

X SPARK 10 SMALL-SCALE ELECTROSTATIC SPARK SENSITIVITY TESTER

Product Datasheet

The X SPARK 10 is the newest generation of universal testing instrumentation (stemming from the ESD 2008A) designed for the precise measurement of the initiation of energy (sensitivity to electrostatic spark) of energetic materials. It is designed for the precise measurement of the initiation energy of crystalline energetic materials in the range of discharge energies (from 25 μ J to 25 J) and voltage up to 10 kV with typical sample mass about 10 mg. Usually about 30 - 40 trials with different spark energies are required to perform of complete test.

Measurement of sensitivity to electric spark is based on the principle of capacitive discharge driven through the granular bed of the tested substance. Selected capacitors are charged by the inbuilt high voltage supply of the instrument and electric discharge of desired energy is generated. The discharge is carried by the leading cable to the spark gap, where the spark is formed and affects the sample which is placed in between the two electrodes.

The X SPARK 10 operates in the two discharge regimes – Oscillating & Damping – for testing the sensitivity to electrostatic spark (discharge) of various classes of energetic materials. The ‘Oscillation discharge mode’ (short duration, intensive and undamped) is used for the testing of high explosives and other similar materials. The ‘Damped discharge mode’ (long duration, low intensity) is used for the testing of propellants, primary explosives, pyrotechnic mixtures. The X SPARK 10 instrument can load the sample with very wide range of spark energies allowing testing all categories of energetic materials ranging from extremely sensitive primary explosives to insensitive high explosives. Several testing modes and replaceable spark gaps designed according to relevant testing standards are available.



Compact design of the X SPARK 10 instrument provides best conditions to reach of maximal efficiency of the electric discharge (low resistivity and inductance of discharge circuit, the shortest length of leading cables and high discharge energy in low value of voltage) and also optimize tester operation which consists as a single portable unit. Small-scale electric spark tester X SPARK 10, as the only one of very few available instruments of this type, allows to precisely measuring total spark energy discharged into the sample. Analyzation and evaluation is conducted via software WINSPARK in the operator’s PC.

These features make X SPARK 10 truly the most advanced ESD sensitivity tester to explosive materials currently available in the market.

ESD-08CC

Additional set of external ceramic capacitors



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THEORY

Amount of the spark energy transferred in to the spark gap differs from the theoretically calculated energy ($E = 1/2 \cdot C \cdot U^2$) stored in capacitor. Final energy of the spark and time profile of the discharge depends on many factors, mainly on the input voltage, capacity, resistivity, impedance and inductance of entire discharge circuit of the instrument. The part of discharge energy is lost during transfer on the parts of the instrument, predominantly on high voltage switch, leading cables and mechanical contacts of the discharge circuit. This energy is dissipated to the surroundings in the form of electromagnetic waves and heat. The part of discharge energy remains also in the discharge circuit after spark extinction in the form of residual charge. Thus the final efficiency of the spark may vary in the range between 20 - 95 % depending on design of the instrument, design of the spark gap, used testing methods and sample parameters, etc. The efficiency strongly falls down with increasing of high voltage level (optimal level of voltage value does not exceed 9 kV). To get the real test data is also necessary to use suitable discharge test mode in order to tailor the discharge parameters to the main initiation mechanism of the tested substance. This can be done by the setting the correct parameters of discharge circuit.

APPLICATIONS

Electrostatic spark is one of the most frequent and the least characterized cause of accidental explosions of energetic materials. To have reliable data related to electric spark sensitiveness of energetic materials is thus a critical imperative in their R&D, quality control of manufactured explosives, characterization and qualification of new explosives, surveillance of in-service explosives, loading or demilitarization and many other testing programs.

COMPLIANCE

EN 13938-2 Explosives for civil uses – Propellants and rocket propellants – Part 2: Determination of resistance to electrostatic energy.

- STANAG 4490: Electrostatic Discharge Sensitivity Tests
- MIL-STD-1751A Safety and Performance Tests for the Qualification of Explosives - Methods 1031, 1032 & 1033.

INSTRUMENT DESCRIPTION

Small-scale electrostatic spark tester X SPARK 10 consists of inbuilt high-voltage power supply, bank of capacitors, damping resistor, remote-controlled high voltage switch, testing chamber including suction fan, set of additional external capacitors, spark gap assemblies, testing stands, remote controller, set of accessories and additional protective plexi-glass shield to protect instrument against influence of explosion effects during measurement of unconfined explosive samples. Selected capacity should be setup by changing position of the jumper on working terminal of the instrument or inserting an external capacitor into the relevant socket on the working terminal. Desired output voltage is setup using potentiometers and is monitored on display placed on the front panel of the instrument.

Several models of spark gap assemblies designed according to requirements of different standards or testing methods are available.

Spark gap assembly according to OZM/TNO/DTX standard is designed for precise testing sensitivity of small amount of confined sample of energetic materials by oscillation and damping mode with fixed distance of planar and flat electrodes;

Spark gap assembly according to MIL-PRF-46676B (AR) for characterization of flexible explosives by oscillation mode with fixed distance planar electrodes.

Spark gap assembly according to MIL-STD-1751 method 1032 & 1033 is designed for testing of unconfined explosives sample with variable distance using approaching needle anode.

Spark gap assembly according to EN 13938-2 standard for testing of confined sample of propellants. Measurement is almost carried out inside robust external testing chamber to protect operator against explosion effects of higher mass of the sample.

Spark gap assemblies are equipped by static cathode which is used as sample holder and anode with fine adjustable level of position. Both electrodes of spark gaps are mounted in one of supplied testing stands.

FIXED ELECTRODES TESTING STAND – automatic & remote controlled universal stand for spark gap assemblies according to standard OZM/TNO/DTX and MIL-STD-1751A methods 1031 with fixed distance of electrodes. This stand is equipped by pair of pneumatic cylinders serves to independent control of moving of replaceable protection cover and anode. Both pneumatic cylinders are lowered down and lifted up automatically before and after releasing discharge to easier manipulation with the cathode. Moving protection cap is designed especially to protect the instrument against explosion effects; protection cap also allows further instrumentation in order of advanced discharge diagnostics or scientific research.

APPROACHING ANODE TESTING STAND – automatic & remote controlled universal stand for spark gap assemblies according to standard MIL-STD-1751A methods 1032 & 1033 equipped by the approaching anode mechanism. This stand is equipped by pneumatic cylinder serves to control of moving of string operated device of the needle anode.

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Time profile of input energy and the fraction of the energy consumed by the sample are measured by a high voltage and current probes connected with oscilloscope and analysed by specialized computer program WINSPARK in the operator's PC.

The instrument is equipped with the several couples of safety features including automated and manual grounding switches and grounding resistors serving for the safe discharging of energy stored in the capacitors and preventing any presence of the residual charge in the tester, while the operator interferes with the discharge circuit. The main doors of the testing box are electronically blocked during charging and firing for the safety of operators.

TECHNICAL PARAMETERS

Apparatus

Output voltage :	0.5 - 10 kV
Output current:	10 mA
Input voltage:	~ 230 V, 50 Hz
Power input:	P = 100 VA
Protection:	IP 40/20

Built-in high voltage capacitors and damping resistor

Capacity $U_{max} = 10kV$:	5; 15; 30; 100; 150; 200 nF
RESISTANCE $U_{max} = 10kV$:	$R_D = 10 k\Omega$

Set of External capacitors:

Capacity $U_{max} = 10kV$:	20; 40; 100; 250; 400 pF, 1; 2; 3 nF (nominal values)
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Discharge energy range

Installed energy of electric charge E:	from 25 μ J to 25 J
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Maximum sample volume/approx. weight:

2.2 mm ³ / 5 mg (ESD-OZM/TNO)
94 mm ³ / 188 mg (ESD-10EEN)

Environmental

Operating temperature: 0 °C to 40 °C
Operating humidity: 0 - 90 % relative humidity, non-condensing
Storage temperature: -40 °C to 70 °C
Storage Humidity: < 95 % RH (no condensation)

SHIPPING DATA

Package dimensions (W x L x H):	122 x 82 x 83 cm
Package gross weight:	150 kg
Custom code:	9031 20 00

INSTALLATION REQUIREMENTS

Apparatus dimensions:
W x L x H: 60 x 51 x 45 cm; Weight: 26 kg

Electric power source:
100 - 240 V / 50 (60) Hz
(to be specified when ordering)

Compressed Air: max 10 Bar, Exhaustion Diam. 80 mm
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STANDARD INSTRUMENT PARTS

ESD-08A	X SPARK 10 INSTRUMENT - main unit - high voltage power supply 10 kV / 10 mA - inbuilt capacitors bank 5; 15; 30; 100; 150, 200 nF / 10 kV - inbuilt damping resistor 10 k Ω / 10 kV - current view resistor - oscillation mode - current view resistor - damped mode - working panel (capacitors changer) - internal testing chamber - suction fan - internal lighting - remote controller - grounding rod
ESD-08CC	Additional set of 11 external ceramic capacitors - 1x20; 2x40; 1x100; 2x250; 2x400 pF, 1x1; 1x2; 1x3 nF / 10 kV
ESD-08-FEST	FIXED ELECTRODES TESTING STAND - universal stand for automatic & remote-controlled testing assembly according to OZM/TNO/DTTX - air-operated cap holder - air-operated adjustable anode pin holder - replaceable open protection plexiglas cap
ESD-OZM-TA	SPARK GAP ASSEMBLY according to OZM/TNO/DTTX - anode pins according to OZM std. (2 pcs) diam. 1.6 mm - cathode body - cathode pins according to OZM std. (2 pcs) diam. 3.7 mm - starting set of sample holder (100 pcs) - starting set of anode protective tube (100 pcs)
ESD-08ACC	Set of tools and accessories - copper flat file - steel flat file - tube cutter - spatula - brush - inert reference material - leading cables - grounding cable (5 m) - jumpers and connectors - plexiglas protection shield - spanners etc.
ESD-08-HVB	Set for MEASUREMENT OF ENERGY OF DISCHARGE - high voltage probe 40kV (substit. of electrostatic voltmeter) - splitter 10:1
WINSPARK	Software for data evaluation OZM WINSPARK 1.0 for W7
ESD-TDS-202	OSCILLOSCOPE TEKTRONIX TDS2002C incl. accessories (2-channels)



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CONSUMABLES (SPARE PARTS)

ESD-08-FEST FIXED ELECTRODES TESTING STAND

ESD-08A-POC	Replaceable open protection plexiglas cap for ESD-08-FEST and ESD-08-AAST
ESD-08A-PCC	Replaceable closed protection plexiglas cap for ESD-08-FEST and ESD-08-AAST
ESD-08A-PS	Plexiglass protection shield for ESD-08-FEST & ESD-08-AAST

ESD-OZM-TA SPARK GAP ASSEMBLY according to OZM/TNO/DTTX

ESD-OZM-AP	Anode pin for ESD-OZM-TA according to OZM/TNO/DTTX standards diam. 1.6 mm
ESD-CP	Cathode pin for ESD-CB according to OZM/TNO/DTTX standards diam. 3.7 mm
ESD-CB	Cathode body for ESD-08-FEST for ESD-OZM-TA and ESD-08-AAST
ESD-OZM-PTH	Protective tube for anode of ESD-OZM-TA according to OZM/TNO/DTTX standards (length: 3 m)
ESD-SHT	Sample holder tube for ESD-OZM-TA and ESD-32-TA (length: 3m)

OPTIONAL ACCESSORIES

ESD-08-AAST	APPROACHING ANODE TESTING STAND automatic & remote controlled stand for spark gap assemblies according to MIL-STD-1751A methods 1031, 1032 & 1033 - stand - air-operated moving needle device
ESD-3133-TA	SPARK GAP ASSEMBLY according to MIL-STD-1751A methods 1031 & 1033 - starting set of needles (100 pcs) - cathode body incl. sample holder diam. 16 mm

ESD-3133-TA & ESD-32-TA SPARK GAP ASSEMBLIES according to MIL-STD-1751A methods 1031 & 1033

ESD-SON	Set of needles (100 pcs)
ESD-3133-C	Cathode body incl. sample holder for ESD-3133-TA according to MIL-STD-1751A methods 1031 & 1033 diam. 16 mm
ESD-CB	Cathode body for ESD-32-TA according to MIL-STD-1751A method 1032
ESD-CP	Cathode pin for ESD-CB according to MIL-STD-1751A method 1032 diam. 3.7 mm
ESD-SHT	Sample holder tube for ESD-OZM-TA and ESD-32-TA (length: 3m)
ESD-32-TP	Insulating tape for for ESD-32-TA according to MIL-STD-1751A method 1032

ESD-EN10-TA SPARK GAP ASSEMBLIES according to EN 13938-2 & EN 13763-13

ESD-32-TA	SPARK GAP ASSEMBLY according to MIL-STD-1751A methods 1032 - cathode body - cathode pin diam. 3.7 mm - starting set of needles (100 pcs) - starting set of sample holders (100 pcs) - insulating tape
ESD-EN10-TA	SPARK GAP ASSEMBLY according to EN 13938-2 & EN 13763-13 - anode - cathode - plastic holder - leading cable 1.8 m - plexiglass protection shield - starting set of sample holders (20 pcs)

ESD-EN10-SH	Set of sample holders incl. copper covers for ESD-EN10-TA according to EN 13938-2 (20 pcs)
ESD-EN10-TV	Anode, cathode and plastic holder for ESD-EN10-TA according to EN 13938-2
ESD-EN10-PB	Plexiglass protection shield for ESD-EN10-TA for testing according to EN 13938-2
ESD-EN10-LHV	Leading high voltage cable (1.8 m)

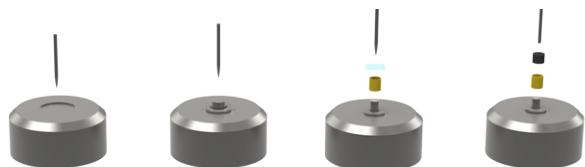
ESD-FE-TA SPARK GAP ASSEMBLY according to MIL-PRF-46676B(AR)

ESD-FE-CB	Cathode body for ESD-FE-TA
ESD-FE-CP	Cathode pin for ESD-FE-TA diam. 6 mm
ESD-SON	Set of needles (100pcs)

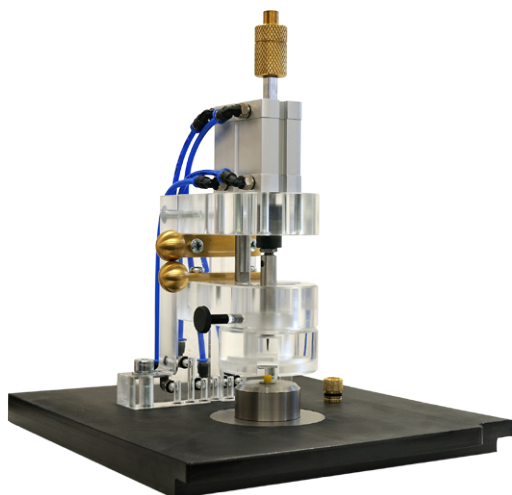
ESD-FE-TA	SPARK GAP ASSEMBLY according to MIL-PRF-46676B(AR) - starting set of needles (100 pcs) - cathode body - cathode pin diam. 6 mm
ESD-TDS-204	OSCILLOSCOPE TEKTRONIX TDS2004C incl. accessories (4- channels)
DAEU-17	Data acquisition and evaluation unit (notebook with the following minimum configuration or higher: 17" display, 2 GHz processor, 1.8 GB RAM, DVD-RW, HDD 250 GB, WLAN, BT, LAN, USB, Win 7)
TCH10	EXTERNAL TESTING CHAMBER for testing according to EN 13938-2 & EN 13763-13 (resistant to explosion of 10 g of explosive)

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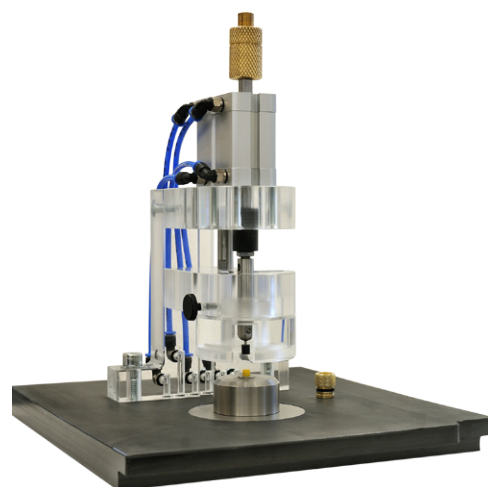
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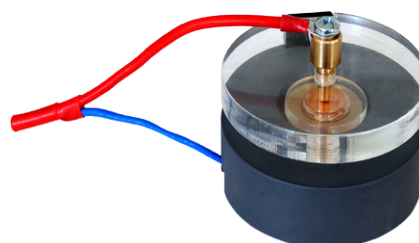
Left to right:
ESD-30133-TA Spark gap assembly acc. to MIL-STD-1751A methods 1031 & 1033
ESD-FE-TA Spark gap assembly acc. to MIL-PRF-46676B (AR)
ESD-32-TA Spark gap assembly acc. to MIL-STD-1751A methods 1032
ESD-OZM-TA Spark gap assembly acc. to OZM/TNO/DTTX



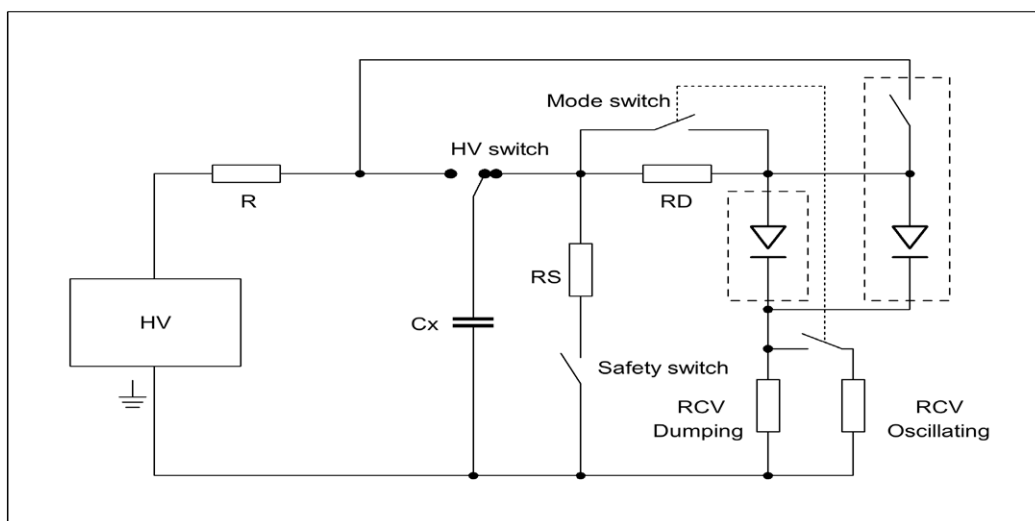
ESD-08-AAST
APPROACHING ANODE TESTING STAND
automatic & remote controlled stand for
spark gap assemblies according to
MIL-STD-1751A methods 1031, 1032 & 1033



ESD-08-FEST Fixed electrode testing stand



ESD-EN10-TA
Spark gap assembly
according to EN 13938-2 &
EN 13763-13



Block diagram of the **X SPARK 10** instrument