Manual

SSS3-FR

Sliding Spark Spectrometer-3
- Fire Retardants

GUT
Environmental Technologies

Table of contents

1 Description of the Sliding Spark Process

By inducing simultaneously vaporization and excitation, the sliding spark process allows electrically non-conducting components (which should preferably be compact and easily to be handled) of plastic and other non-conducting materials to be subjected to atomic spectrometric investigations under simple external conditions. Each investigation is carried out directly, almost no sample preparation is required. Surfaces, that are slightly dirty, can be freed of the material adhering to them by carrying out several measurements on the same sparking spot (measurement surface cleaning).

The basic principle of the method is the thermal vaporization of a small amount of the plastic surface using high current sliding sparks of defined discharge characteristics. The complete measurement process is carried out in air under normal atmospheric conditions. A significant characteristic of the sliding spark process is the brief electric discharge that is induced to take place between two electrodes, which are separated from one another by a distance of a few millimeters, placed on the surface of the non-conducting material, i.e. the spark "slides" over the surface of the sample to be tested. In the course of this the components of the material (here: plastic) are vaporized, fragmented and ionized; bright, tube-shaped creeping discharge plasma is excited which emits characteristic light radiation.

The ability to vary the discharge characteristics (hard or soft discharge) enables spectral lines with different excitation energies for light emission to be generated. Spectral analysis (in respect of the presence of particular wavelengths) of the spectrum as captured produces on the one hand information on the elements excited by the sliding spark. At the same time conclusions can be drawn on the concentration of an element in the sample from the intensity of the characteristic spectral lines.

In addition, in the course of a sequence of sliding spark discharge processes, the surface of the material is changed in a specific manner since the continuous dissipation of energy along the sliding spark path leads to continuous removal of material. In the case of many plastics, continued discharges produce charring (e.g. in the case of plastics containing styrene such as ABS, PS, PPE etc.) or, as the case may be, incrustation of the sample surface. The progress of these surface changes provide a further characteristic of the sample being tested and yields a parameter for the material-specific function of the disruptive discharge voltage (that can be measured) as a function of the number of discharges.

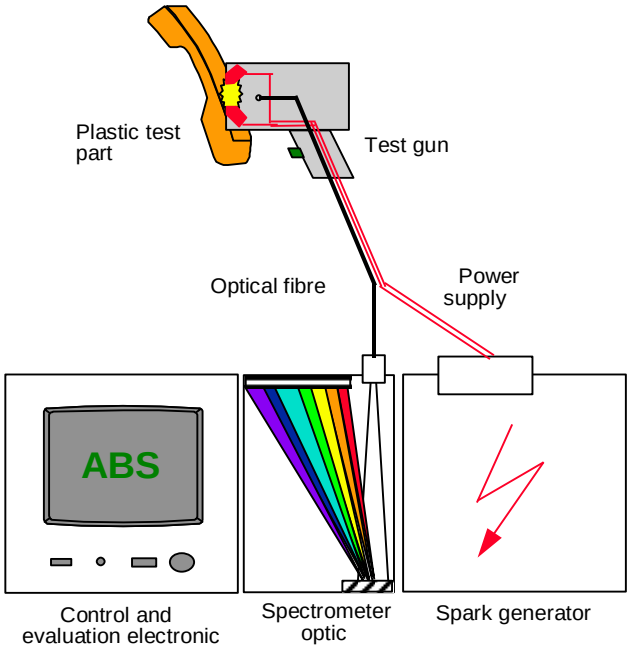
From the optical emission spectrum and the additional information from the dynamic disruptive discharge voltage values (Dynamic Discharge voltage Detector, DDD), statements can be made on the composition of the material under test. These can be used for the identification of different plastics, e.g. for recycling purposes. After the system has been appropriately calibrated with known samples, the approximate levels of particular elements in the sample can be obtained - even when the percentage levels of these are low. Evaluation of mean value spectra permits the reproducibility or precision of the statements to be increased.

The SSS3-FR-spectrometer does only evaluate the spectral intensity lines of Bromine and Chorine. It does not identify polymer types except PVC due to high concentration of Chlorine.

2 Setup of the Sliding Spark Spectrometer – SSS3-FR

The device which is equipped with a carrying handle and mainly consists of four function groups:

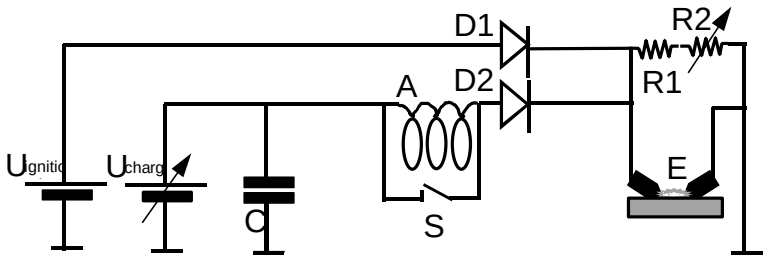
- Sliding spark generator
- Measuring pistol
- Spectrometer optics
- Computer with control and measurement electronics



2.1 The Sliding Spark Generator

The pulse generator function group serves to generate the high current spark that "slides" over the surface of the dielectric material. The spark between the two electrodes is brought about with a high voltage pulse (U_{ign}), which increases linearly to a level of several KV within a few milliseconds.
Immediately following ignition along the path between the two electrodes, the energy stored in the capacitors (C, see figure) discharges via the spark path (E). The discharge of energy produces a short-lived direct current arc (current-carrying plasma) over the surface of the material. The duration of the charging process of the pulse capacitors (U_{charge}) and thereby the amount of energy stored in them can be set via the software. Bringing into circuit an air coil (A) as additional inductance enables the discharge characteristics of the sliding spark to be changed. The air coil increases the period of the discharge and reduces the peak current (soft discharge). The ignition and charging circuits are separated from one another by diodes (D1, D2).

Fig. Schematic circuit diagram of the generator
C = capacitor
S = switch
D = diodes
R = resistance
E = electrodes



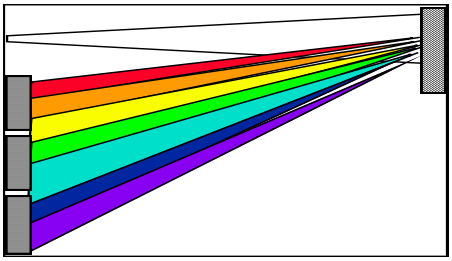
The abrupt collapse of the high voltage marks the breakdown of the spark path and the commencement of the abrupt high current discharge. The high voltage is measured indirectly with the aid of two high ohm resistors (R1, R2) connected in series. The maximum voltage measured immediately prior to the breakdown of the sliding spark path represents the ignition voltage for the specific material (DDD capturing).

2.2 The Measuring Pistol

The measuring gun is connected to the housing with a 82 cm long metallic protective hose jacketed in PVC. A signal lamp (green/red) on the measuring gun indicates that the device is operational. The transmitting of the light from the spark path to the spectrometer optic is carried out with a fiber link, whereby the end of the optical fiber is protected against contamination with a quartz window at the base of the sparking chamber. The measuring gun itself enables the device to be brought up to the sample in an easy manner. The cylindrical measuring head (∅ 50 mm) is pressed flush on to the sample as a closing piece and the measurement is triggered by pressing the start button. During the sparking process, a vacuum pump sucks the vaporization products out of the sparking chamber via a coarse particle filter through a filter cartridge filled with activated carbon. Sealing rings on the measuring head damp down the sparking noises. A capacitive proximity switch integrated in the measuring head as a protective switch avoids sparking on conducting materials.

2.3 The Spectrometer Optic

The radiation generated by the sliding spark is transported via the optical fiber to the input gap of the multi-channel spectrometer to be scattered into its different wavelengths. From the end of the optical fiber the beam of light falls on an imaging diffraction grating.



The light reflected by the grating in the flat output level falls on a CCD (Charge Coupled Device) line sensors. This photo-detectors convert the light into electric analog signals. Approx. 2100 pixels of the optical spectrum are scanned simultaneously, whereby an almost complete overview spectrum in the spectral range from 480 to 560 nm with a resolution of approx. 0.1 nm is recorded. To improve the signal/noise (S/N) ratio, the signals are accumulated by the software after each individual sparking process and then a mean average value is formed by the number of measuring cycles that has been set to give the spectral representation that follows. The scaling of the dynamic range extends from 0 to 4096 arbitrary counts for a single scan (12 bit intensity resolution). For a improved scaling the dynamic range is rounded to 4100.

2.4 The Computer with Control and Measurement Electronics

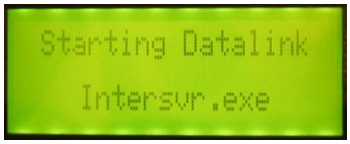
The functional tasks of the computer (PC/104 technology) are to transmit the sparking parameters to the generator and the spectrometer electronics and to further process and evaluate the signals received before outputting them on the LCD touch-screen. A serial interface (9 pole SUB-D plug) is provided for exchanging data via a PC-Link program.

2.5 PC-Link for Data Exchange

For communication with other computers and the update of software the MS-DOS communication system Interlink/Interserver is used for the communication between the device system and other computers (only working for computers equipped with Windows95® or Windows98®) for with the aid of the serial interface, a zero modem cable (Laplink-cable, 9p-SUB-D).

Copy the interlnk.exe file (supplied by Floppy-Disk or e-mail) to a directory on the computer (e.g. your Desktop or Laptop computer) where you want to make the communication with the systems. The interlnk.exe file should be placed in the main root c:\ of the external computer and should get an entry in the config.sys file[1] as following:

device=c:\interlnk.exe /com /noprinter /auto.



1. Connect a serial zero modem cable to the COM interfaces of the device (acts as Server) and the external computer (acts as Client).

2. Press the **<Link>** icon in the *Main Menu* to start data exchange program (intersvr.exe).

3. Reboot the external computer (e.g. your Laptop or Desktop-PC) to start the data exchange program. The drives of the measuring device (e.g. A:\, C:\) will appear now as additional drives (e.g. F:\, G:\) at your external computer which you can now access to copy files for updates or to copy stored spectra to your computer.

4. If no computer link could be established then restart the external computer again and press repeatedly **<F8>** to enter the Microsoft Window 98 Start Menu. Press **<5>** to select the Dos prompt level.

5. Power down the SSS3-FR-device to quit the PC-Link-program[2].

Do not start a sparking process while a connection cable is connected at the COM port of the device. The electromagnetic radiation on the line could otherwise destroy the computer interface.

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[1] Please recognize that there might be some config.xxx files on your computer in the root directory (usually c:\) depending on the operating system you may have for initial starts or the later change to MS-DOS. In such a case all files named config.xxx should be altered accordingly with the above mentioned line. Please make sure that also the lastdrive command is giving enough figures for the deviated disks on your computer when connecting to the SSS3-FR. Always place the new command at the end of the config.xxx files to avoid conflicts with other commands redirecting drives. Then either from the Windows Explorer or alternatively starting the MS-DOS mode, updates for the unit can be easily copied.

[2] Rebooting the SSS3-FR is necessary, because the Touchscreen and Keyboard function is disabled while intersvr.exe is running. Therefore the <ALT+F4> command will not work.

3 Hints and Instructions

3.1 Warnings and Safety Instructions

Ensure that sparking is only carried out on the compact, non-conducting materials to be tested. When the device is used properly, a capacitive proximity sensor integrated in the measuring head prevents sparking to conducting materials (e.g. metals, metallized plastic surfaces, human beings and other living organisms).

IMPORTANT: Never attempt to trigger sparking on human beings or conducting materials. The current shock can cause injuries.

! In order to ensure that the device can operate properly, fix it in a manner so that it cannot slip and will not be subject to vibrations.

! Ensure that there is an adequate circulation of air for the. The openings on the device are for ventilation purposes and must not be covered over or otherwise blocked. The openings are designed to ensure that the device can function properly.

! Take care that no liquid gets into the unit or the measuring gun. This can lead to internal components being damaged or to a short-circuit.

! To avoid current bridges, do not use the unit near water or in moist ambient surroundings.

! The unit may only be operated when connected to a socket with a grounded line.

! Do not look visually into the sliding spark process without protection.

! Do not operate the unit if the capacitive proximity sensor is not functioning properly.

! Ensure that the gray protective hose of the measuring pistol is not subjected to stress (no torsion!) when being coiled up for transportation (damage of the fiber optic). Clamp the hose into the clip on the top of the SSS3-FR device. Put in the measuring pistol in its holder and fix it gently with the security screw.

! This measuring device consists of sensitive electronic components. Use not in accordance with the instruction may result in their destructions. Electrostatic discharges, induces voltage peaks and balance currents between different voltage potential are particularly harmful.

3.2 Approval Instructions

Tests should be carried out if possible in a shielded cabin (Faraday cage) in order to maintain the required limit values.

It is essential that attention is paid to the fact that the sliding spark spectrometer described is a specialist device. By reason of its specification, it is normally only to be used under laboratory conditions in an industrial operation. When the device is used in the proper manner for the purpose for which it was designed, high frequency electromagnetic radiation is generated automatically and inevitably during the sparking process as part of its function.

3.3 Technical Data

Rated voltage:	for Europe: 230Volt~/50Hz
Rated voltage:	for Japan: 100 Volt~, 50/60 Hz
Rated current:	2 A max.
Protection class:	I
Type of protection:	IP 20
Mains connection:	device plug
Fuse:	5 A, fast, 20mm
Dimensions (WxHxD):	260x150x160 mm
Weight:	4 kg
ambient temperature:	15...35°C
Max. relative air humidity:	Operating: 10%...90%

4 Operation instructions

4.1 Starting

1. Set the device up in a manner and at a place where it will not slip and where it will not be subject to vibration. Ensure that the test device has an adequate circulation of air through the slits provided for this purpose.

2. Connect the device to an earthed mains connection.

3. To transport the unit, coil up the of the measuring pistols.. Fix the protective hoses into the clip mounted on the top of the device. Clamp the measuring pistols gently in its pistol holders with the aid of the

4. Solve the knurled screw at the pistol holder cup and take out the protective hoses carefully from the fixing clip and from the pistol holder cup.

Attention: Ensure that the gray hose is not subjected to excessive stress. Do not twist and/or bend it more than 180°. The fiber optic is made of quartz glass and might break!

5. Check the movable alignment of the electrodes in the measuring head. The electrode gap should be 4.5 ± 0.1 mm (see: Electrodes Adjustment).

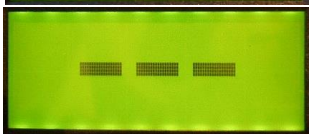
6. Switch the device on at the rocker switch on the right side. The green light ignites on the rocker switch and on the measuring gun. Hardware parameter and last settings are automatically loaded and set. The device starts the program for the detection of fire retardants automatically. The readiness of the device is signaled as shown:

7. Check the safety function of the proximity sensor on the measuring head by touching the sensor with your finger. The signal lamp on the measuring gun must change from green to red whereby an audible click of the relay must be heard. If you now attempt to start the device with the start button, you should find that sparking is disabled. The device may only be operated when this sensor is functioning properly. The sensor prevents a sparking of electrical conductive samples like strong soot filled, metallized or damp samples or your skin..

4.2 Measuring

1. For the detection of fire retardants press the measuring head against the sample surface. The surface should be smooth and as clean as possible. If not, scratch the surface with the attached knife to obtain a fresh new material surface. Both movable electrodes must have closed contact to the surface.

2. Press the start button and keep it pressed for about 1 second. When the button is pressed, the suction pump starts up and the sparking process is starting. The result is displayed after the sparking process on the LCD screen. The screen display with the results window remains displayed until the next measurement is carried out. The device shows detected Bromine and Chlorine as well as PVC (high concentration of Cl). The statement (in %) is semi-quantitative.



1. If no fire retardants are measured, the screen displays **(---)**.

2. When pressing the left side of the LCD touch screen then you can leave the result display back to the Main Menu.

3. Clean the quartz window inside the measuring head with cotton wool sticks regularly. From time to time the stick should be moistening a bit with Isopropanol to remove obstinate contaminations from the quartz lens which reduce the spectral intensity. Use the other end of the cotton stick to dry the lens.

4.3 Powering Down

1. Touch the left side of the screen in the Ready display entering the Main menu. Press <*End*>-icon to quit the program.

2. As soon as *Program End* is shown, the device can be powered down. Last settings are stored automatically and reloaded again for the next putting into operation.

3. To transport the unit, bend carefully the protective hose of the measuring pistol and fix it into the clip mounted on the top of the device. Clamp the measuring pistol gently in its pistol holder with the aid of the knurled screw.

5 Electrodes Adjustment

1. Switch the device off.

2. Lift up the small sealing ring from its slot.

3. Insert grub screw driver (SW0.9) and loose both M2 fixing screws for the electrodes.

4. Set the gap between the electrodes to 4.5 ± 0.1 mm using a slide gauge.

5. Adjust the flattened tips of the electrodes so that these are plane with the plane of the face of the measuring head.

6. Tighten up the M2 grub screws for the electrodes again.

7. Press the sealing ring into the slot with a drop of instant glue.

again. Secure the seal if necessary

6 The Fire Retardant Detection Program on the LCD-Panel

6.1 The LCD-Touchscreen Elements

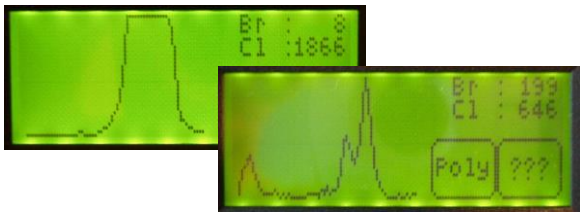
The unit is simply operated by the LCD touch screen. The software program with the given functions can be run on an external computer (e.g. Laptop), too.

After powering on the device the Ready-window is shown at first. By touching the LCD display the **Main Menu** of the program appears.

6.2 The Main Menu

End: Correct closing and quitting of SSS3-FR program. Afterwards the unit can be powered off.

Spec: Shows an auto-scaled region of the spectrum where the Bromine - and/or Chlorine spectral lines are measured. On the right side of the screen the calculated net-intensities of these halogens are listed.



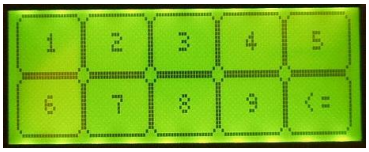
Poly: Activates the Poly-View mode to see some spectra parts in comparison. Therefore the left side of the LCD screen will not be deleted until pressing this function again. In the Poly-mode the intensities refer to the last measuring result.

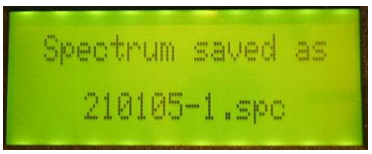
???: Switches back to the result window of the last measurement.

Set: Switches to the Set-Menu for setting parameters (see: The Set-Menu)

LOD: Switches to the LOD-Menu(see: The LOD-Menu).

Save: Switches to the Save-Menu for saving spectra by pressing one of the nine icons. The file name of the spectrum is automatically generated using the actual date with the corresponding icon (e.g. date 21.01.05 and icon #1 is pressed => 210105-1). Afterwards the spectrum can be copied by data exchange link into another computer for detailed viewing and evaluating (see: The Fire Retardant Detection Program for the VGA-Mode).

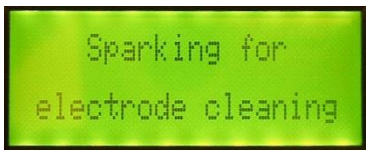




Link: Starts the data exchange program (Interlink) to link the device to an external computer (see: PC-Link for Data Exchange). To quit the connection the SSS3-FR device must be turned off and then powered on again.

???: Switches back to the result display of the last measurement.

Cln: Starts a sparking measurement for cleaning to remove possible memory effects of elements which came up in high concentration range before (e.g. Cl in PVC). The amount of pre-sparks are automatically set to 100 scans. Renewed touching the **<Cln>** icon deactivates the Cleaning function. Press the trigger at the pistol to start the cleaning.

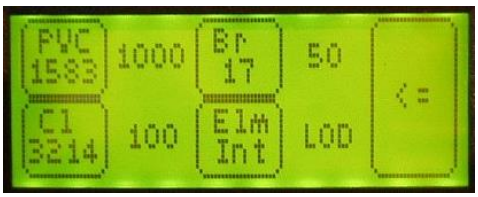


<=: Switches back to the READY-window.

6.2.1 The LOD-Menu

Detection of the halogens is carried out on the basis of the presence of a characteristic spectral line of Bromine and Chlorine at a pre-set pixel position. The net intensities ($I_{net} = I_{total} - I_{background}$) of the analysis lines are determined here by the base line subtraction method. The intensity of the background is determined at two defined points left and right next to the particular measuring line peak maximum (left Background, LBG and right Background, RBG) using a straight line equation and interpolated on the measurement line. The background intensity determined in this way is then subtracted from total intensity as determined of the analysis line. The element is presented as being identified in the results display if the line intensity after correction for the background exceeds the pre-set intensity threshold value of this line (LOD).

It means that the threshold value gives the value that has been set which the element signal for the particular type of plastic in question must exceed before the element can be displayed as being detected. The detection limit can be changed at any time by entering a new threshold value.



In the LOD-Menu the measured net-intensities for Bromine, Chlorine and PVC[3] are shown within the icon of the corresponding element symbol. The pre-set threshold values are listed on the right hand. Pressing the element-intensity-icon decreases gradually the LOD value where else pressing the corresponding LOD-icon increases the LOD threshold value. Adjusting the LODS might be useful either in case the device often detects Chlorine-, Bromine or PVC although there is no halogen existing. Or the element result should be suppressed because it is detected too sensitively (e.g. Cl memory after lot of PVC analysis).

PVC: Changing the LOD threshold value for the PVC statement.
Br: Changing the LOD threshold value for the Bromine statement.
Cl: Changing the LOD threshold value for the Chlorine statement.
<=: Switches back to the Main Menu with automatically saving the set LODs in the unit.

6.2.2 The Set-Menu

PreS: Sets the amount of Pre-sparks which are not used for evaluation. The plasma light from these sparks will not be evaluated. In other words the pre-sparks can be used for slightly cleaning the surface whereby in general a compromise must be made between cleaning the surface and degrading the material surface (carbonization). Pressing the *PreS*-icon decreases the amount of Pre-sparks, pressing the *amount*-icon gradually increases it.
Time: Sets the time interval up to the next sparking process (sequence of sparks). Pressing the *Time*-icon decrease the measuring time, pressing the *amount*-icon gradually increases it.
Scan: Sets the amount of sparks which are used for evaluation. Pressing the *Scan*-icon decreases the amount of scans, pressing the *amount*-icon gradually increases it.
Chrg: Sets the charging energy time (depends on the local power voltage). The higher the value that is selected, the longer will the pulse capacitors be charged for, i.e. the larger the amount of energy stored, the higher the amount of energy at sparking (more light intensive). Pressing the *Chrg*-icon decrease the charging time, pressing the *amount*-icon gradually increases it.
<=: Switches back to the Main Menu.

Parameters of given Sliding Spark Spectrometer part have been optimized for halogen identification and should not be changed without practical advice by specialists

[3] For the PVC-detection a spectral line of Chlorine is used which is not so sensitive (less intense) to avoid an Overload-Signal in comparison to the spectral line used for the Chlorine statement. A polymer sample is detected as PVC if more than ca. 20% of Chlorine is analyzed otherwise it is shown as Cl.

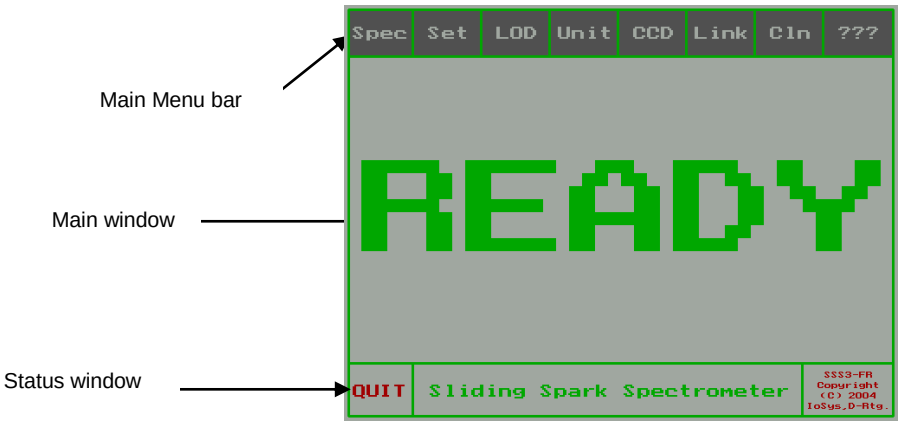
7 The Fire Retardant Detection Program for the VGA-Mode

7.1 Conventions in this Manual

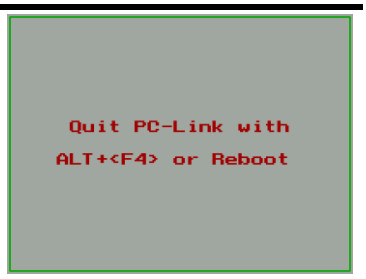
The SSS3-FR program can be run on an external computer (e.g. laptop)[4], too. The upper 8 icons of the display corresponds to the function keys F1..F8 on a common keyboard. If a number of keys have to be pressed simultaneously then this is indicated with a plus sign (+) between the individual key legends, e.g. **<SHIFT>+<F1>**. Usually small characters should be entered.

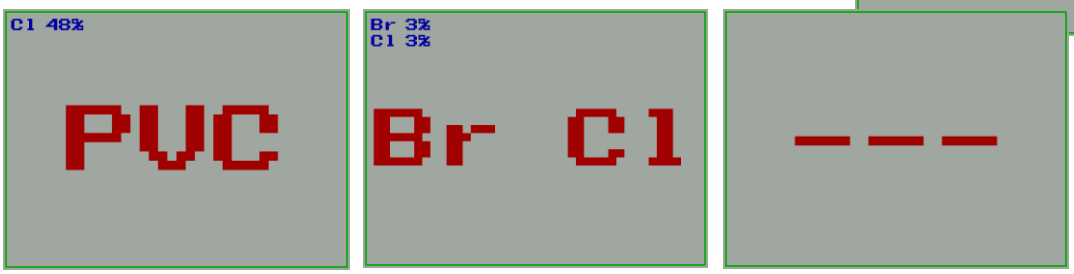
Pressing a key activates or deactivates a mode or function. In general a repeated pressing of the same key again deactivates/activates the respective operation.

7.2 Operating Elements in the Ready-window



Icon	Key	Function
SPEC	**F1**	Switches to the SPC mode for detailed viewing atomic emission spectra (see: Operating Elements in the SPC mode).
SET	**F2**	Switches to the SET mode to set[5] the sparking parameters and scanning time (see: Operating Elements in the SET-Mode).
LOD	**F3**	Opens the LOD menu to set the threshold values for the halogen detection (see: The LOD-Menu).
UNIT	**F4**	Starts the unit test program to locate potential hardware failures for trouble shooting.
CCD	**F5**	Switches to the CCD-spectrometer optic test program (for manufacture only).
Link	**F6**	Starts the PC-Link program[6] (intersvr.exe) to enables data exchanges for updates or copying files to another computer (see: PC-Link for Data Exchange).
Cln	**F7**	Starts a sparking measurement for cleaning to remove possible memory effects of elements which came up in high concentration range before (e.g. Cl in PVC). The amount of pre-sparks are automatically set to 100 scans. Renewed touching the **<Cln>** icon deactivates the Cleaning function..
???	**F8**	Switches to the results display. If no halogen is detected, the LCD displays only (**---**), it means the sample is without halogen depending on the limit of detection threshold value!





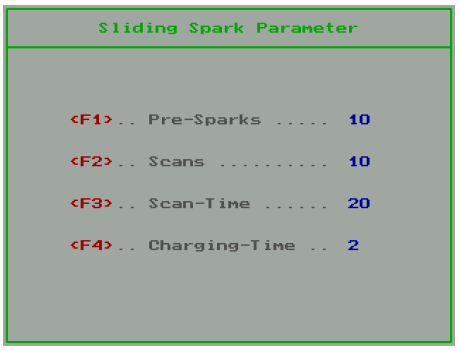
[4] If the program is used on an external computer then the testing programs and the sparking is out of order. However, spectra can be loaded and seen in detailed. To do so, an initialization of the external computer must be carried out once (see: The Initialization: Ini.Set)

[5] Parameters of given Sliding Spark Spectrometer part have been optimized for identification and should not be changed.

[6] To exit the PC-Link program the SSS3-FR device must be powered down, because the LCD touch screen and keyboard function is disabled while intersvr.exe is running. Therefore the <ALT+F4> command will not work (Beenden=Exit/End).

7.3 Operating Elements in the SET-Mode

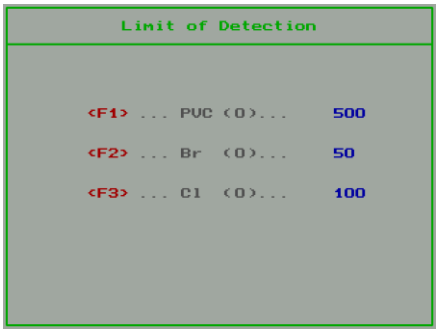
Icon	Function
F1	Sets the amount of Pre-sparks which are not used for evaluation. The plasma light from these sparks will not be evaluated. In other words the pre-sparks can be used for slightly cleaning the surface whereby in general a compromise must be made between cleaning the surface and degrading the material surface (carbonization).
F2	Sets the amount of sparks which are used for evaluation The number of measuring cycles scans is the same as the number of sliding sparks which will be grouped and evaluated together within a sequence of sparks to form an average mean.
F3	Sets the time interval up to the next sparking process (sequence of sparks). The longer the measuring time is, the greater will be the time interval up to the next sparking process (slower sequence of sparks) and thus the longer integration time available for the spectrometer optics will be.
F4	Sets the charging energy time (depends on the local power voltage). The higher the value that is selected, the longer will the pulse capacitors be charged for, i.e. the larger the amount of energy stored, the higher the amount of energy at sparking (more light intensive.



Parameters of given Sliding Spark Spectrometer part have been optimized for halogen identification and should not be changed without practical advice by specialists.

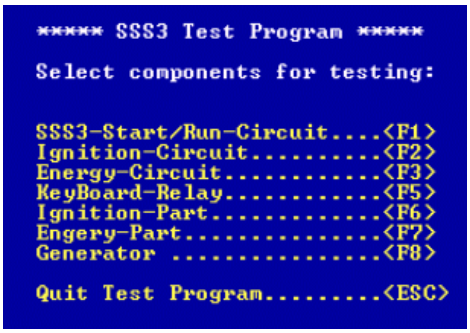
7.4 Operating Elements in the LOD-Menu

Icon	Function
F1	Sets the LOD threshold value for the PVC statement. For the PVC-detection a spectral line of Chlorine is used which is not so sensitive (less intense) to avoid an Overload-Signal in comparison to the spectral line used for the Chlorine statement. A polymer sample is detected as PVC if more than ca. 20% of Chlorine is analyzed otherwise it is shown as Cl.
F2	Sets the LOD threshold value for the Bromine statement.
F3	Sets the LOD threshold value for the Chlorine statement.



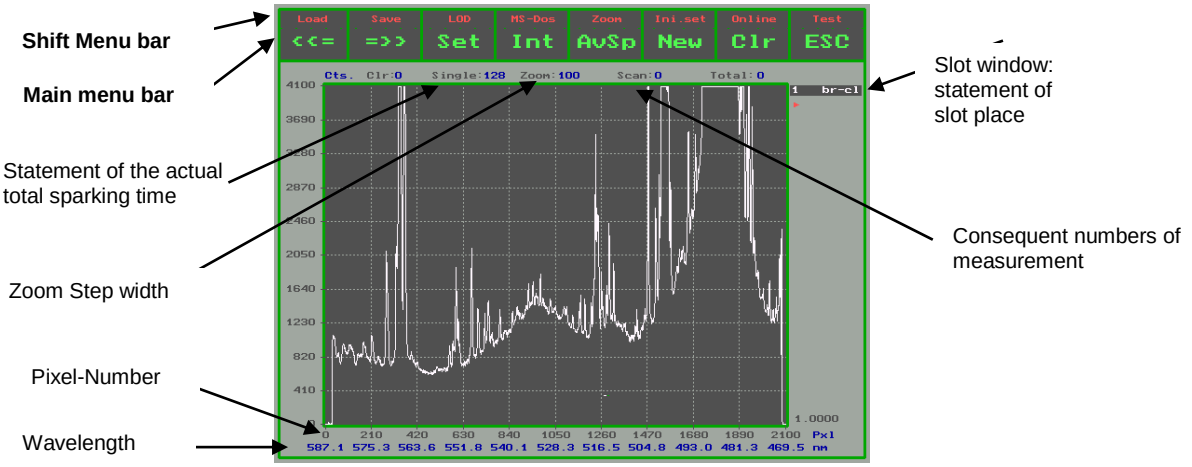
7.5 Operation Elements in the SSS3-Test Program UNIT

Icon	Function
F1	Pressing the SSS2-pistol trigger the status on the display should switch from OFF to ON. At the same time a distinct relay clicking inside the device should be heard.
F2	Testing the Ignition board circuit (for manufacture only)
F3	Testing the Energy board circuit (for manufacture only)
F5	While pressing a distinct relay clicking inside the device should be heard.
F6	While pressing the pistol trigger, weak sparks (high voltage ignition sparks) should appear.
F7	While pressing the pistol trigger, weak “high frequency sound” inside the device should be heard.
F8	While pressing the pistol trigger, high current spark discharges should appear. In this mode the sliding spark generator, consisting of the Ignition- and Energy-part as well as the control electronics located on the Interface-Board are tested together.
ESC	Quits the test program. Back to the READY-window.

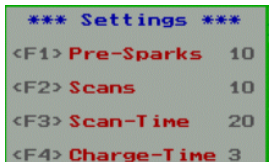


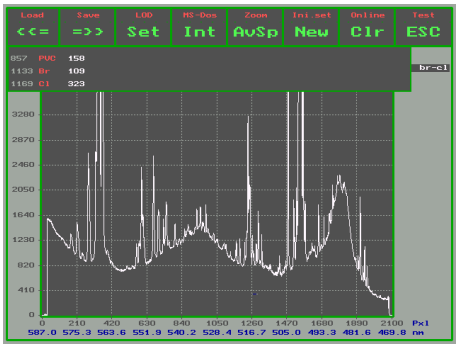
7.6 Operating Elements in the SPC mode

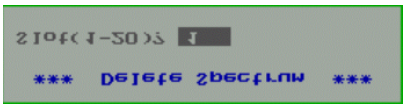
7.6.1 The Main Menu



Icon	Key	Function
<=	**F1**	Move to the next spectrum image section to the left in the pixel step width set under ZOOM in zoomed and auto scaled form.
=>	**F2**	Move to the next spectrum image section to the right in the pixel step width set under ZOOM in zoomed and auto scaled form.
Set	**F3**	Opens the SET-window in the Spec-Mode to enter the sparking parameters.
INT	**F4**	Listing of the net intensity values of the pre-set halogen element lines from all spectra displayed (max. 20 spectra). In the left column of the Intensity window the drift-corrected[7] pixel positions for the analysis lines are listed. ⇐ Displays the first 10 spectra (1 to 10). ⇒ Displays the last 10 spectra (11 to 20).
AvSp	**F5**	Calculating of an Average Spectrum from all spectra displayed. The average spectrum is written into last slot place (#20) and marked with a blue bar. Pressing the function key again cancels the arithmetic meaning.
NEW	**F6**	Opening of a new window, for deleting the representation of a spectrum at the slot place. The next spectrum now appears at the slot place marked with „ ▸ ".
CLR	**F7**	Deleting of all the spectra represented at the slot place.
ESC	**F8**	Leaves the SPC mode, back to the READY window.







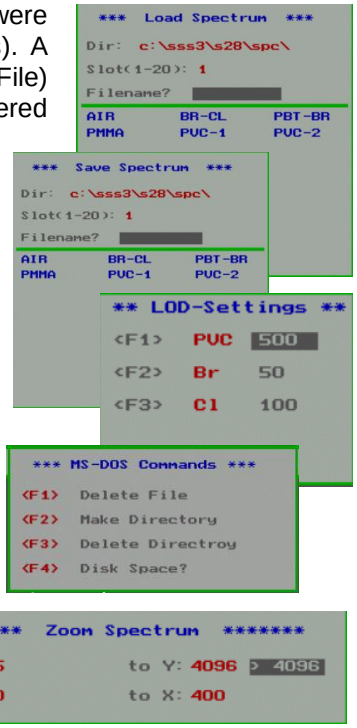
7.6.2 Additional Operating Elements

Icon	Key	Function
./.	⇑	Auto scaled representation of spectrum section in the pre-set pixel step width.
./.	⇓	Full image representation of the spectrum window in question.
Zoom	**‘ ‘**	Setting of the pixel step widths in steps of 20, 50, 100, 200 and 2100 steps for detailed spectra viewing. Change the step widths by pressing the **<Zoom>** icon or **<Space>** key repeatedly.
Scan	**S**	Starts a measurement without sparking and pistol triggering.
./.	**T**	Displaying the last NIR-curve (highest Slot-number) as a thick or thin curve.

[7] Displacements of the predefined pixel positions in the spectrometer optics can come about as a result of temperature effects. The program routine determines and corrects this pixel drift by determining the deviation in relation to the defined drift correction line for the current position. In addition the analysis lines as set are "run through" so that the particular peak maximum of the scan line is automatically brought in for the net intensity calculation. The drift-corrected pixel positions of the highest slot place are listed in the left-hand column of the INT menu. Marking of the particular pixel number in red indicates that the position of the current peak maximum of the analysis line has been moved by 2 pixel units to the left in comparison with the pre-set pixel number, a blue marking that it has been moved by 2 pixel units to the right.

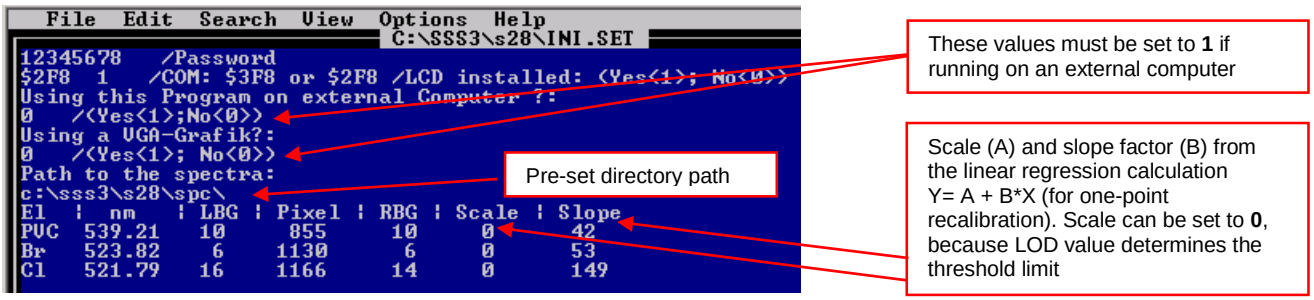
7.6.3 The Shift Menu

Touch	Key	Function
Load	**Sft+F1**	Opens the Load-Spectrum window to open spectra which were saved in the directory path edited under Dir (max. 22 letters). A temporary change to the pre-set directory (edited in the Setup File) and path can be carried out under Dir. The files are listed in filtered form in accordance with the characters entered. Moving within the window can be done with the Enter or Cursor up/down key. Loaded spectra are shown in different colors after quitting the menu.
Save	**Sft+F2**	Opens the Save-Spectrum window to permit spectra to be stored in the directory path edited under Dir (max. 22 letters). A saved spectrum file gets the file suffix „*.spc“ and are written in a Flat-ASCII text format.
LOD	**Sft+F3**	Opens the LOD menu to set the threshold values for the halogen detection (see: The LOD-Menu).
MS-Dos	**Sft+F4**	Opens a MS- Dos menu for the entering or carrying out given MS-Dos operation commands: **F1** Delete File **F2** Make Directory **F3** Remove Directory **F4** Disk Space
Zoom	**Sft+F5**	Opens the zoom menu with numbers block for entering a section window for detailed viewing of the spectra.
Ini.set	**Sft+F6**	Starts the text editor (edit.com) with automatically loading the initialization file *ini.set* for for editing modifications like directory paths, scale factors (B) or pixel numbers (see: The Initialization: Ini.Set).
Online	**Sft+F7**	Continuous running and reading of the spectrometer optics whereby the online spectrum is always displayed in the first slot. This mode permits external light emission sources (e.g. HCL, neon lamp) held in front of the measuring head to be spectroscopically analyzed. In the online mode, sparking with the measuring gun is disabled (function for manufacturer only).
Test	**Sft+F8**	The Test-function permits to control changes in the scanning sensitivities of the scanning and reading electronics. In this mode the dynamic range[8] of the photo-sensors can be determined and thus to be checked. The start button of the measuring gun is disabled in TEST mode (function for manufacturer).



8 The Initialization: Ini.Set

Pre-set parameters like directory paths, pixel positions of the spectral lines and their backgrounds calibration data for semi-quantitative statements are stored in the file *Ini.set*. This text file can be opened by pressing the **<Sft>+<F6>** (*ini.set* icon). As an exam ple a typical initialization file is listed. If operating the *sss3.exe* program on an external computer please take care that all files are located in the same subdirectory together with the spc-subdirectory (e.g. here c:\sss3\s28)



Do not make any changes to the formatting in the text files. Do not insert a decimal point with Integer numbers.

[8] In the <Test> mode the spectrometer signals are continuously shown in slot place #1. Pressing the function key again causes switching between the initial zoomed image representation (LEDoff= dark signal: 0-100 Cts. and LEDon = saturation signal: 4000-4100 Cts.) and the full image representation (0-4100 Cts.).

9 Non-identifications / Incorrect identifications

The fact that a known sample (e.g. PVC) has not been identified is indicated with the No-Result (---) on the results screen. If no improvement in identification performance comes, one of the following can be responsible:

Possible cause	Solution / elimination of mistakes
Surface of sample painted	a) Repeat the measurement at another point, e.g. on the inside of a monitor housing.
Dirty sample surface place	a) Scratch the surface with a knife to obtain a fresh new material surface
Structured sample surface	a) Repeat the test if possible at a point which is smooth or less structured b) Scratch the surface with a knife to even the surface
Electrodes do not come into contact with the sample surface	a) Check the position of the seals in their slots. b) Check the position of the electrodes. c) Adjust the distance between the electrodes if necessary (see: Electrodes Adjustment).
Permanent display of particular element/s (memory effect)	a) Carry out a number of "cleaning shots" by placing the measuring head in the measuring head holder and carrying out a few sparking cycles. b) If necessary correct the threshold value for the halogen elements in the LOD-Menu.
Dirt on the quartz window	a) Clean the quartz window inside the sparking chamber with cotton wool sticks[9]

10 Operational Disruptions

Fault	Elimination
Green rocker switch does not illuminate	a) Check the device fuses inside the power plug socket and if necessary insert a new one of the same type (5A/fast).
Computer and display is not starting	a) Switch the device off and then try to start again.
Program „crashes“ after a sparking process	a) Switch the device off and try to start again. b) Check the device parameter settings and if necessary load the default values of original settings.
Spectra cannot be loaded.	a) Check the spectra directory and path
Sliding spark ignites poorly	a) The particular type of plastic is inherently unsuitable for the sliding spark process b) Check the alignment of the electrodes and reset the distance between them if necessary (see: Electrodes Adjustment).
The sliding spark ignites but is too weak	a) Check the charging time of the capacitor charging energy. b) Switch the device off and then on again. c) Defect of the energy circuit board (maintenance)
Proximity switch triggers too often	a) Release the fixing screw and push the sensor deeper into the measuring head until the desired sensitivity is reached. Screw up the grub screws again.
No halogens are detected using known samples (e.g. PVC)	a) Clean the quartz window inside the measuring head with cotton wool sticks moisten with alcohol. Dry the lens with the other end. b) Remove adhere contaminations on the electrodes.

[9] From time to time the cotton stick should be moistened with a little bit of Isopropanol (Isopropylalcohol) to remove invisible coatings on the quartz window which decreases the light intensities.