High-Precision Ballistic Analyzer

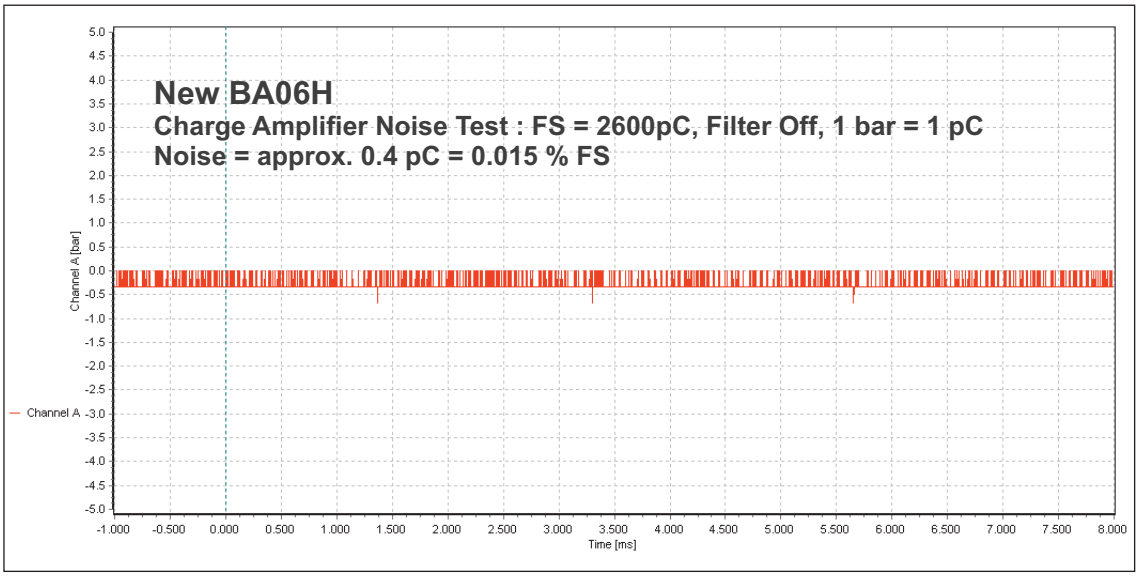
BA06H

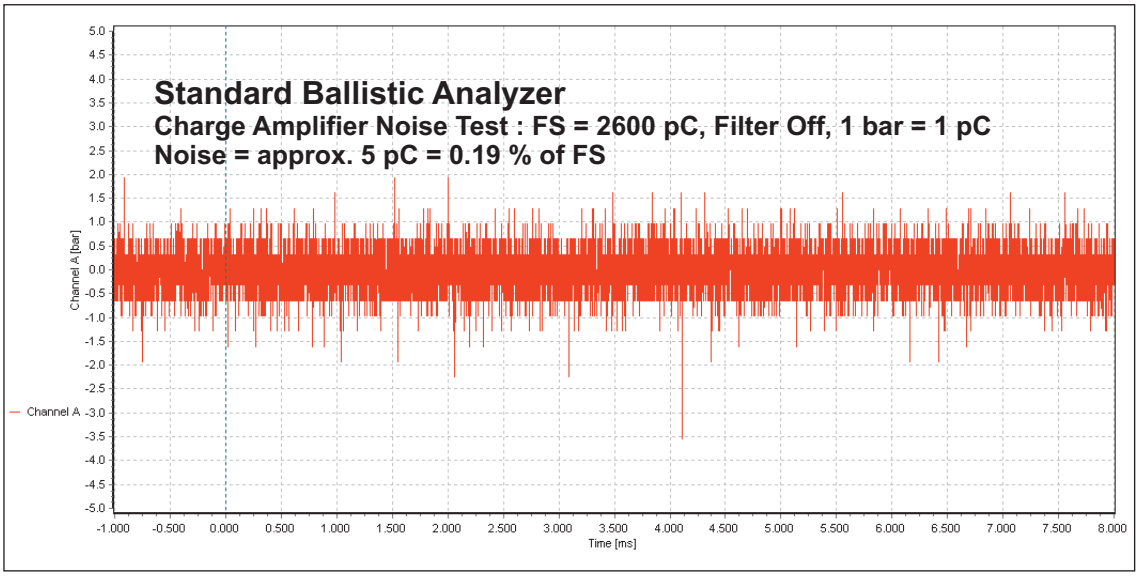
BA06H - Accuracy improved to 0.1%

The key parameter for increasing of accuracy is the maximum possible reduction of the noise of the Charge Amplifier and the A/D Converter.

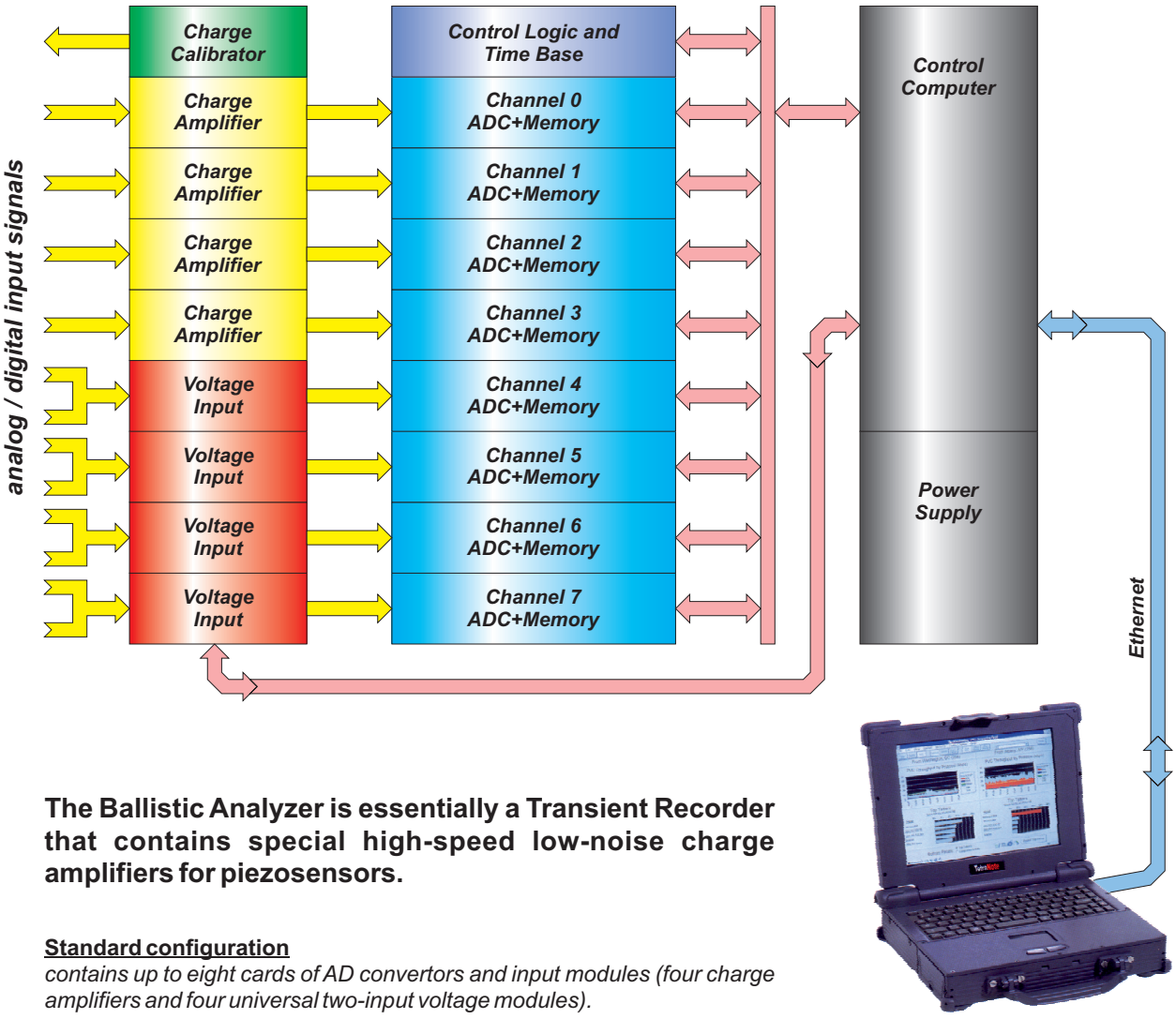
Older ballistic analyzers guaranteed typically accuracy 0.5% and noise typically 0.2% of the measuring range. For the development of new products, it is necessary to improve measurement accuracy ideally to 0.1%, but in this case it is necessary to reduce noise to at least 0.05%.

The result of our development is the state of the art BA06H, which has noise reduced to a level of 0.015% and guaranteed accuracy 0.1% (charge inputs).





BA06H Block Diagram and Parameters



notebook or desktop PC

The Ballistic Analyzer is essentially a Transient Recorder that contains special high-speed low-noise charge amplifiers for piezosensors.

Standard configuration
contains up to eight cards of AD convertors and input modules (four charge amplifiers and four universal two-input voltage modules).

Special configuration
Based on special requirements it is possible to realize a different configuration of input modules, or to develop special input modules for other types of sensors.

BA06H : COMMON PARAMETERS

Input Channels :	Max. 8 Independent Channels (ADC+RAM), Full Synchronised					
Analog to Digital Converter (ADC) :	16 bit (±15 bit), ±5V Input Range					
Memory (RAM)	512k x 16 bit SRAM					
	Max. 400 000 Points Accessible					
	Max. -100 000 Points (Pretrigger), +300 000 Points (Posttrigger)					
Sample Rate &	Sample Rate :	Pretrigger [Points] :	Pretrigger [ms] :	Posttrigger [Points] :	Posttrigger [ms] :	BREAK Function :
Record Length :	2.0 MHz (MSa/s)	- 100 000	- 50	+ 300 000	+ 150	No
	1.0 MHz (MSa/s)	- 100 000	- 100	+ 300 000	+ 300	No
	0.5 MHz (MSa/s)	- 100 000	- 200	+ 300 000	+ 600	No
	0.2 MHz (MSa/s)	- 100 000	- 500	+ 300 000	+ 1 500	No
	0.1 MHz (MSa/s)	- 100 000	- 1 000	+ 300 000	+ 3 000	No
	50.0 kHz (kSa/s)	- 100 000	- 2 000	+ 300 000	+ 6 000	Yes
	20.0 kHz (kSa/s)	- 100 000	- 5 000	+ 300 000	+ 15 000	Yes
	10.0 kHz (kSa/s)	- 100 000	- 10 000	+ 300 000	+ 30 000	Yes
	5.0 kHz (kSa/s)	- 50 000	- 10 000	+ 300 000	+ 60 000	Yes
	2.0 kHz (kSa/s)	- 20 000	- 10 000	+ 300 000	+ 150 000	Yes
	1.0 kHz (kSa/s)	- 10 000	- 10 000	+ 300 000	+ 300 000	Yes
	0.5 kHz (kSa/s)	- 5 000	- 10 000	+ 300 000	+ 600 000	Yes
	0.2 kHz (kSa/s)	- 2 000	- 10 000	+ 300 000	+ 1 500 000	Yes
	0.1 kHz (kSa/s)	- 1 000	- 10 000	+ 300 000	+ 3 000 000	Yes
Time Base Parameters :	X-tal Controlled, Error < ±100 ppm					
	Ageing < ±5 ppm/year					
	Temperature Coefficient < ±1 ppm/°C					
	Shock Resistance < ±20 ppm					
Time Measurement Error :	±((0.0001 * Time) + 2 / (Sample Rate))					
	Time = Measured Value of Time in [s] (between START and STOP Cursor), Sample Rate in [Hz]					
	Temperature Coefficient < ±10 ppm/°C					
Trigger :	Trigger Source :	Channel A (CH0) to Channel H (CH7)				
	Trigger Level :	0 to ±87.5 % of Full Scale in 12.5 % Increments				
	Trigger Edge :	Rising or Falling				
Power Supply :	Voltage :	12 - 26V DC - External 100 - 240V AC Power Adapter included				
	Consumption :	nom. 25W (max. 40W)				
Operating Conditions :	Temperature Range :	-20°C to +40°C				
	Relative Humidity :	Less than 90% (no condensation)				
	Sealing :	IP50				

BA06H : TIME MEAS. ACCURACY

Total Error, max. @ Tcal, [s] :	(0.0001 x Time) + (2 / SR)
Total Error, max. @ Tcal, [%] :	0.01 + 200 / (Time x SR)
SR = Sample Rate (20 kHz = 20 000, 5 MHz = 5 000 000, etc.)	
Time = measured value of time (START - STOP) [s]	
Temperature coefficient < 0.001%/°C	

BA06H VELOCITY MEAS. ACCURACY (with WLS03/04 or WTS03/04 : Base = 1m, Accuracy = 0.2%)

Total Error, max. @ Tcal, [m/s] :	(Base / Time) - (Base / (Time + (0.0001 x Time) + (2 / SR))) + (0.002 x Base / Time)
Total Error, max. @ Tcal, [%] :	0.01 + 200 / (Time x SR) + 0.2
SR = Sample Rate (20 kHz = 20 000, 5 MHz = 5 000 000, etc.)	
Time = measured value of time (START - STOP) [s]	
Base = base for measurement of velocity [m]	
Temperature coefficient (TC) < 0.005%/°C	

BA06H : CHARGE AMPLIFIER

Input Ranges (FSR) :	Range [pC]	dQ/dt @ AZON max. [pC/s]	dQ/dt @ AZOFF max. [pC/s]
	2 600	80	2
	5 200	80	2
	10 600	80	2
	20 200	80	2
Nonlinearity, max. [%] of FS :	0.05		
Total Error, max. [%] of FS @ Tcal :	0.1	(AZOn)	
TC, max. [%/°C] :	0.005		
Noise (Peak Value, Unfiltered) :	< ± 0.015 % of FS		
Capacity of Cable & Sensor :	unlimited	(guaranteed stability only)	
Automatic Drift Compensation :	yes		
High-Speed Discharge :	yes		
High-Speed Overload Recovery :	yes		
High-Speed Overload Recovery Time, max. [s] :	1		
Max. Input Voltage (DC or AC, DC+AC <1kHz) [V] :	±50		
Bandwidth (-3dB) :	Filter	Bandwidth	Rise/Fall Edge
(Bessel 2nd order Low-Pass Filter)	[kHz]	[kHz]	10% to 90% [µs]
	10	10	<50
	20	20	<25
	40	40	<12
	OFF	>500	<1

BA06H : VOLTAGE INPUT

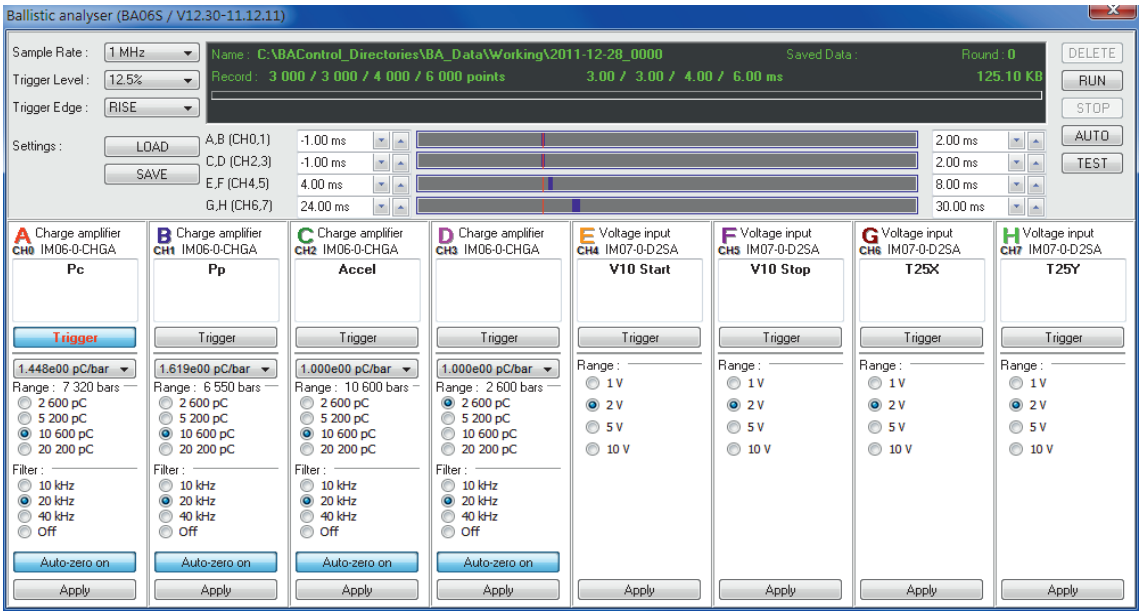
Input Ranges (FS) :	1.00
	2.00
	5.00
	10.00
Input Impedance [kOhm] :	10
Slew Rate [V/us] :	10
Bandwidth [kHz] :	>400
Nonlinearity, max. [%] of FS	0.1
Total Error, max. [%] of FS @ Tcal	1.0
Max. Input Voltage (DC or AC <1kHz) [V] :	±50

BA6H : CHARGE CALIBRATOR

Output Voltage [V] :	±2.4000
Output Voltage Step [V] :	0.0001
Output Voltage Error, max. [% of FS] :	±0.050
Output Voltage Temperature Drift, max. [% of FS / °C] :	±0.002
Output Voltage Time Drift, typ. [% of FS / 1000 hours] :	±0.005
Output Voltage Noise, 0.1-10Hz, typ. [µVpp] :	5
Output Impedance, typ. [Ohm]:	100
BA06PCAL is precision voltage-step source, which is converted	
by means of precision reference capacitor to charge.	
Recommended calibration capacitor :	
KISTLER 5371A10000 (10nF nom. ±0.1%)	

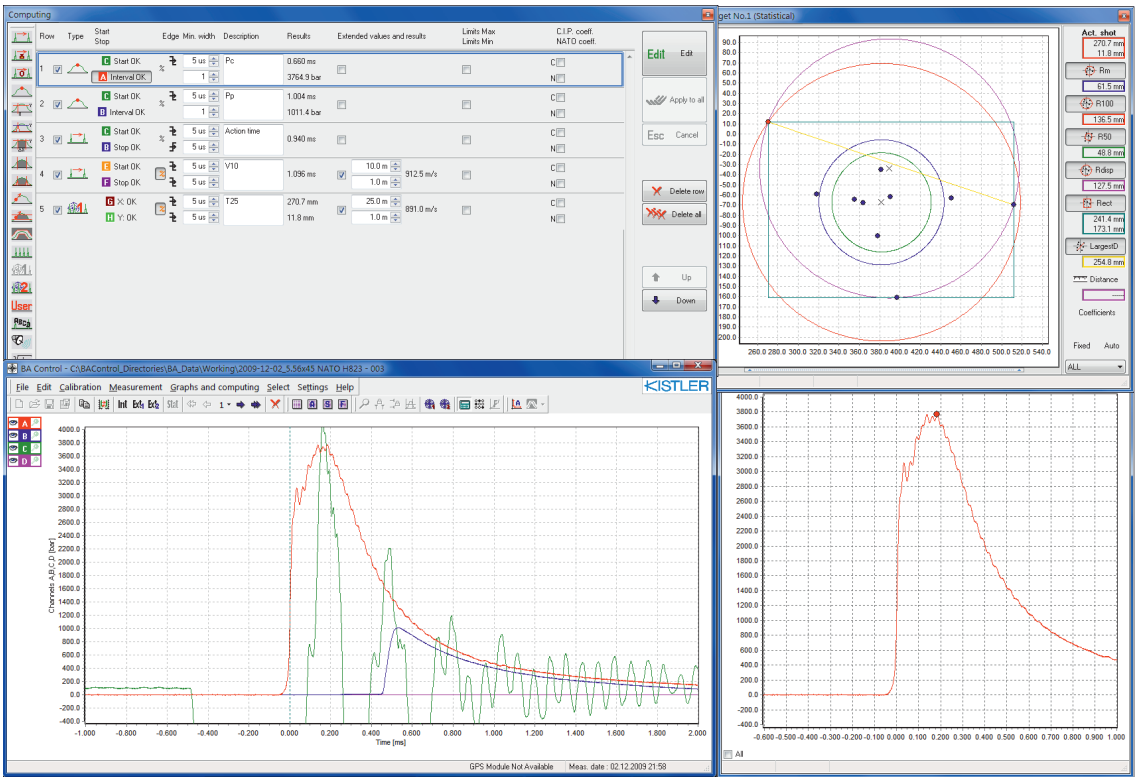
BA06H Control Software and Applications

Control panel of the virtual ballistic analyzer

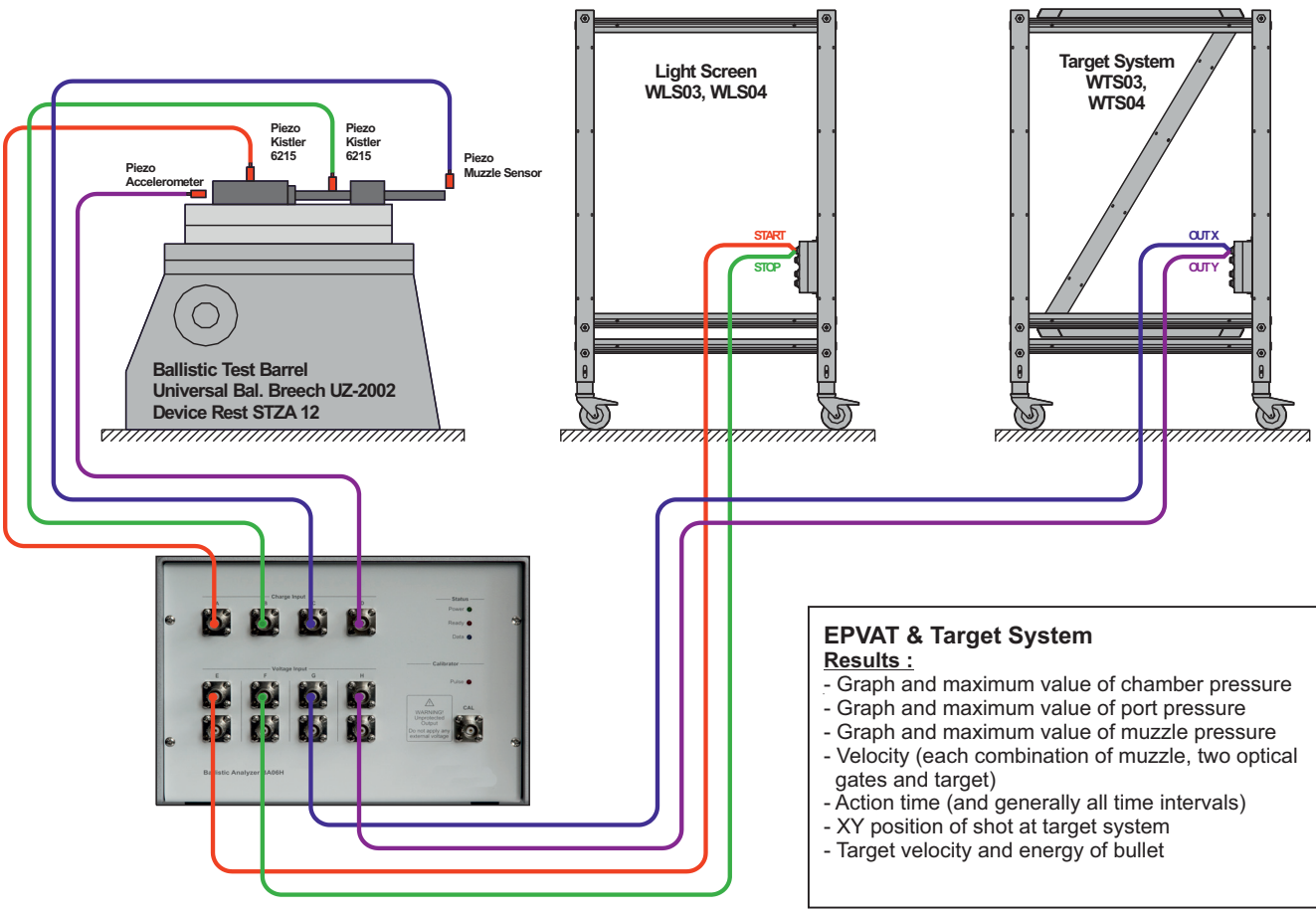


This panel serves for the adjustment of all the parameters of the ballistic analyzer during the measuring. It contains (from left to right) : the adjustment of sampling rate, the level and the edge of triggering, the display for the list of important information, setting up the memory and the mode of the measurement, and in the lower row, the panels for the controlling of the output moduli.

Viewing of the graphs, computing and output report



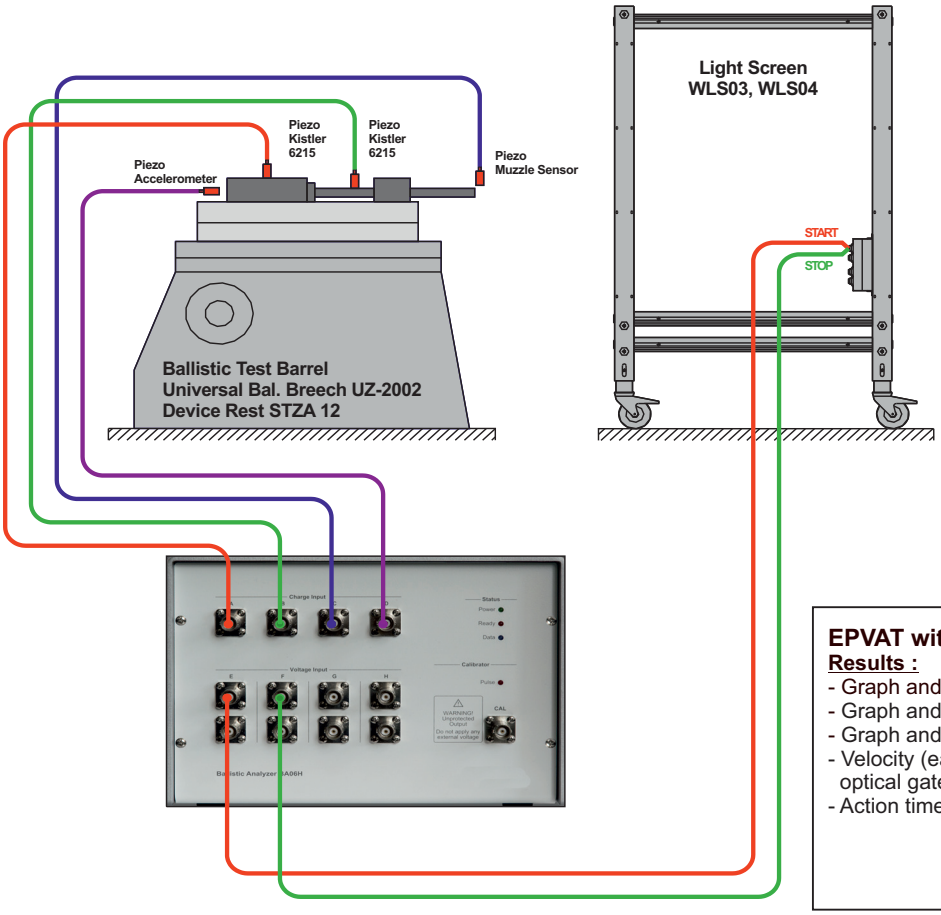
In these windows of the programme, the measured graphs are displayed. It is also possible to do their detailed analysis, to count the values of pressures, time intervals and velocities and to make an output report on the shooting according to given regulations. All the settings are possible to save and, this way, make standard measuring methods.



EPVAT & Target System

Results :

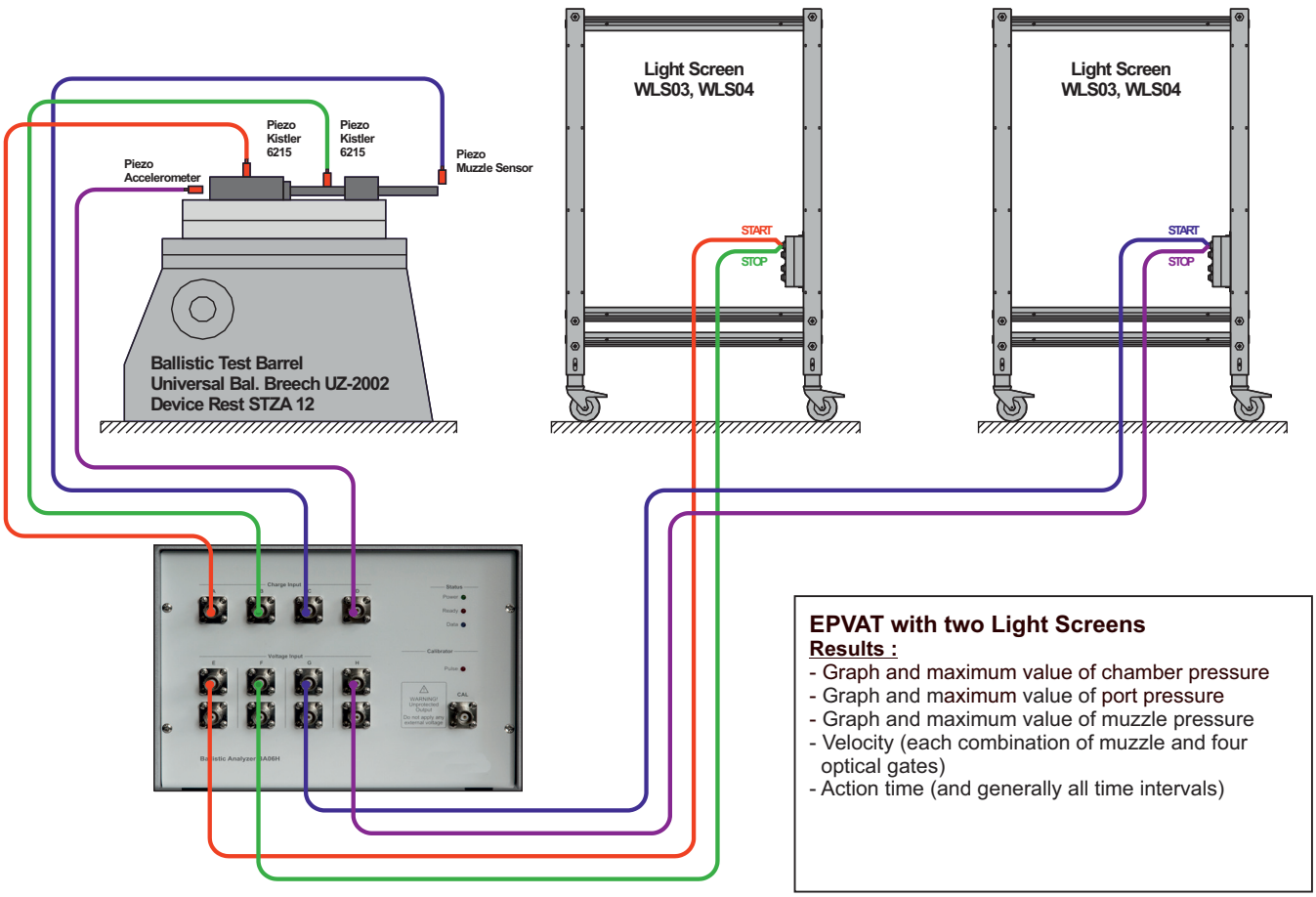
- Graph and maximum value of chamber pressure
- Graph and maximum value of port pressure
- Graph and maximum value of muzzle pressure
- Velocity (each combination of muzzle, two optical gates and target)
- Action time (and generally all time intervals)
- XY position of shot at target system
- Target velocity and energy of bullet



EPVAT with one Light Screen

Results :

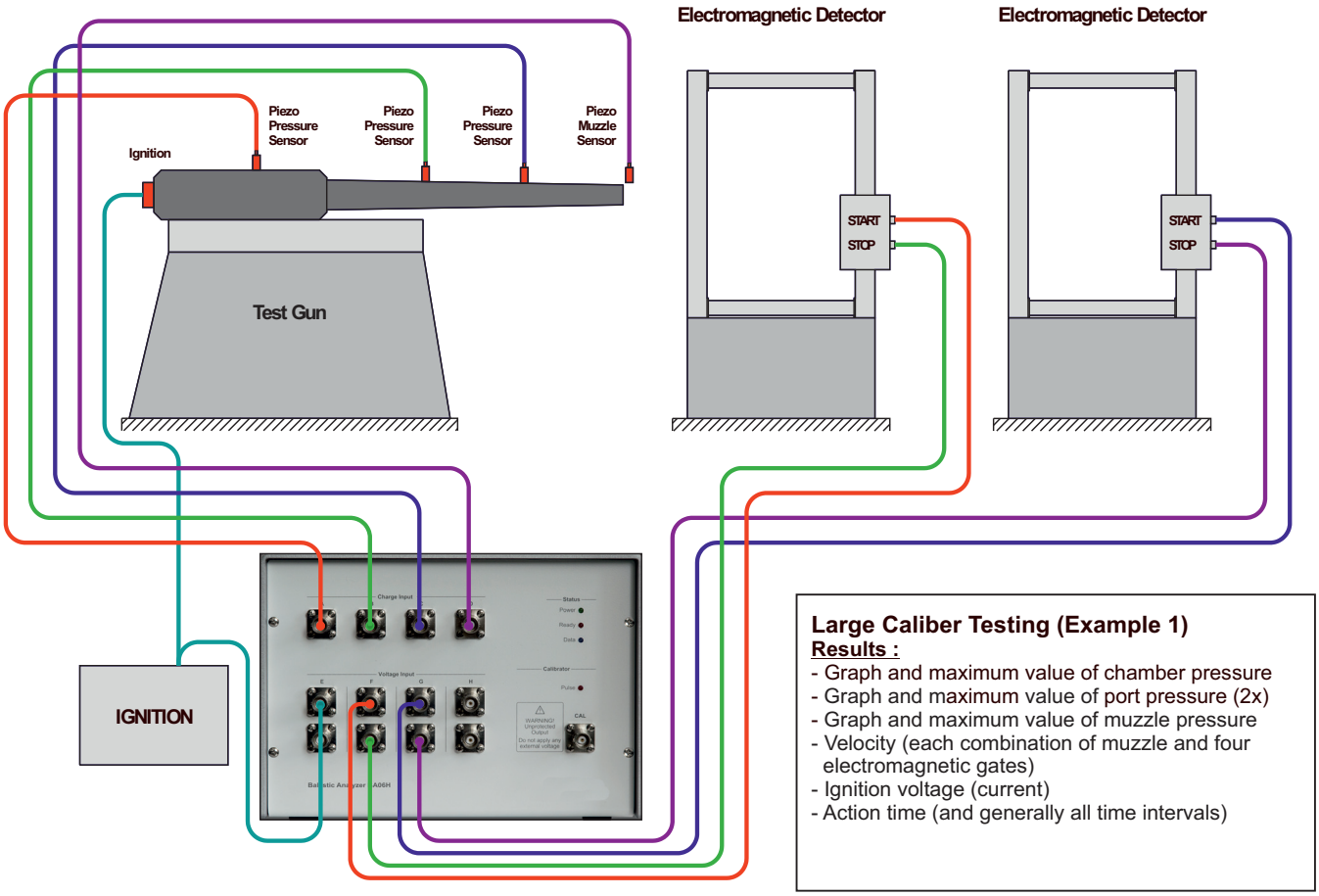
- Graph and maximum value of chamber pressure
- Graph and maximum value of port pressure
- Graph and maximum value of muzzle pressure
- Velocity (each combination of muzzle and two optical gates)
- Action time (and generally all time intervals)



EPVAT with two Light Screens

Results :

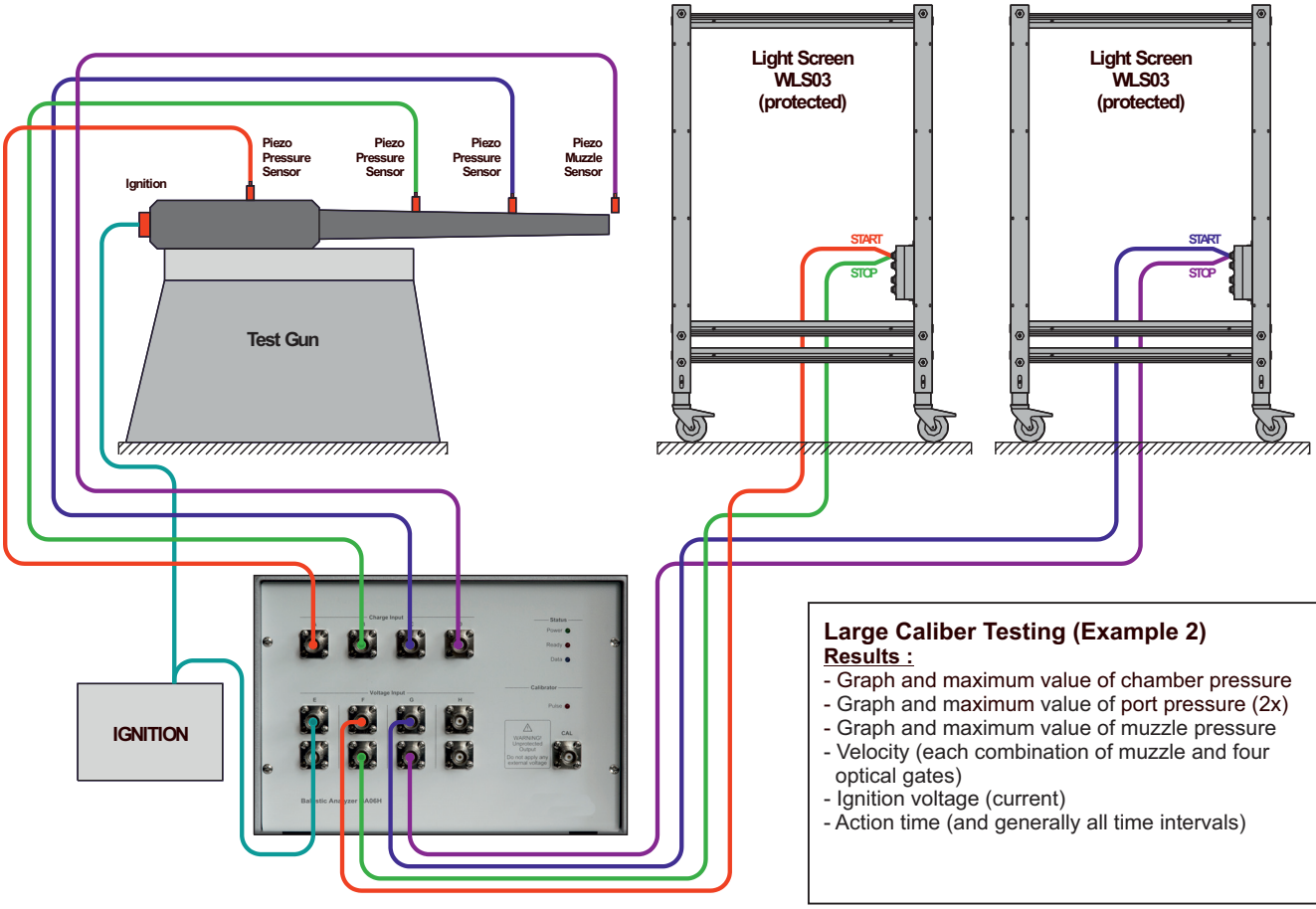
- Graph and maximum value of chamber pressure
- Graph and maximum value of port pressure
- Graph and maximum value of muzzle pressure
- Velocity (each combination of muzzle and four optical gates)
- Action time (and generally all time intervals)



Large Caliber Testing (Example 1)

Results :

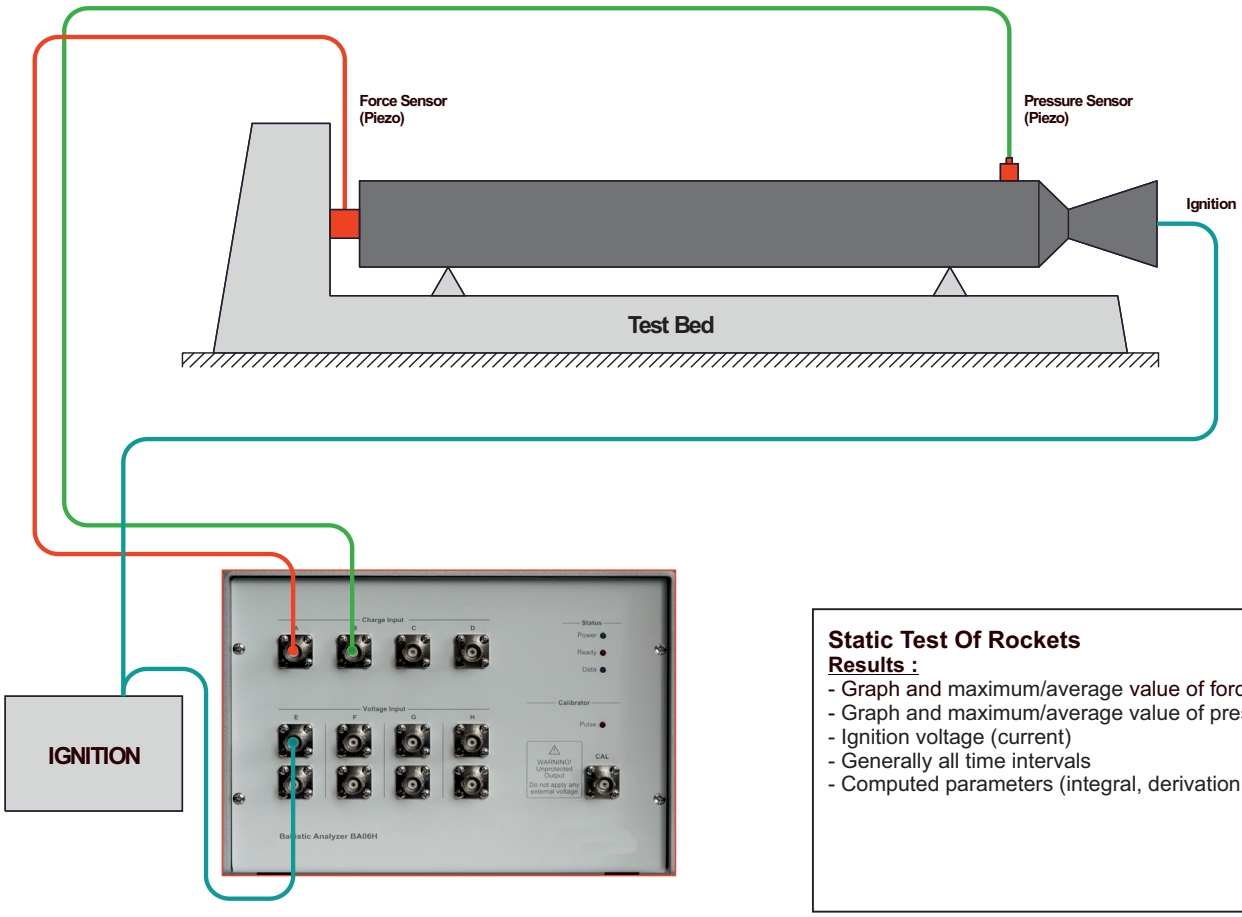
- Graph and maximum value of chamber pressure
- Graph and maximum value of port pressure (2x)
- Graph and maximum value of muzzle pressure
- Velocity (each combination of muzzle and four electromagnetic gates)
- Ignition voltage (current)
- Action time (and generally all time intervals)



Large Caliber Testing (Example 2)

Results :

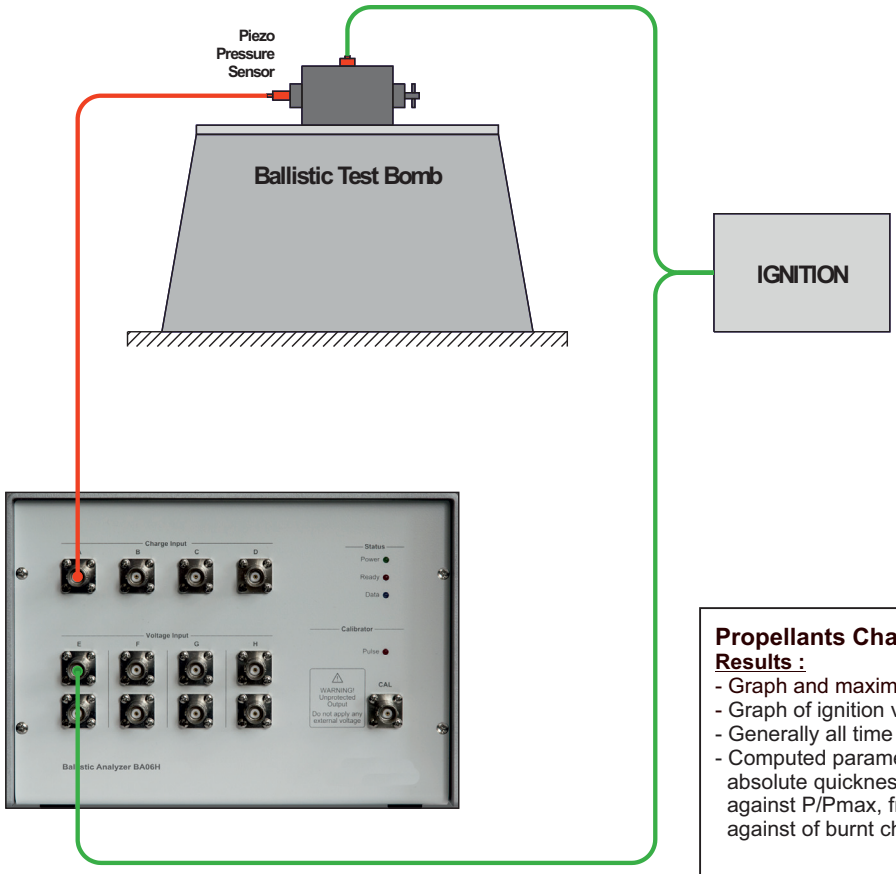
- Graph and maximum value of chamber pressure
- Graph and maximum value of port pressure (2x)
- Graph and maximum value of muzzle pressure
- Velocity (each combination of muzzle and four optical gates)
- Ignition voltage (current)
- Action time (and generally all time intervals)



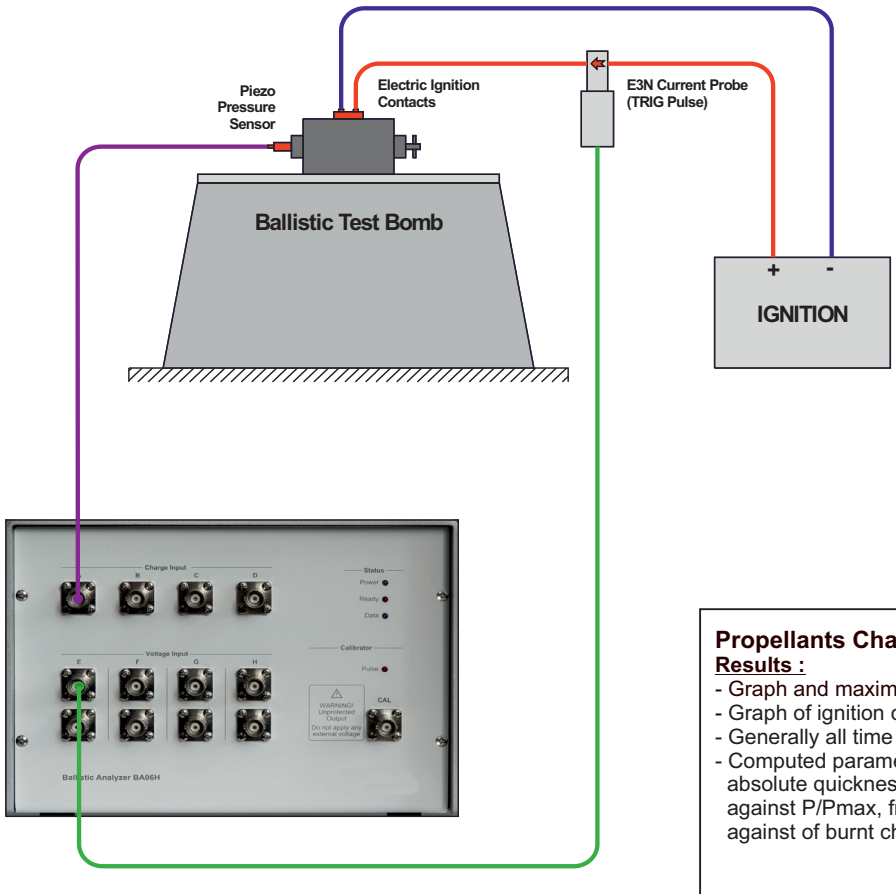
Static Test Of Rockets

Results :

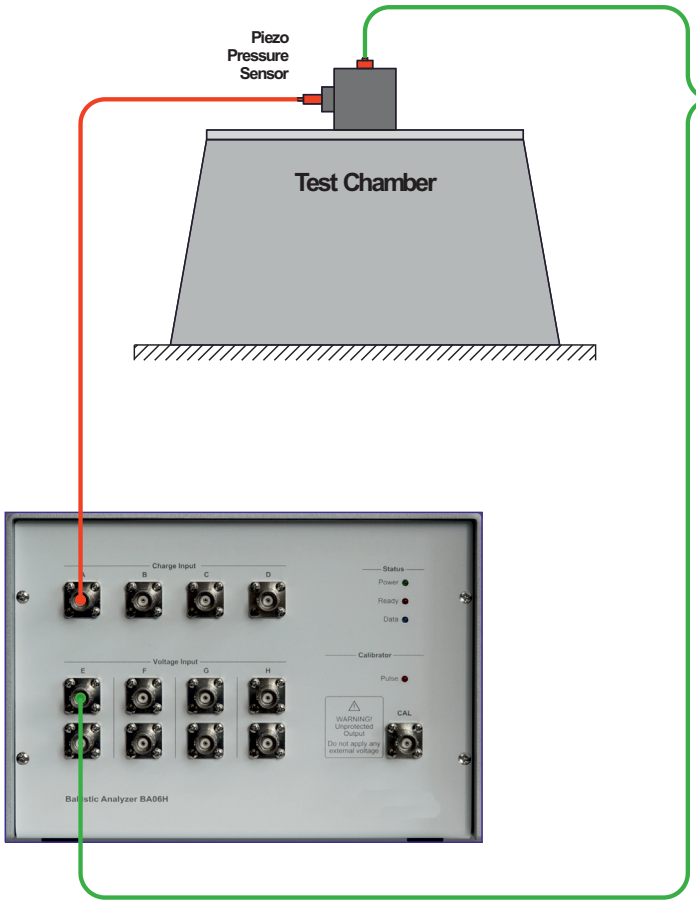
- Graph and maximum/average value of force
- Graph and maximum/average value of pressure
- Ignition voltage (current)
- Generally all time intervals
- Computed parameters (integral, derivation etc.)

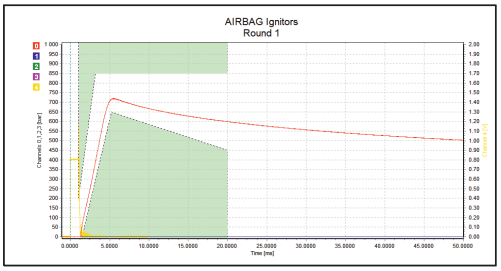


Propellants Characteristics (MIL STD 286B)
Results :
- Graph and maximum value of bomb pressure
- Graph of ignition voltage (current)
- Generally all time intervals
- Computed parameters (force, covolume, pressure exponent, absolute quickness, relative quickness, dynamic vivacity against P/Pmax, fraction of burnt charge, dynamic vivacity against of burnt charge, ...)



Propellants Characteristics (MIL STD 286B)
Results :
- Graph and maximum value of bomb pressure
- Graph of ignition current
- Generally all time intervals
- Computed parameters (force, covolume, pressure exponent, absolute quickness, relative quickness, dynamic vivacity against P/Pmax, fraction of burnt charge, dynamic vivacity against of burnt charge, ...)





Pyrotechnics (AIRBAG igniters etc.)

Results :

- Graph and maximum value of chamber pressure
- Graph of ignition voltage (current)
- Generally all time intervals
- Pass/Fail testing (by use of limit bands)