
       A2.1.

A2.1: Addressing the ports

The following parameters must be specified in the NSG 650 software in order to use differing serial ports:

- Base address of the interface module (must be the module 8250 !)

- Interrupt used

The parameters are input by means of the following "Environment Variables":

- NSGPORT   (Base address of the interface module)
- NSGIRQ   (Interrupt used)

Normal base addresses and interrupts for COM1 ... COM4 are:

	Base address	Interrupt
COM1:	3F8	IRQ 4
COM2:	2F8	IRQ 3
COM3:	3E8	IRQ 5 or 7
COM4:	2E8	IRQ 5 or 7

The following interrupts are supported by the NSG 650 software:

- IRQ 3   (COM2)
- IRQ 4   (COM1)
- IRQ 5   (LPT2)
- IRQ 7   (LPT1)

The base address may be in the following range: 0 ... 65535

Example for COM1:

    SET NSGPORT=3F8
    SET NSGIRQ=4

Example for COM2:

(Batch-file: NSGCOM2.BAT)

      SET NSGPORT=2F8
      SET NSGIRQ=3

Example for COM3:

      SET NSGPORT=3E8
      SET NSGIRQ=5

Example for COM4:

      SET NSGPORT=2E8
      SET NSGIRQ=7

Attention: The software will automatically use COM1 if no other values or invalid values are given for "NSGPORT" and "NSGIRQ".

Important: The "SET instruction" (e.g.: SET NSGPORT=2E8) will not be executed if another program such as the "Norton Commander" is running!

A3: Pulse current monitoring

A new feature permits a peak current to be defined so that the behaviour of an item of equipment under test (EUT) can be observed. This enables, for example, the switching performance of a series of protective elements to be automatically monitored and logged.

A test procedure can hence be terminated during a system test on the basis of a specific peak current that is attributable to erroneous behaviour or a defect on the part of the EUT without an EUT-Fail signal having to be input.

The "EUT Failure Action" field in the PARAMETER menu has been expanded to include the criterion "Ipeak". A further field is provided for the entry of the relevant peak current value (range: 10 A to 3000 A).

```
SCHAFFNER     PC Controlled Surge Test System  V02.05
PARAMETER SETUP:  DEFAULT.PAR                              30-03-93 09:01:32

Test Mode: Sequence                    Start Mode: Keyboard

Repetition Rate:      30 sec           Beep: On
Repetition:            1 sequences      EUT Failure Action: Ipeak    Ip:  120 A

        +------+--------+-----+------+-------+--------+
        | Prof.| Form   | Pol.| Up   | Angle | Nr. of |
        | Nr.  |        |     |      |       | Surges |
        +------+--------+-----+------+-------+--------+
        |  1   | Surge HZ|  + | 1000| A| --- |   1    |
        |  2   | Surge HZ|  + | 1200| A| --- |   1    |
        |  3   | Surge HZ|  + | 1400| A| --- |   1    |
        |  4   | Surge HZ|  + | 1600| A| --- |   1    |
        +------+--------+-----+------+-------+--------+

Total Number of Surges:     4           approx. Execution Time:    2.0   min

 New      Modify      Save      Load      Print      Quit
ENTER selects the highlighted choice. Use <- OR -> to move to another choice.
```

The computer compares the value of Ip measured during the test-run and terminates the procedure should the predefined value be exceeded. The action is logged in the "EUT" column with the remark "nok".

The behaviour during a test procedure is then identical to that when an EUT-Fail signal occurs.

Schaffner Elektronik AG
CH-4708 Luterbach
Switzerland
Telephone (065) 41 11 81
Telex 934 491 scha ch
Telefax (065) 42 14 04

Subsidiary companies
Tochtergesellschaften
Succursales

Schweiz:
ALTRAC AG
Mühlehaldenstrasse 6
CH-8953 Dietikon
Telephon (01) 741 46 44
Telefax (01) 741 19 60

Deutschland:
Schaffner Elektronik GmbH
Schoemperlenstr. 12
D-7500 Karlsruhe 21
Telephon (0721) 56 91- 0
Telex 7 826 671 schaf d
Telefax (0721) 56 91- 10

France:
Schaffner S.A.
5, rue Michel Carré
F-95100 Argenteuil
Téléphone (13) 947 86 36
Télex 608 723 schafra f
Télécopieur (13) 947 02 28

USA:
Schaffner EMC Inc.
9-B Fadem Road
Springfield, NJ 07081
Phone (201) 379 7778
Toll free 800 367 5566
Telex 910240 2985 schaff UQ
Telefax (201) 379 1151

United Kingdom:
Schaffner EMC Ltd.
Ashville Way
Molly Millar's Lane
Wokingham
Berkshire RG11 2PL
Phone (0734) 77 00 70
Telex 848 235 schemc g
Telefax (0734) 79 29 69

Schaffner Elektronik AG
CH-4708 Luterbach
Switzerland
Telephone (065) 41 11 81
Telex 934 491 scha ch
Telefax (065) 42 14 04

Subsidiary companies
Tochtergesellschaften
Succursales

Schweiz:
ALTRAC AG
Mühlehaldenstrasse 6
CH-8953 Dietikon
Telephon (01) 741 46 44
Telefax (01) 741 19 60

Deutschland:
Schaffner Elektronik GmbH
Schoemperlenstr. 12
D-7500 Karlsruhe 21
Telephon (0721) 56 91- 0
Telex 7 826 671 schaf d
Telefax (0721) 56 91- 10

France:
Schaffner S.A.
5, rue Michel Carré
F-95100 Argenteuil
Téléphone (13) 947 86 36
Télex 608 723 schafra f
Télécopieur (13) 947 02 28

USA:
Schaffner EMC Inc.
9-B Fadem Road
Springfield, NJ 07081
Phone (201) 379 7778
Toll free 800 367 5566
Telex 910240 2985 schaff UQ
Telefax (201) 379 1151

United Kingdom:
Schaffner EMC Ltd.
Ashville Way
Molly Millar's Lane
Wokingham
Berkshire RG11 2PL
Phone (0734) 77 00 70
Telex 848 235 schemc g
Telefax (0734) 79 29 69

HIGH ENERGY
PULSE GENERATOR
NSG 650

COMMUNICATIONS PROTOCOL

601-110A

CONTENTS

1   Introduction

A user, who operates the generator with a PC and the software supplied, does not need to concern himself with the details of the information flow through the interface.

Knowledge of the communications-protocol is only necessary if:

* The NSG 650 is to be integrated software-wise into a whole system concept.
* Another, non PC-compatible control computer is to be used.
* Special software is to be written for a particular application.
* Single commands are to be transferred to the generator from an ASCII-terminal.

The protocol used, data security, the command structure as well as the behaviour under error conditions are all described in this publication together with an extensive description of the individual commands.

2   Protocol

Communication with the NSG 650 takes place exclusively via the RS 232 port.

The same protocol is used for communication between the NSG 650 and the computer as is usual for "Terminal-Host" connections except that here the NSG 650 is to be seen as the 'host' and the computer as the 'terminal'.

Features of the protocol:

* The NSG 650 sends an echo for every character received (provided the parity bit is correct). This echo can be suppressed by means of a command to the NSG 650.
* Every command to the NSG 650 ends with a CR.
* The command is only interpreted and executed after receipt of the CR.
* The execution of the command is confirmed by ">" (the prompt message) being sent back.
* The NSG 650 remains passive if a transmission error is detected, i.e. the command received is ignored.
* If the NSG 650 cannot interpret a command, e.g. because of a syntax error, it responds with an error message.
* The NSG 650 does not send spontaneous messages to the computer. A strict master-slave principle is used whereby the computer is always the master.

3   Data security

A low error rate is to be expected when short, suitably screened cables are used and particularly when an opto-link is utilized for data transfers.

The following methods are used to keep the data secure:

* Parity
* Information feedback (echoplex)

4   Technical specifications of the data port

* RS 232/Opto-Link
* Transmission rate: 9600 bit/sec
* Number of data bits: 8
* Parity: EVEN
* Number of stop bits: 1
* Control signals: None

5   Error treatment

The following types of error can possibly occur during a transfer of data between the computer and the NSG 650:

* Parity-error
* Command is not understood by the NSG 650
* The echo from the NSG 650 is missing
* The NSG 650 does not respond to a command
* The response to a command is not understood by the computer

Error	Reason	Reaction
Parity error recognized by NSG 650		The NSG 650 remains passive i.e. the prompt character (>) is not sent
Parity error recognized by the computer	Disruption on the transmission path	The computer repeats the command 1) (No differentiation is made between a parity error that occurs within the echo to a command and one within the response to a command)
Command is not understood by the NSG 650	- A transmission error was not detected by the parity check - The computer sends commands that are not implemented in the NSG 650 (only occurs during the debugging phase)	- The NSG 650 answers with an appropriate error message - The computer repeats the command 1)
Echo from the NSG 650 missing	- Physical link to the NSG 650 missing - The NSG 650 is not switched on - Hardware problem with the serial link (comp. or NSG 650)	- The computer repeats the command 1)
The NSG 650 gives no response to a command	- The NSG 650 was switched off while executing command - Problem with the NSG 650 hardware	- The computer repeats the command 1)
The response to a command is not understood by the computer	- A transmission error was not detected by the parity check	- The computer repeats the command 1)

1) If the problem cannot be overcome after the command has been repeated three times, the fact is reported to the applications software by means of an appropriate error message.

6   Command structure

All the commands for the NSG 650 are based on the following configuration:

<Command name> [<Delimiter>] [<Argument>] [<Delimiter>] ...
[<Argument>] CR

Command name: Designation of the command to be executed.
The command name may be abbreviated. Generally, the first 3 letters form a valid abbreviation. The applicable abbreviation is shown in capital letters in the definition of the syntax.

Delimiters: Delimiters are needed to separate the 'command name' and the 'argument' from one another.

Valid delimiters are:

*   ' '   (space)
*   ','   (comma)
*   ';'   (semi-colon)
*   '/'   (slash)
*   ':'   (colon)

Argument: Arguments, or the requirements of arguments, depend on the command to be executed itself.

Following are the reasons that apply to the requirement for arguments:

*   Argument for command alteration (option)
*   Argument as a parameter
*   Argument as an input/output control

Valid characters: The characters valid for 'command name' and 'argument' are ASCII-characters in the range from 20H (space) up to and including 7FH (DEL) (The control characters 00H - 1FH are not allowed). No distinction is made between upper and lower case letters.

Remark: The NSG 650 responds to a 'CR' with a 'CR' and 'LF' (provided that the echo is switched on).

7 Commands and messages

The following sections list and describe in detail all the commands implemented for the NSG 650 together with the messages produced by the NSG 650.

7.1 Explanation of symbols

[...]   Items enclosed in square brackets may be left out.

"CAPITALS" Letters in a word that are written in capitals must be entered, the rest of the word can be entered optionally.

| OR

7.2 Summary of the commands

Command	Function	Syntax	Response
Abort	Command to terminate a pulse that has been started	ABOrt	-
Arm	Command to prepare for each "Execute" command. The HVE command must have been executed at least 5 sec before this command otherwise the error message 'ERROR 012' will be generated	ARM	-
Async.	Selects asynchronous pulse triggering	ASYnchronous	-
Beep	Buzzer to signal the switching on or off of the high voltage	BEEp,<Mode> Mode = ON|OFF	-
Config.	Request to send the hardware and the software configuration of the NSG 650	CONfiguration	HW and SW Configuration

Command	Function	Syntax	Response
Echo	Switch the echo on the serial link on or off	ECHo,<Mode> Mode = ON|OFF	-
EOT	Activation of the 'End of Test' output	EOT	-
EUT	Request to send the status of the EUT Failure input	EUT	Status of EUT input
Execute	Command to trigger a pulse	EXEcute	-
Extstart	Request to send the status of the 'External Start' input	EXTstart	Status of ext. start input
HVdisable	Request to the NSG 650 to switch off the HV generator. The red warning light is switched off and the green one switched on	HVDisable	-
HVenable	Request to the NSG 650 to switch on the HV generator. The red warning light is switched on and the green one switched off	HVEnable	-
Init	Request to initialize the NSG 650	INIt	-
Input [1]	Request to send the status of the selected input	INPut, <Number> Number = 0...7	Status of specified input
Negative	Selection of negative pulse polarity	NEGative	-

Command	Function	Syntax	Response
Output [1]	Request to write to the selected output	OUTput,<Number>, <Status> Number = 0...15 Status = ON|OFF	-
Positive	Selection of positive pulse polarity	POSitive	-

Profile	Selection of all the parameters necessary to define the pulse	PROfile, <Form>,
		      <Upeak>,
		      <Pol>,
		      <Mode>
		
		Form = SURge,LZ|
		      SURge,HZ|
		      RINg,LZ|
		      RINg,HZ|
		
		Upeak = 200...6600
		
		Pol = POSitive|
		      NEGative
		
		Mode = ASYnc|
		      SYNc,
		      <Angle>
		
		Angle = 0...359
			-

Result	Request to send the result of the pulse generated	RESult	Upeak, Ipeak and EUT
Ring	Selection of ring-wave pulses	RINg,<Impedance> Impedance = LZ|HZ LZ: Low impedance HZ: High impedance	-

[1] Through the use of the optional I/O-board

Command	Function	Syntax	Response
Setup	Request to send all the specified parameters for the pulse definition	SETup	Parameters specified
Status	Request to send the status of the NSG 650	STAtus	NSG 650 status
Summary	Request to send pulse statistics	SUMmary, <Mode> SURge| RINg| TOTal	Statistics
Surge	Selection of surge wave pulses	SURge,<Impedance> Impedance = LZ|HZ LZ: Low Impedance HZ: High Impedance	-
Sync.	Selects synchronous pulse triggering	SYNc,<Angle> Angle = 0...359	-
Test	Request to the NSG 650 to execute a self-test	TESt	Result of self-test
Upeak	Selects the open-circuit pulse voltage	UPEak,<Value> Value = 200...6600	-

7.3   Summary of the messages from the NSG 650

Message	Function	Syntax
Configur-ation	Response to the configuration enquiry	CONfiguration, <Firmware Vers> <Hardware Vers> [2] Firmware Version = Vxx.xx (x = 0...9) Hardware Version = 650|651 [2]
EUT	Response to the EUT enquiry	EUT,<Status> Status = OK|NOK
Extstart	Response to the Extstart command	EXT,<Status> Status = YES|NO
Input	Response to the input command	INPut,<Number>,<Status> Number = 0...7 Status = ON|OFF
Result	Response to the result enquiry	RESult,<Upeak>,<Ipeak>,<EUT> Upeak = 0...6600 Ipeak = 0...3300 EUT = OK|NOK
Setup	Response to the setup enquiry	SETup,<Form>,<Upeak>, <Polarity>,<Mode> Form = SURge,LZ|SURge,HZ| RINg,LZ|RINg,HZ Upeak = 200...6600 Polarity = POSitive|NEGative Mode = ASYnchronous| SYNchronous,<Angle> Angle = 0...359

Message	Function	Syntax
Status	Response to the status enquiry	STAtus,<Status> Status = STA 00|STA 01|STA 02 (See Section 8.2.2)
Summary	Response to the summary enquiry	SUMmary,<Mode>,<Value1>, ... <Value8> Mode = SURge|RINg|TOTal Val(x) = Number of pulses
Test	Response to the test command	TESt,<String> String = TES 00|TES 01|TES 02|TES 03 (See Section 8.2.3)

[2] from software version 01.04 onwards

7.4   Description of the commands

7.4.1 Introduction

The commands that can be implemented are described below in greater detail and in alphabetical order.

Every command must be terminated with a CR as already mentioned earlier in Section 2 "Protocol". The general structure of the individual commands has already been outlined in Section 6 "Command structure".

An error message is generated if a command cannot be executed. The syntax of the error messages is treated in Section 7.3 "Error messages".

7.4.2 Abort

Syntax:	ABOrt
Response:	-
Error message:	ERROR 007
Description:	The "Abort" command cancels the start of a pulse, i.e. the surge capacitors are discharged and the HV generator is switched off.

7.4.3 Arm

Syntax:	ARM
Response:	-
Error message:	ERROR 006 or ERROR 012
Description:	Each "Arm" command prepares the NSG 650 for one "Execute" command. This command is only recognized if the HVEnable command has been executed at least 5 sec previously.

7.4.4   Asynchronous

Syntax: ASYnchronous

Response: -

Error message: -

Description: Asynchronous pulse triggering is specified by means of the "Asynchronous" command, i.e. the triggering occurs completely arbitrarily relative to the phase of the power supply to the NSG 650.

7.4.5   Beep

Syntax: BEEp,<Mode>   Mode = ON | OFF

Response: -

Error message: -

Description: The buzzer in the NSG 650 is switched on or off with the "Beep" command. The buzzer is used to signal that the surge capacitors will be or are charged to a high voltage.

7.4.6   Configuration

Syntax: CONfiguration

Response: CONfiguration, <Firmware Version>
                                 <Hardware Version>
                 Firmware Version = <Vxx.xx>
                 Hardware Version = 650 | 651
                 Example: V01.04 650

Error message: -

Description: The "Configuration" enquiry requests the NSG 650 to send its hardware and software set-up.

7.4.7 Echo

Syntax:	ECHo,<Mode>	Mode = ON│OFF
Response:	-	
Error message:	-	
Description:	The echo feature on the serial link is switched on or off with the "Echo" command.	

7.4.8 EOT

Syntax:	EOT
Response:	-
Error message:	-
Description:	The NSG 650 is notified that a test has ended with the "EOT" instruction which, in turn, activates the "End of test" output on the generator.

7.4.9 EUT

Syntax:	EUT	
Response:	EUT,<Status>	Status = OK│NOK
Error message:	-	
Description:	The "EUT" command requests the NSG 650 to send the status of the EUT-input. The "OK" status indicates that the equipment under test is still in working order.	

7.4.10 **Execute**

Syntax:	EXEcute
Response:	-
Error message:	ERROR 004
Description:	A pulse is started with the "Execute" command, i.e. the surge capacitors are charged to the required voltage and the pulse is triggered as soon as that voltage is attained (taking the minimal repetition rate into account).

Each "Execute" command is only performed by the NSG 650 if an "Arm" command has been received within the last 10 s.

Performing the "Execute" command also resets the "Arm" status.

7.4.11 **Extstart**

Syntax:	EXTstart	
Response:	EXT,<Status>	Status = YES | NO
Error message:	-	
Description:	The "Extstart" enquiry requests the NSG 650 to send the status of the "External start" input. The "YES" status in the response indicates that the "External start" input is active.	

7.4.12 **HVDisable**

Syntax:	HVDisable
Response:	-
Error message:	-
Description:	The "HVDisable" command instructs the NSG 650 to switch the HV generator off. The red warning light is switched off and the green light is switched on.

7.4.13 HVEnable

Syntax:	HVEnable
Response:	-
Error message:	-
Description:	The "HVEnable" command instructs the NSG 650 to switch the HV generator on. The red warning light is switched on and the green one is switched off. The NSG 650 is can produce pulses 5 seconds after this command has been executed.

7.4.14 Init

Syntax:	INIt
Response:	-
Error message:	-
Description:	The NSG 650 is initialized with the "Init" command which also sets the default set-up conditions. (The default conditions are described in Section 9 "Default set-ups").

7.4.15 Input *(Only in conjunction with the optional I/O-board.)*

Syntax:	INPut,<Number>	Number = 0...7
Response:	INPut,<Number>,<Status>	Number = 0...7 Status = ON|OFF
Error message:	-	
Description:	The "Input" command requests the NSG 650 to send the status of the selected input on the line-coupler interface. The "ON" status in the response means that the corresponding input has been activated.	

7.4.16 Negative

Syntax:	NEGative
Response:	-
Error message:	-
Description:	Pulses of negative are selected with the "Negative" command.

7.4.17 Output *(Only in conjunction with the optional I/O-board.)*

Syntax:	OUTput,<Number>,<Status>	Number = 0...15 Status = ON|OFF
Response:	-	
Error message:	-	
Description:	The "Output" command instructs the NSG 650 to switch the selected output on or off.	

7.4.18 Positive

Syntax:	POSitive
Response:	-
Error message:	-
Description:	Positive pulses are selected with the "Positive" command.

7.4.19 Profile

Syntax: PROfile,<Form>,<Upeak>,<Polarity>,<Mode>

                          Form =   SURge,LZ|SURge,HZ|
                                         RINg,LZ|RINg,HZ|
                          (LZ = low impedance, HZ = high impedance)
                          Upeak =   200...6600
                          Polarity = POSitive|NEGative
                          Mode =   ASYnchronous|SYNchronous,<Angle>
                          Angle =   0...359

Response: -

Error message: -

Description: The "Profile" command downloads all the parameters to the
                          NSG 650 that are necessary to define a pulse.

7.4.20 Result

Syntax: RESult

Response: RESult,<Upeak>,<Ipeak>,<EUT>

                          Upeak =   0...6600
                          Ipeak =   0...3300
                          EUT =   OK|NOK

Error message: ERROR 005

Description: The "Result" enquiry requests the NSG 650 to send the results
                          for the last pulse to have been generated.

7.4.21 Ring

Syntax: RINg,<Impedance>   Impedance = LZ|HZ
                          (LZ = low impedance, HZ = high impedance)

Response: -

Error message: -

Description: The "Ring" command sets the ring-wave type of pulse. The
                          maximum current (200 A or 550 A) is determined by the
                          impedance setting of "HZ" and "LZ" respectively.

7.4.22 Setup

Syntax:	SETup
Response:	SETup,<Form>,<Upeak>,<Polarity>,<Mode>

> Form = SURge,LZ | SURge,HZ |
> RINg,LZ | RINg,HZ |
> (LZ = low impedance, HZ = high impedance)
>
> Upeak = 200...6600
>
> Polarity = POSitive | NEGative
>
> Mode = ASYnchronous | SYNchronous,<Angle>
>
> Angle = 0...359

Error message:	-
Description:	The "Setup" enquiry requests the NSG 650 to send the settings of all the parameters that are necessary to define a pulse.

7.4.23 Status

Syntax:	STAtus
Response:	STAtus,<Status> Status = STA 00	STA 01	STA 02
Error message:	-
Description:	The "Status" enquiry requests the NSG 650 to send its current status. The various statuses that are possible (STA 00 etc.) are explained in Section 8.2.2 "Summary of status messages".

7.4.24 Summary

Syntax:	SUMmary,<Mode>
	Mode = SURge|RINg|TOTal
Response:	SUMmary,<Mode>,<Value1>, ... <Value8>

Mode = SURge\|RINg\|TOTal

Val(x) = 6 ASCII-characters (0-9)
(Preceding zeros are not suppressed)

Value1 = Number of pulses with Upeak 0-1 kV
Value2 =   "   "   "   "   "   1-2 kV
Value3 =   "   "   "   "   "   2-3 kV
Value4 =   "   "   "   "   "   3-4 kV
Value5 =   "   "   "   "   "   4-5 kV
Value6 =   "   "   "   "   "   5-6 kV
Value7 =   "   "   "   "   "   6-7 kV
Value8 = Total of the pulses with 0-7 kV

The Upeak figure refers to the specified open-circuit voltage (charging voltage for the surge capacitors) and not to the voltage measured at the output, Upeak.

Error message:	-
Description:	The "Summary" command instructs the NSG 650 to send summary of the pulses that have been generated. Depending on the mode specified, the summary contains details of just the ring-wave, just the surge-wave or the total of the pulses.

7.4.25 Surge

Syntax:	SURge,<Impedance> Impedance = LZ|HZ
Response:	-
Error message:	-
Description:	The surge-wave type of pulse is selected with the "Surge" command. The maximum current (120 A or 3 kA) is determined by the impedance setting of "HZ" and "LZ" respectively.

7.4.26 **Synchronous**

Syntax:	SYNchronous,<Angle>	Angle = 0...359
Response:	-	
Error message:	-	

Description: Synchronous pulses are specified by the "Synchronous" command, i.e. the pulses are triggered in synchronism with the phase of the supply to the NSG 650.

The phase angle can be preselected in steps of 1degree.

7.4.27 **Test**

Syntax:	TESt
Response:	TESt,<String> String = TES 00|TES 01|TES 02|TES 03
Error message:	-

Description: The NSG 650 is instructed to carry out a self-test with the "Test" command. The "String" (TES 00, etc.) is explained in Section 8.2.3 "Summary of test messages".

7.4.28 **Upeak**

Syntax:	UPEak,<Value>	Value = 200...6600
Response:	-	
Error message:	-	

Description: The open-circuit voltage is selected by means of the "Upeak" command.

8   Messages

8.1 Structure of the messages

All of the messages are structured in the following manner:

$$<Type>\ <Value>:<String>CR/LF$$

Type: ERROR =   Error message
         STA =   Status message
         TES =   Test message

Value: Error, status or test-result number: 0 ... 999

String: Brief description of the error.

Max. 70 ASCII-characters in the range from 20H (space) to 7EH (˜) inclusive.

The brief description of the error is only implemented in the English language in the NSG 650. It is an easy task for the operating software to convert the description of the message into any other language, as required, by making use of the number.

8.2 Summary of the messages

8.2.1 Summary of error messages

ERROR 000:   Invalid characters

Characters have been found in the command received
that are not valid.

ERROR 001:   Command not valid

An invalid command has been issued to the NSG 650.
(A syntax error has been detected).

ERROR 002:   Command not implemented

The NSG 650 has not understood the command. (The command
has not been implemented or a syntax error has been detected).

ERROR 003:   Invalid argument.

The command contains an invalid argument.

ERROR 004:   NSG 650 not armed

An "Execute" command has been sent to the NSG 650 without
an "Arm" command having previously been sent.

ERROR 005:   No results available

The NSG 650 can send no results since no pulses
have been triggered yet.

ERROR 006:   External interlock failure

The external interlock was not active, i.e. the NSG 650
has not executed the command.

ERROR 007:   No execute command active

An "Abort" command has been received by the
NSG 650 although no pulse was active.

ERROR 008:   High voltage charge failure

The high voltage could not be charged. A further pulse can
only be triggered after executing an "INIt" command.

ERROR 009:   Measurement failure

A error has been detected while measuring Upeak and Ipeak. (In
this case, no information about the last pulse can be obtained
with the RESult enquiry).

ERROR 011:   Execute command aborted

The "Execute" command has been terminated by the user.

ERROR 012:   NSG not operational

The NSG 650 is not capable of generating pulses at the moment,
i.e. the "HVEnable" command has not been executed, or, less
than 5 seconds have elapsed before an "Arm" command was
sent after the "HVEnable" command was executed.

8.2.2   Summary of status messages

STA 00:   OK

The status of the NSG 650 is in order.

STA 01:   External interlock active

The external interlock is currently active.

STA 02:   Self-test failure

The self-test cannot be satisfactorily carried out.

8.2.3   **Summary of test messages**

TES 00:   Self-test OK

               The self-test has been satisfactorily carried out.

TES 01:   Program memory error

               A program memory error has been detected
               while carrying out the self-test.

TES 02:   Calibration memory error

               An error has been detected in the calibration memory
               while carrying out the self-test.

TES 03:   RAM error
               An error has been detected in the RAM memory
               while carrying out the self-test.

9   Default settings

The NSG 650 is loaded with the following default settings when it is first switched on or following an "Init" command:
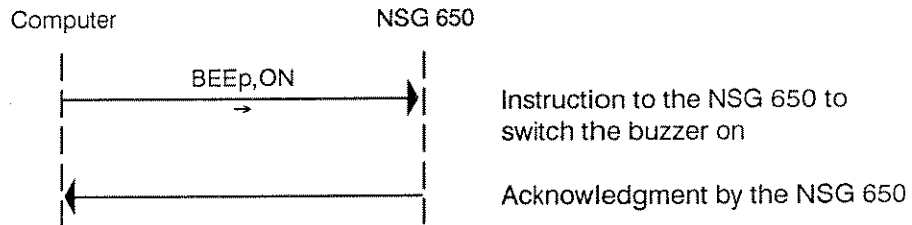
Beep:	ON
Echo:	ON
Form:	Surge HZ
Upeak:	200 V
Polarity:	Positive
Mode:	Asynchronous

10   Data transfer

Transfers of data between the NSG 650 and the computer are explained in the following sections by means of various examples. It is assumed that the echo facility has been switched off.
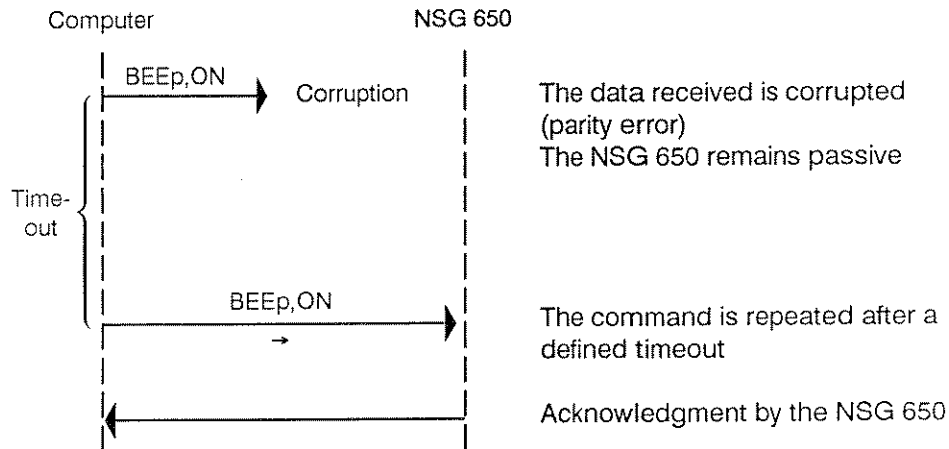
10.1 Data exchange: computer -> NSG 650

10.1.1 Normal data exchange

Computer   NSG 650

BEEp,ON
→

Instruction to the NSG 650 to switch the buzzer on

Acknowledgment by the NSG 650

10.1.2 Corrupted data exchange

10.1.2.1 The command is corrupted

Computer   NSG 650

BEEp,ON   Corruption

The data received is corrupted (parity error)
The NSG 650 remains passive

Time-
out

BEEp,ON
→

The command is repeated after a defined timeout

Acknowledgment by the NSG 650

10.1.2.2 The Acknowledgment is corrupted

Computer   NSG 650

BEEp,ON

Instruction to the NSG 650 to
switch the buzzer on

Corruption

Acknowledgment is corrupted
The computer remains passive

Time-
out

BEEp,ON

The command is repeated after a
timeout (Tout)

Acknowledgment by the NSG 650
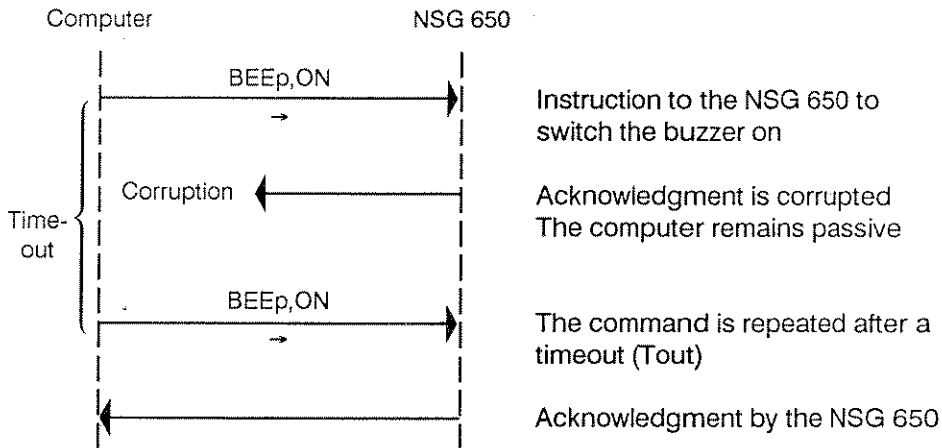
The above example shows that a so-called "information duplication" occurs in the
NSG 650, i.e. the "Beep" command is carried out twice by the generator. This
situation does not have any serious consequences except in the case of the
"Execute" command. There must be absolutely no chance that the "Execute"
command can be accidentally carried out twice. This is the reason for the intro-
duction of the "Arm" command.