FEATURES

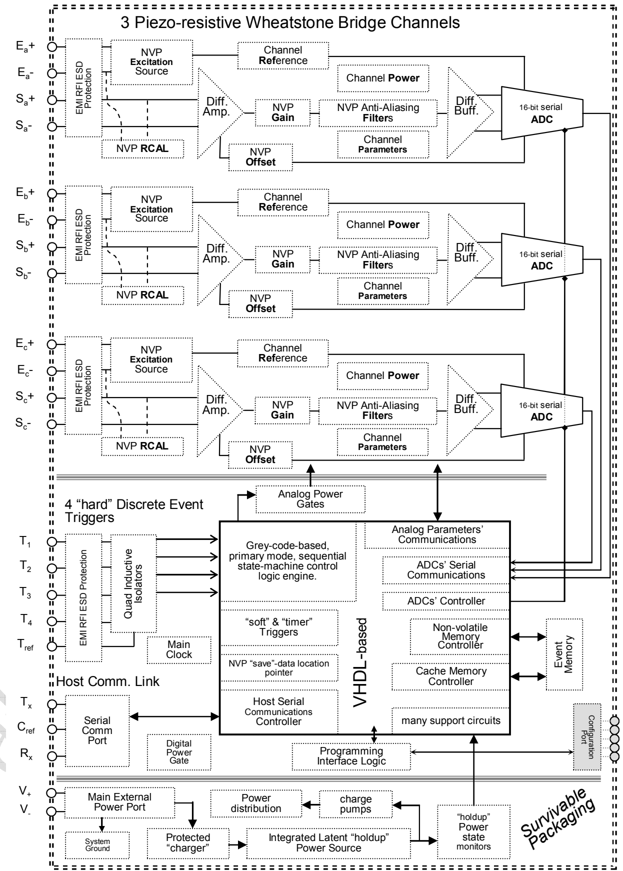
Compact (*thumb-size*), self-contained, autonomous operations
Signal conditioners for piezo-resistive bridges, and voltages
Super-ruggedized, extreme-shock survivable[a] packaging
Multiple-sampling-rates event-driven acquisition profiles
Quad "external," with "timer" & data derived "soft" triggers
Integrated "latent" power source for untethered operations
Programmable simul-Sampling Rates (F_s) up to <u>500,000</u>s/s/c[b]
Tunable sensor sampling bandwidth (F_c), up to <u>40 kHz</u>
Circular-buffer & non-volatile <u>524,268 samples</u> storage
EMI-RFI-ESD protection on all external connections

FULLY PROGRAMMABLE, VERSATILE, RELIABLE, RUGGED, FLEXIBLE

...MORE FEATURES:

True Differential, wide-bandwidth sensor-input Interfaces
Four-arm bridge sensors: 100Ω ➤ 3,500Ω *piezo-resistive*
NVP[c] Excitation Sources (75 voltage values each, +1.5➤+5.2v)
NVP Shunt Calibrators (128 Ω values each: 100 Ω ➤10,100Ω)
NVP Sensor Gain Blocks (2,688 values each : 0.0078➤1024 V/V)
NVP Mid-Scale (bias) adjusts (128 values each: +0.04➤+4.40ΔV)
Tunable (10 pole) Linear Phase anti-aliasing filters for optimum time-domain data analysis (*linked to ADC sampling rates*)
Simultaneous sampling, 16-bit, 3-channel (ADI's PulSAR™) ADCs
Continues running after removal of external power source
4 electrically isolated external discrete inputs → "hard" triggers
Unlimited[d] charge and discharge cycles (EDLC's, *no batteries*)
"e-**QUIET**," custom Grey-code sequential state machine engines
Fully programmable "save data anywhere" pointer location

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The SER system is a part of a new generation of compact, technologically advanced, high performance, "unconstrained" Data Acquisition System Modules designed to provide wide bandwidth, high speed digitization and non-volatile data storage from an assortment of sensors during extremely quick, and often environmentally violent test events, including those involving ultra-extreme mechanical impulse shock events and wide bandwidth random vibration conditions.

It is self-powered for untethered (unconstrained) testing scenarios using the latest in Electrochemical Double Layer Capacitor[e] technology. The analog and digital circuits use high-accuracy, extremely tiny components for minimum mass and maximum performance. The circuitry is protected by both the packaging and the signal line conditioning circuits against large EMI, RFI, and ESD events, which are common phenomenon in many pyro-based testing scenarios.

All user-adjustable parameters are saved on-board in non-volatile memory, including: sensor excitation voltages, RCAL resistance values, mid-scale bias-offsets, gains, cutoff frequencies and sampling rates, and the "save-data" pointer value. Test sequence (mode) profiles are also field-selectable.

TYPICAL APPLICATIONS

- Mil-STDs: (167, 202F, 331, 810F) testing for Gunfire, Explosions, Random Drop, Pyroshock, High impact Shock, & extreme accelerations
- Untethered, free-flight article testing, like ejection seat testing, and/or crash landings…
- Manikin tests: passenger injuries, safety equipment studies, vehicle-pedestrian collisions
- Sudden-stop failure mechanism studies; *think*: fast moving hard object hitting a brick wall
- Free-fall packaging durability studies; crated material falling out of the back of a moving truck
- Pyro-Blast survivability testing
- Works well where telemetry fails due to antenna misalignments & large RFI fields
- Automated Seismic "pulse" recording
- Size is ideal for integrated MEMs-based velocity, acceleration, jerk, and rotation testing

WORKS WHERE OTHERS FAIL

Note that the "S" in "SER," in addition to Shock, could also stand for any of these, also appropriate, S-words: Safety, Salvo, Sample, Satellite, Savage, Scary, Scientific, Screaming, Secure, Self-contained, Sequential, Serious, Severe, Short, Significant, Snapshot, Speedy, Strategic, Strong, Sturdy, Substantial, Successful, Sudden, Superb, Surge, Survivable, Swift, Synchronous, even: Superior, Slick, or Svelte.

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DESCRIPTION OF OPERATION

The SER is designed to implement high-end testing functions with the vital features and functions necessary to capture and store the event data with the highest confidence possible using the latest technology and tiniest components available. Minimum mass is a primary goal due to the SER's intended operational testing environment (extremely violent mechanical shocks, etc.). Any extra data-massaging, formatting, and support functions are performed outside the SER to preserve the minimum power and mass needs.

After the SER has been configured for a particular test, and installed as payload in its test article/vehicle and is connected to its sensors, it is "armed" for a single data capture event which will occur as defined by the selected mode of operation and the appropriate sequence of external hard, internal soft, and timer-based triggers.

Each trigger event, including the loss of external power, can change the operational state of the SER, starting the digitization of sensor information, storing the results in the circular buffer, changing the sampling rate and sensor bandwidth midstream as the event profile dictates via the varying trigger occurrences. Generally, the "last" trigger is used to also start the "save-data" pointer countdown sequence, where the internally stored "samples-to-go" parameter determines how many more samples to acquire before permanently saving all of the last 524,268 samples. When sensor-sampling is completed, all channels are placed in RCAL mode, and one sample per channel is also permanently stored as a confidence test for survivability (if RCAL values are good, the rest of the data should be OK also since the circuitry survived the shock event). Each trigger event is also tagged and stored with the sensor data for post-test reconstruction and analysis.

Post-test, the saved data set is serially uploaded to a host computer for archiving, sorting, time-stamping, and analysis purposes.

MODES OF OPERATION

- Tethered to Host:
  - Channel Setup (adjust all NVP's, etc.)
  - Sequence Definitions (triggers, etc.)
  - Pretest Readiness (state verification)
  - Storage Arming (enable non-volatile store)
  - Post-test Data Retrieval (data upload only)
- Untethered (except for external power, or not):
  - Wait for test (armed and running)
  - Real-time Event Recording (saving data)
  - Post-test shutdown (stop-all & remember)

Changes that can selectively change sequence definitions include:

- ➢ Loss of external power
- ➢ Change on any of the four external discrete inputs: "hard" triggers
  - ❖ High State
  - ❖ Low State
  - ❖ Rising Edge
  - ❖ Falling Edge
- ➢ Data stream value on any of three sensor channels: "soft" triggers
  - ✓ Greater than value
  - ✓ Equal to value
  - ✓ Less than value
- Timer delays for any of the hard or soft triggers listed above

SPECIFICATIONS (design)

- ➤ Sensor Inputs: $4.20V_{diff\_max}$, $+8V_{cm}$; 80kΩ typical differential input impedance; slew rate = 0.1V/μS; -3dB bandwidth = 300kHz; includes EMI-RFI-ESD protection circuits.
- ➤ Discrete (hard trigger) inputs: ADI's iCouplers; 100nS Maximum propagation delay @ 5Vinput (PWR ground reference); Insulation rating = 2.5kV; UL/CSA/VDE (all pending)
- ➤ Power Input: 7volts minimum (current limited to 200mA) to 16volts maximum.
- ➤ Communications with Host: Pre-test and post-test serial UART; 19,200 baud; fixed protocol (see User's Manual for details); includes post-test data uploads

Sensor *(inline)* **Input Protection and Channel Bandwidth Filters** ⚡

Function & Purpose	**Details** *(also see ⚡ note at bottom of table)*
RFI Input Protection	-3dB @3MHz ➤ -52dB @ 450MHz (3-terminal capacitor)
EMI Input Filter	PI-style CRC network: -3dB @ 31MHz, -44dB @ 1.25GHz
ESD Input Protection	±8kV (contact discharge) Compliance: IEC61000-4-2 (level 4); ±15kV MIL-STD-883, Method 3015 (Human Body)
Front-end Filter	3-pole Sallen-Key Low-Pass Bessel Filter; 200kHz cutoff
Anti-Aliasing	10-pole, DC accurate, clock Tunable Switch Capacitor; Linear Phase (see table below for sampling-rate tracking values)
Back-end Filter	3-pole Sallen-Key Low-Pass Bessel Filter; eliminates clock feed-through from Switched Capacitor Anti-aliasing Filter

⚡ This "filter" string is designed for Linear Phase operations as typically required for Time Domain, post-test data analysis work. The RFI, EMI, and ESD protection circuits are also on all other power and discrete IO lines.

Trigger Selectable Sensor Channel Bandwidths & Sampling Rates

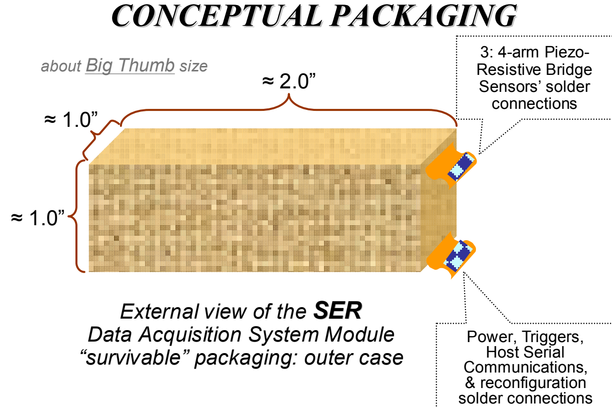
≈ Channel Bandwidth	Sampling Rate s/s/c	Time/Sample	Total Time*
39KHz	156,250	6.4μS	1.054Sec
19.5KHz	78,125	12.8μS	2.109Sec
9.8KHz	39,062.5	25.6μS	4.218Sec
4.9KHz	19,531.25	51.2μS	8.436Sec
2.4KHz	9,765.625	102.4μS	16.872Sec♣
1.2KHz	4,882.813	204.8μS	33.743Sec♣
610Hz	2,441.406	409.6μS	67.487Sec♣
305Hz	1,120.703	819.2μS	134.973Sec♣

* Total Time to fill Memory at just this sampling rate

♣ Will probably require having external power applied for all of this time (except last 10 seconds) to successfully acquire all of these samples.

These are the built-in "standard" values; sampling rates up to 500Ks/s/c are possible

CONCEPTUAL PACKAGING



External view of the ***SER***
Data Acquisition System Module
"survivable" packaging: outer case

There are special packaging techniques deployed within the SER to enable it to withstand repeated high-shock impulses, up to about 100,000G's.

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[a] Assumes "non-crushing" impacts
[b] s/s/c ≡ samples per second per channel (each of 3)
[c] NVP ≡ Non-Volatile, Programmable (parameter)
[d] Unlimited really is >500,000 cycles (not infinite; not bad!)
[e] EDLC's *a.k.a.*: BoostCaps, UltraCaps, BestCaps, GoldCaps, AerogelCaps, & SuperCaps

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