New Data Recorder for Gun Launch and Impact Test with Options for Built-in High G Accelerometers and Angular Rate Sensors

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May, 2011
**DTS Introduction**

- Data recorders and sensors for high shock testing
- Founded in 1990 by three test Engineers
- Small US private corporation with 55 staff members in 6 offices worldwide
- 90+% of customers do “must collect data” testing
- Key DTS staff have over 100 years of combined high shock test experience
DTS Introduction – Customers

Military/Aero

Research

Automotive

DTS www.dtsweb.com Public Releasable – Distribution Unlimited
Applications for DTS Products

- Data recorders for Manikin and cadaver test
- Vehicle and soldier blast event
- Ejection seat drop tower and rocket sled
- Aircraft/spacecraft flight and crash test
- Hard target recorders
Applications and Shock

- Hard Target Recorder
- Gun Launch
- Military Blast
- Vehicle Crash Safety
- Motorsports

<table>
<thead>
<tr>
<th>Shock</th>
<th>Sample Rate</th>
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<tbody>
<tr>
<td>100,000 g</td>
<td>1 Msp/s</td>
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<tr>
<td>20,000 g</td>
<td>100 Ksp/s</td>
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<tr>
<td>5,000 g</td>
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<tr>
<td>500 g</td>
<td>5 Ksp/s</td>
</tr>
<tr>
<td>100 g</td>
<td>5 Ksp/s</td>
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Data Acquisition History

1980s
Amplifiers
Tape Recorders
and
Oscillographs

1990s to Present
Self-contained Data Recorders
Technical Terms

- **DAS**: Data Acquisition System, includes analog electronics for sensor inputs, digital conversion and non-volatile memory
- **Sensor or Transducer**: converts physical world to analog or digital voltages
- **ADC**: converts analog signals to digital data, usually 12 or 16 bit resolution
- **Sampling Rate**: how fast ADC samples each channel (sps)
- **Bandwidth**: analog frequency content of data (Hz, usually expressed as -3dB point filter roll-off)
- **AA Filter**: anti-alias filter, determines bandwidth
SLICE HG

• Based on DTS SLICE data recorder technology

• Eglin Air Force Research Lab ASPIRE Program
  • Phase I and Phase II SBIR, ~Jan 2009 to March 2011
  • Develop 50+ Kg recorder

• DTRA Hard Target Recorder
  • Phase I SBIR, ~Mar 2010 to Dec 2010
  • Develop 100+ Kg recorder

• Also have worked with Sandia Labs and China Lake

• Current contract with Army to up sample rate to 1 Msp/s/chan, production in 2012
SLICE Overview

- Two package options, same electronics:

**SLICE NANO**
- 26 x 31 mm footprint
- Circular connector inputs
- For tight space or embedded applications

**SLICE MICRO**
- 42 x 42 mm footprint
- Circular connector inputs
SLICE Modularity

Up to 8 sensor SLICEs per STACK (24 channels)

Bridge SLICE
- 26 x 31 x 5.5 mm
- 3 channels, 16 bit/chan
- 9-poles of Butterworth filter, adjustable 1 to 40 KHz
- 5V sensor excitation
- Auto offset and shunt

Base SLICE
- 26 x 31 x 6.5 mm
- USB 2.0 plus USB hub
- 7 GB Flash memory
- Up to 120 Ksps/chan
- 1 Msps coming in 2012
- Standard 5 Kg shock
- HG packaging to ~50 Kg

Emergency Backup Power, up to 3 minutes
SLICE Bridge – Sensor Interface

Piezo-resistive, strain gauge or voltage inputs

**Excitation Source**
- One per channel
- 5-volts std, 2.5V opt.
- 20 mA continuous
- Short circuit safe
- ESD Protected

**Basic Analog Features**
1) 0-5 volt Input Range
2) Gains of 1 to 1,280
3) True Bridge Completion
4) 60KHz Bandwidth (max)
5) ESD and RFI Protection

**Excitation Source**
- One per channel
- 5-volts std, 2.5V opt.
- 20 mA continuous
- Short circuit safe
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**Shunt Check**
**Adj Gain 1-1280**

**Differential Instrumentation Amplifier**
Gain 1-128

**Multi-function Summing Amp**
(Gain 1 or 10)

**9-poles of Butterworth filtering**

**TEDS ID**

**Auto Offset**

**Electronic ID Interface**

**2-pole 50 KHz Filter**

**5-pole 1Hz to 45 KHz Adjustable Filter**

**2-pole 50 KHz Filter**

16-bit ADC
SLICE HG – General Specs

- Uses standard SLICE PCBAs (1 Base SLICE, 1 Bridge SLICE, 1 Battery SLICE), packaged in two stage potting process
- 3 channels, 120 Ksps/chan
- 40 KHz bandwidth, 9 pole hardware AA filters
- 7 Gbyte non-volatile flash memory = > 2 hours
- Backup power source for ≥ 3 minutes
- Every unit tested at DTS to > 20 Kg, 0.1 msec
SLICE HG – Arming and Triggering

Arming Options
• Arm on Power up – wait for Start signal
• Start Recording on Power up

Triggering Options
• Start signal on separate 0-5V input
• Event (T=0) on Contact Closure or Level Trigger
• Over 2 hours of data collection
• Non-volatile flash memory
SLICE HG - Packaging

Two stage, hard then software potting

1 7/8” DIA enclosure
3 channel SLICE data recorder
Hopkinson bar adapter
SLICE HG – Shock Testing

Tested at DTS to ~23,000 g’s, 0.1 msec
SLICE HG – Shock Testing

Tested at Endevco on Hopkinson Bar, ~80,000 g’s, 0.04 msec
SLICE HG – Shock Testing

• China Lake has run sled tests for missile impact with success
• 6 SLICE HG units delivered to Eglin AFB for test
• SLICE HG at Sandia for test
Shock Hardening Considerations

For 20 Kg+ g environments, DTS products incorporate these features:

- Large IC’s on PCB epoxied down before soldering
- Other larger components have adhesive applied
- Crystal time base oscillators used, up to 100K g rating
- Other high shock rated components used as required
- Visual and X-Ray inspection used on PCB assemblies and solder joints
- PCB assemblies are potted in a two-stage potting process
- All final products are 100% shock tested to 20+ Kg to verify robust operation before delivery to customer
SLICE HG – Package Sizes

- 1.875” DIA x 1.05” (47.6 x 26.5 mm)

- 1.25” DIA x 1.67” (31.8 x 42.5 mm)
SLICE HG – Configurations

Option for embedded 3 axis accelerometers from various manufacturers or an angular rate spin sensor.

PCB 3501 60 Kg accels
SLICE HG – Configurations

- Up to four 3 chan. units can be chained (12 chan.)
- External power: ~12V at 250 mA per 3 channel unit
- Units are independent, standalone. The failure of one does not cause failure of another
- Various options for triggering and monitoring
SLICE HG – Availability

- In production
- Price is ~$15,000 per 3 channel unit
- Additional cost of built-in accelerometer or ARS options depend on sensor manufacturer/model
- Typical lead time is 8 weeks
- Export status is pending review
- DTS offers 24/7 technical support and on-site training
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