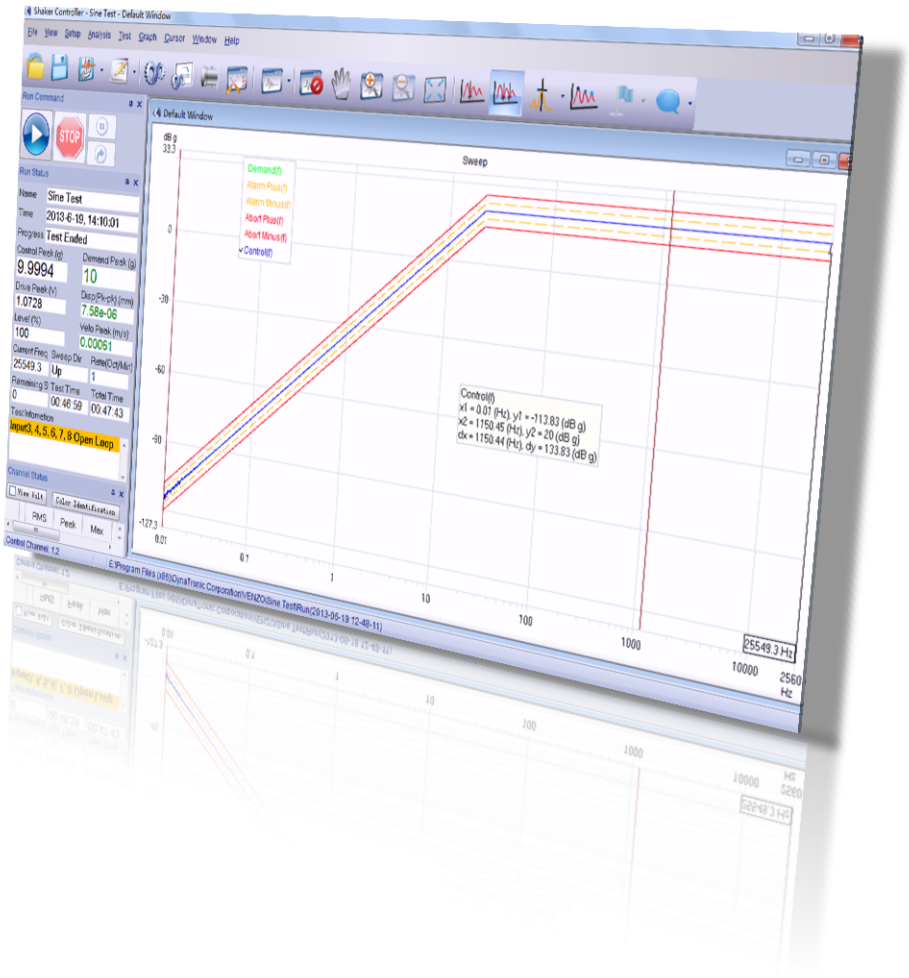
Why adopt multivariable control?

-DynaTronic Corporation Ltd.



Multivariable Control

- ✓ 150 dB Dynamic Range
- ✓ 0.01-25600Hz Swept Sine Range

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Why adopt multivariable control?

As we all know, before doing vibration testing, we should edit the reference spectrum with the vibration controller, usually low frequencies with constant displacement spectrum, middle frequencies with constant velocity spectrum, while the high frequencies with constant acceleration spectrum. This method has some relationships with Shaker control algorithm; on the other hand, we can study the amplitude conversion relationship among acceleration-velocity-displacement to understand the principle.

Sine acceleration response signal can be indicated as $\mathrm{A}\sin(2\pi\mathrm{ft}+\theta)$, whose amplitude is A, through once integral obtained velocity amplitude $\mathrm{V}=\frac{A}{2\pi f}$, through twice integrals obtained displacement amplitude $\mathrm{D}=\frac{A}{4\pi^2 f^2}$, by above relations, we know at 0.1Hz, if the displacement amplitude is 10mm, then you can get the acceleration amplitude 0.00395m/s^2, which is 0.0004g. Generally, the sensitivity of acceleration sensor is around 100mv/g, that is to say, the voltage amplitude of measured by acceleration sensor is about 0.00004v. In this case, the measured acceleration signal basically are buried in the noise, unable to complete the measurement of the real acceleration signal, in other words, it is very difficult to control low frequencies through the acceleration sensor's feedback.

The displacement sensor sensitivity is generally several hundred mv/mm, for more convenient, taking 100mv/mm, then in this case the voltage signal of displacement amplitude is up to 1000mv, with very good signal to noise ratio, therefore, from a view of control point, got a high SNR feedback signal, can greatly enhance the control precision.

When the sine signal frequency is 100Hz, how is the situation? At this time, assuming that the amplitude of acceleration is 1g, the amplitude of the displacement can be calculated as 0.025mm, the corresponding amplitude of the voltage signal, respectively is 100mv and 2.5mv, obviously, this time adopt acceleration feedback control can achieve greater signal to noise ratio.

Therefore, at low frequencies, adopt high SNR displacement signal feedback control; at high frequencies, adopt high SNR acceleration signal feedback control, this is multi-variable control strategy, which can be across the whole frequency band to obtain satisfactory control channel SNR, to improve the overall control accuracy.

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How to set up multivariable control parameters?

Control channel contains at least one acceleration sensor and one displacement sensor, which are co-located at the desired control points. You can select multiple acceleration sensors and multiple displacement sensors, this time, among the acceleration control channels and the displacement control channels can use the weighted average, maximum or minimum control strategies. Then set the low-frequency range for displacement control and high-frequency range for acceleration control. You may also enter the desired Transition range between high-frequency range and low-frequency range, a pseudo-velocity variable control is used in this transition range, to achieve linear smooth switch of the control physical quantities.

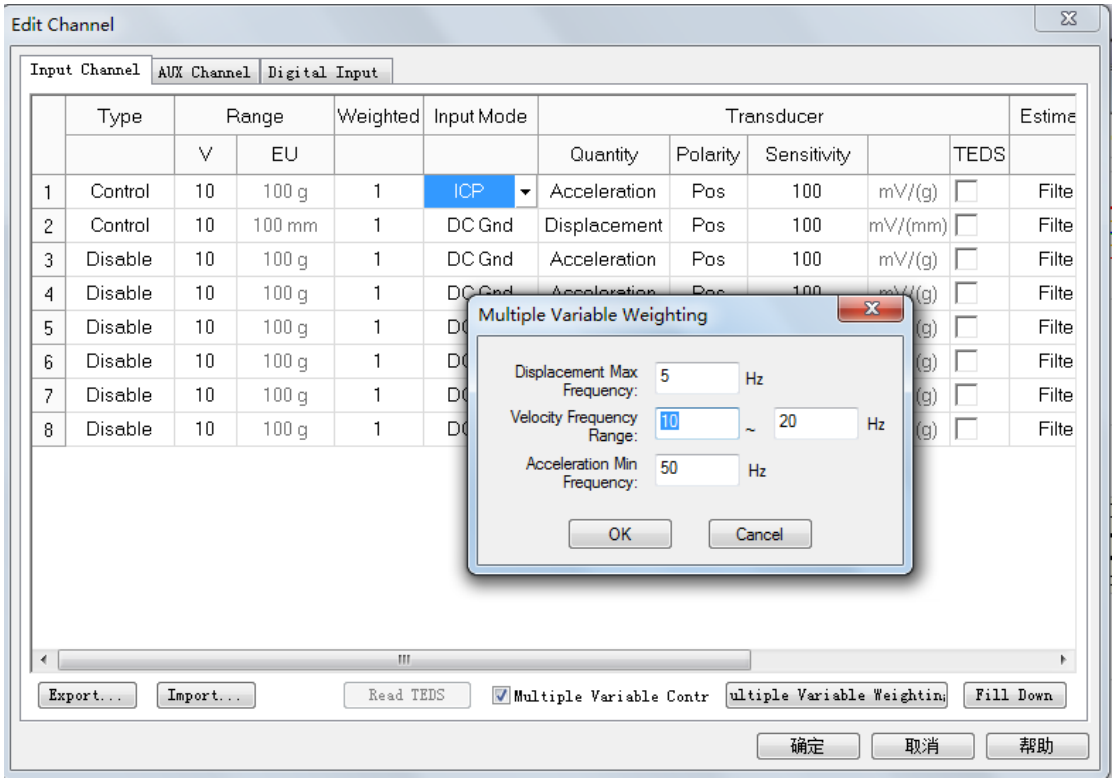

Figure 1 Edit Channel

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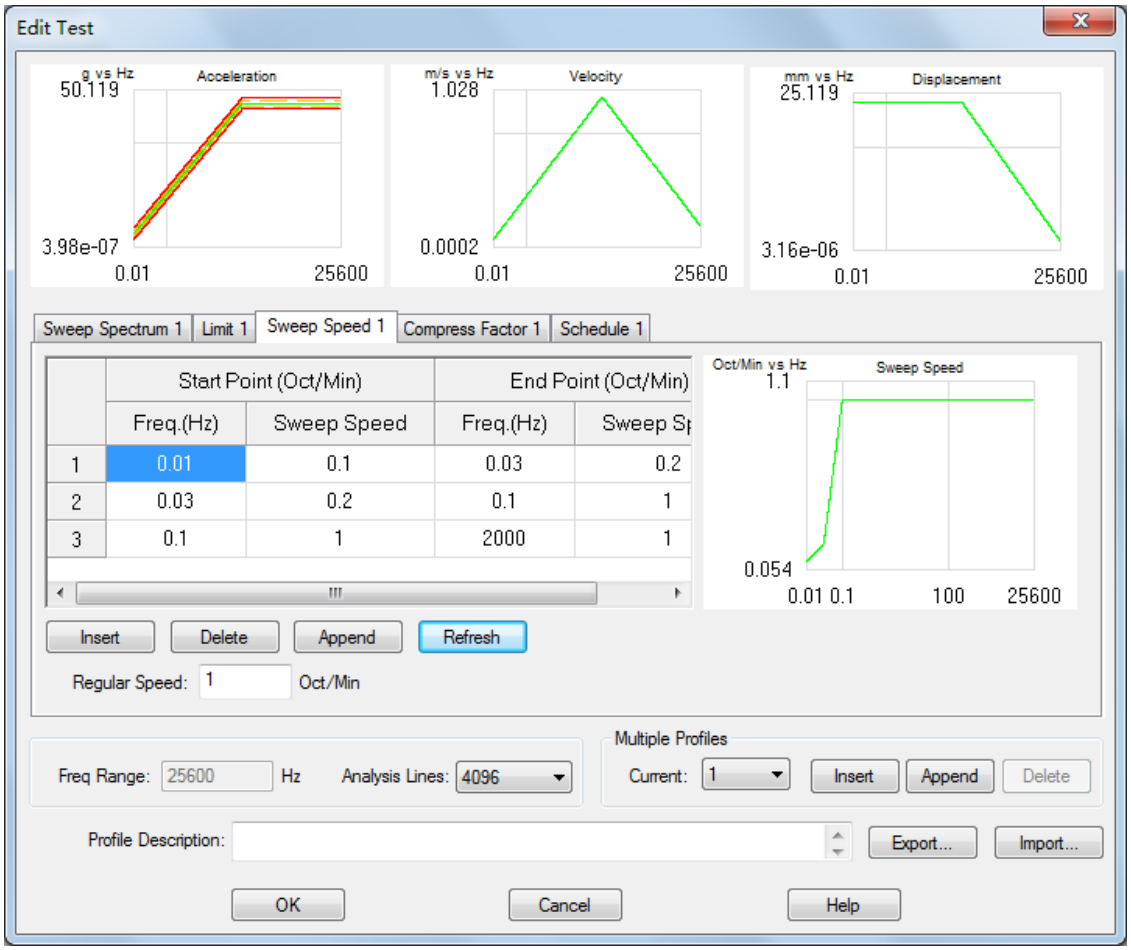

Figure 2 Edit Test Spectrum (Set lower sweep speed of low-frequency band will get better control accuracy)

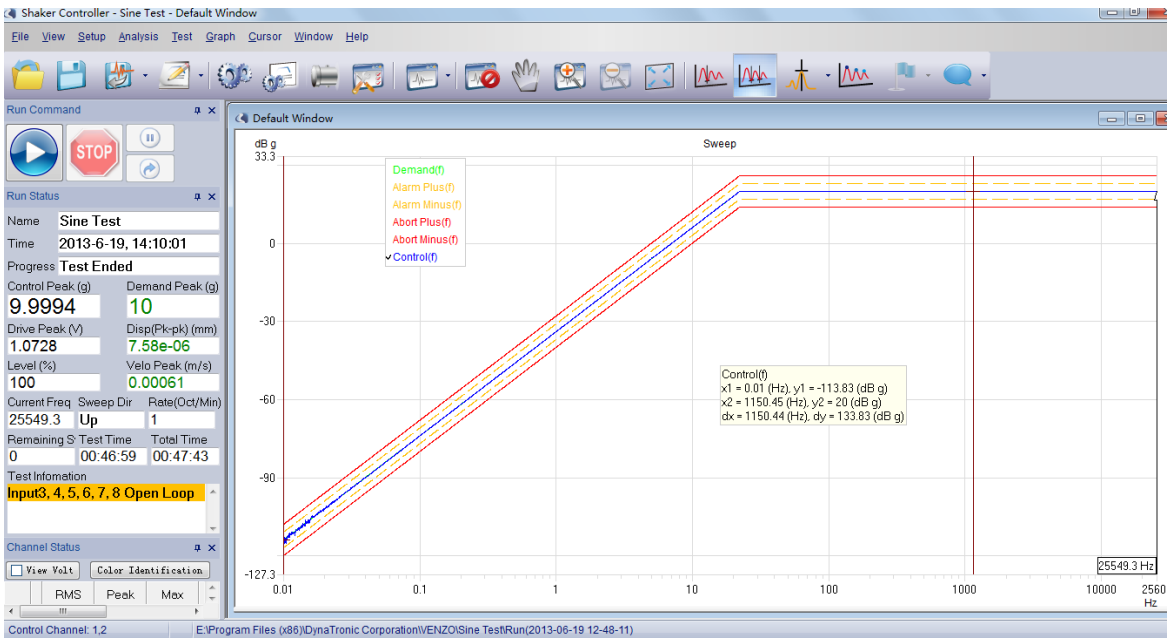

Figure 3 Continuous Swept Sine Test from 0.01H to 25600Hz

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Multivariable Control Effects and Summary of Benefits

Adopting multivariable control strategy is greatly expanding the frequency control range, VibExpert control software for VENZO vibration controller can realize continuous sine sweep test from 0.01Hz to 25600Hz, the dynamic range of controllable sine acceleration signal is up to 150dB. Especially for hydraulic shaker, join with the displacement control channel, greatly improving the low frequency control precision, effectively avoiding the runaway phenomenon under the traditional acceleration control, such as hydro-cylinder collision, over displacement and so on. By the way, waveform distortion is also effectively suppressed with multivariable control strategy.