

New Time Waveform Control Features

(TTH, TWR, and SRS Synthesis)

© Crystal Instruments, August 2013

What is Time Waveform Control?

- Reproduction of Time Waveforms
 - Time domain transients
 - Recorded data
 - Imported data
- Synthesis of Shock Response Spectra (SRS)
- Applications
 - Seismic
 - Road simulation
 - Bellcore testing



Implementation in EDM

- Transient Time History (TTH) Control
 - Short duration transient waveforms
- Time Waveform Replication (TWR)
 - Arbitrarily long waveforms
- SRS Synthesis Control
 - Waveform from Required Response Spectrum (RRS)



TWR – What's New

- Multiple profiles in Schedule
- Multi-point Control
- Long Waveform Recording
- Now Includes EDM Waveform Editor Import and Edit Waveforms of different file types



TWR - Multiple profiles in Schedule

Any number of profiles can be added in 4GB hardware memory space and played back in schedule





TWR – Multi Point Control

Up to 8 control channels on the master module can be enabled.

| Di Input Cha | nnels for T | WR7 [VCS(| TWR | 01 | | _ | | | 1 . A | | | - 92 | x. |
|--------------|-------------|-----------------|------|----------------|-------------------------|---|----------|------------------|---------------|---|--------|-------------------------|-----|
| Fill + Ex/Im | - Units | Sensor + | LORG | f From Libra | y Saveto Library | N | on-accel | ration Control | | | | | |
| | On/Off | Channel Type | | Location ID | Measurement Quantity | | Unit | Sensitivity | Input Mode | | Sensor | Max. Sensor Range | Hig |
| 1 | IV On | Control | | Ch1 | Acceleration | | 0 | 100.0000 (mV/g) | AC-Single End | | | 20.0000 (V) | Off |
| 2 | 2 Qn | Control | ٠ | Ch2 | Acceleration | | 0 | 100.0000 (mV/g) | AC-Single End | | - | 20.0000 (V) | Off |
| 3 | On 🛛 | Control | | Ch3 | Acceleration | | 9 | 100.0000 (mV/g) | AC-Single End | | | 20.0000 (V) | Off |
| 4 | 😰 On | Control | | Ch4 | Acceleration | | 9 | 100.0000 (mV/g) | AC-Single End | | | 20.0000 (V) | Off |
| 5 | 🗵 On | Control | | ChS | Acceleration | | 9 | 100.0000 (mV/g) | AC-Single End | ٠ | | 20.0000 (V) | Off |
| 6 | 📝 On | Control | ٠ | Ch6 | Acceleration | | ø | 100.0000 (mV/g) | AC-Single End | - | | 20.0000 (V) | Off |
| 7 | I On | Control | | Ch7 | Acceleration | | 9 | 100.0000 (mV/g) | AC-Single End | ٠ | | 20.0000 (V) | Off |
| • 8 | IV On | Control | | Ch8 | Acceleration | ٠ | 0 | 100.0000 (n/V/g) | AC-Single End | - | | 20.0000 (V) | Off |
| | | | | | | | | | | | | | |
| * | | | | | | | | | | | | | |
| | | | | | _ | | | | | | QK | Gance | |



TWR – Long Waveform Recording

- Introduced recording of Time Stream Data
- Recording can be done to the limit of the Hardware's internal flash which is 4GB.

| Time | e Stream Time Blo | cks PC Math Sign | als Other All Signa | ls | 4 |
|------|--------------------|----------------------|---------------------|--------------|---|
| | 1easure All 🗵 Enal | ole All for Record L | ist Save And Record | ing Options | |
| | Signal Name | Measure | Record List | Signal Color | |
| F | Ch1 | | | | |
| | Ch2 | V | J | | |
| | drive(t) | 1 | | | |



TWR: Importing and Editing Data

- Any pre-recorded
 time stream data
- Flexible file import
- Edit waveforms with the Time Waveform Editor

| File Name: H:\Ca Data Format: ODS | | ar Console with 20 | 0 Hz LP filter | _Profile_TWRPro.atf | fx Profile Browse | |
|--------------------------------------|---------|--------------------|----------------|---------------------|---------------------|--|
| | | ATF_XML | | | | |
| | | | Data A | ttributes | | |
| Data points to | read: | 62464 | | Signal: | Profile | |
| QuantityType: | | Acceleration | | DeltaT: | 0.0001953125 | |
| Value Unit: | | m/s² | ~ | Sampling Rate: | 5120 | |
| | _Co | mpensation | | <u>ا</u> | Digital Re-sampling | |
| No compensati | on is a | pplied to | | Sampling Rat | te: Auto | |
| Apply con | npensat | tion S | iet up | Sampingisa | | |
| (a) Insert sna | relove | nwrite) From | 1/At Point | 4 | | |
| Insert spa | Letover | (write) | · | | | |



TWR: Importing and Editing Data

 Re-sampling, Decimation, Re-scaling, Selecting parts of Waveform can all be done using Waveform Editor





TWR: Importing and Editing Data

Waveform Editor supports the import of multiple file types:





TWR: Profile Editing and Setting Shaker and Abort Limits





Transient Time History (TTH)

- Supports very
 large block size:
 up to 64k
- Building blocks:
 sine, triangle, &
 white noise
- Apply windows





TTH: What's New

- 64K Block Size is now supported with up to 4 channels.
- Significant improvements in Pre-test
- Improved Noise measurement



64k Block Size

Up to 4 control channels on Master module
 Up to 32 Monitor channels across 8 modules



Improved Pre-test and Noise Measurements

- Pre-test now takes
 up to 40% less
 time for profiles
 with long duration
- Noise

measurement frame is reduced to under 5 seconds for Profile of any time length



Under 2 seconds Noise frame for a frame of 50 seconds.



Improved Pre-test and Noise Measurements (continued)

- Preserves the advantages of having noise measurement and takes extremely small amount of time
- Test with Saved FRF starts off immediately – ideal for Earthquake simulators



Test (of any duration) with Saved FRF starts within 3 seconds and still measures the noise floor



TTH: Bellcore

Bellcore
 standard
 waveforms
 built-in



| New Test Wizard × | | | | | | | | |
|--|--|--|----------------------|----------------|-------------------------|---------------|------|--|
| Select the te This test wi | st type ill be applied to th | e configured default system | | | | | | |
| Dynamic | Signal A | nalysis (DSA) | Vibration | Control S | ystem (VCS) | All Templates | | |
| R | landom | Classical shock cont | rol full version | (Shock Cont | rol) | | | |
| Sine on Random Random on Random Long waveform recording: Enabled | | | | | | | | |
| Sw | Block sizes from 4096 to 65536 available: Enabled Swept Sine | | | | | | | |
| Re Search | sonance h and Dwell | Advanced functions: • Shock Response Spectrum analysis: Enabled • Shock Response Spectrum control: Enabled | | | | | | |
| Clas | Classical Shock Snock Kesponse Spectrum synthesis and control: Enabled | | | | | | | |
| Transi Histor | ient Time ry Control | | | | | | | |
| Shock Spectru | k Response um Synthesis | Bellcore Type | | | | | | |
| Sine (Diag | oscillator nosis Tool) | None | asta s hallcore test | t choose the h | ellcore type from the : | above list | | |
| Time Re | Waveform plication | Bellcore3 Bellcore4 | with single control | g anoose are b | encore cype nom the t | | | |
| | | | | | < Bad | Next > Ca | ncel | |



- Test Profile is
 Shock Response
 Spectrum
- Called Required
 Response
 Spectrum (RRS)





Waveform generated from Sine Wavelets





Sum of wavelets produces transient waveform





- Iterative process
- Wavelet
 parameters
 adjusted so that
 SRS converges on
 RRS
- Step Forward until
 Fitting Error
 minimized





Waveform Compensation

- Remove DC
- Residual velocity, displacement to zero
- High-pass filter
- Brick-wall high-pass
- Low-pass filter







Safety Limits

Profile validation

- Shaker limits
- Acceleration, velocity, displacement

Abort Checks

- RMS changes, control signal loss
- Abort Sensitivity setting makes adjustment easy

Hardware Abort Buttons





| Max.Velo: 0.93961 m/s 53% | |
|-----------------------------|--|
| Min.Velo: -0.85482 m/s 48% | |
| Max.Disp: 131.8 mm 2076% | |
| Min.Disp: -105.59 mm 1663% | |
| Max.Acce: 1.1262 g 2% | |
| Min.Acce: -1.0309 g 2% | |
| Max.Force: 3.3134 Newton 1% | |

Waveform Max/Min Value

| Abort Sensitivity | | | |
|----------------------|------|----------------|-----------|
| Θ | | | Customize |
| 0.0 Not Sensitive | 0.99 | 1.0 Very Se | nsitive |



Transfer Function Calculation

Pre-test

- Random noise or time waveform
- Calculates FRF
- Can be skipped with saved FRF
- Continuous updating





Automatic and Manual Run Control

Run Schedule

Schedule Edit Entry Remove Entry Move Up Move Down ---Schedule Begin-- Loop Times: 5 Level 50.00% Pulses 2 Level 50.00% Pulses 2 Level 75.00% Pulses 2 Level 100.00% Pulses 100 Level 100.00% Pulses 100 End Loop End Loop

Full Manual Control





Analysis Tools

FFT, Power Spectrum, Transmissibility



□ SRS Analysis





Special Displays

Time block history: RMS, Peak, Peak-peak

Control History



