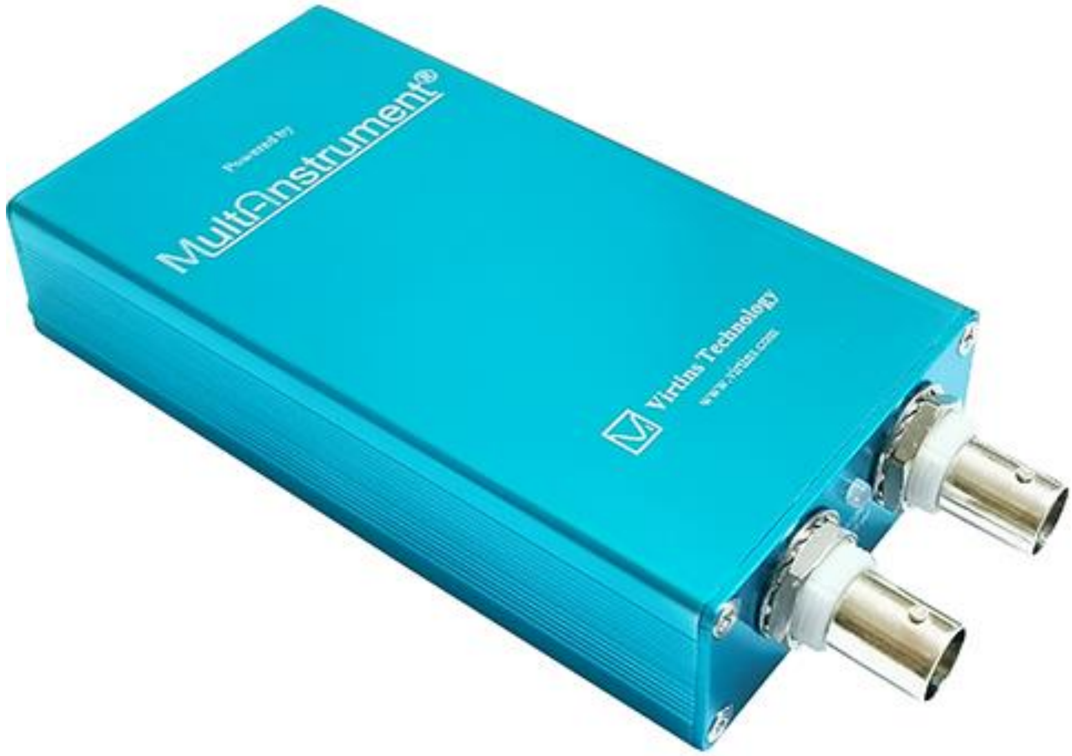
VT CAMP-2G05/A/B Manual

24-bit Dual-Channel 48 kSPS 0.03Hz~23kHz
USB Data Acquisition Interface with Charge Input (Digital Charge Amplifier)



This product is designed to be used by those who have some basic electronics and electrical knowledge. It is absolutely dangerous to connect an unknown external voltage to the VT CAMP-2G05/A/B unit. Generally only sensors with electric charge output can be connected to the BNC connectors of this product.

Note: VIRTINS TECHNOLOGY reserves the right to make modifications to this manual at any time without notice. This manual may contain typographical errors.

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1 Installation and Quick Start Guide

VT CAMP-2G05 is a 24-bit, dual-channel, USB data acquisition interface specially designed for use with sensors with electric charge output such as piezoelectric sensors. Each channel has a built-in charge amplifier with 12 calibrated charge measurement ranges for easy calibration to sensor sensitivity: ± 250 pC, ± 500 pC, ± 1 nC, ± 2.5 nC, ± 5 nC, ± 10 nC, ± 25 nC, ± 50 nC, ± 100 nC, ± 250 nC, ± 500 nC, ± 1 µC. High-precision capacitors with low dissipation factors, low dielectric absorptions and very constant capacitance values against temperature and humidity variation are used in the charge amplifiers to convert charge to voltage. The charge amplifiers are equipped with an overload indicator and a reset facility. Each channel contains a hardware high-pass filter with 5 selectable -3dB corner frequencies: None (0.03 Hz), 1.8 Hz, 119 Hz, 236 Hz and 464 Hz. The signals sensed by the charge-output sensors can be amplified and output directly from the stereo headphone jack even without running the PC software. When used in conjunction with the Multi-Instrument® software, the setup allows you to take reliable and quality vibration and noise measurements as simply as plug & play. No external power supply and driver installation is required. It is a truly hassle-free portable vibration and noise test & measurement solution.

VT CAMP-2G05A has the same specifications as VT CAMP-2G05, except that its Channel B has a 60 dB higher analog gain, with its charge measurement ranges changed to: ± 0.25 pC, ±0.5 pC, ± 1 pC, ± 2.5 pC, ± 5 pC, ± 10 pC, ± 25 pC, ± 50 pC, ± 100 pC, ± 250 pC, ± 500 pC, ± 1 nC. The increased gain makes it more capable of measuring low level signals such as a low-dB sound in water.

VT CAMP-2G05B has the same specifications as VT CAMP-2G05, except that its two input channels A & B have a 60 dB higher analog gain, with their charge measurement ranges changed to: ± 0.25 pC, ±0.5 pC, ± 1 pC, ± 2.5 pC, ± 5 pC, ± 10 pC, ± 25 pC, ± 50 pC, ± 100 pC, ± 250 pC, ± 500 pC, ± 1 nC. The increased gain makes it more capable of measuring low level signals such as a low-dB sound in water.

It is possible to run multiple VT CAMP-2G05/A/B using multiple instances of the software on the same computer.

1.1 Package Contents

1.1.1 Standard Package

A standard VT CAMP-2G05/A/B Package contains the following items:

1) VT CAMP-2G05/A/B unit with a hardware activated Multi-Instrument Standard software license

2) USB cable (1.5 m)

3) CD (contains the copy-protected Multi-Instrument software)

4) Carrying case

1.1.2 Optional Items

1) Charge-mode piezoelectric accelerometers, force sensors, impedance heads, impact hammers, pressure sensors
2) Charge-mode piezoelectric contact microphones
3) Charge-mode piezoelectric film sensors
4) Charge-mode piezoelectric hydrophones
5) Magnetic mounting base
6) USB Isolator
7) Calibration Capacitors
8) Software license upgrade

Note: It is usually possible to place the optional items inside the same carrying case with VT CAMP-2G05/A/B.

1.2 Multi-Instrument Software Installation

Multi-Instrument is a powerful multi-function virtual instrument software. It is a professional tool for time, frequency and time-frequency domain analyses. It supports a variety of hardware ranging from sound cards which are available in almost all computers to proprietary ADC and DAC hardware such as NI DAQmx cards, VT DSO, VT RTA, VT

IEPE, VT CAMP and so on. It consists of an oscilloscope, a spectrum analyzer, a multimeter, a spectrum 3D plot, a vibrometer, a data logger, a LCR meter and a Device Test Plan, all of which can run simultaneously. Please refer to the Multi-Instrument software manual for details.

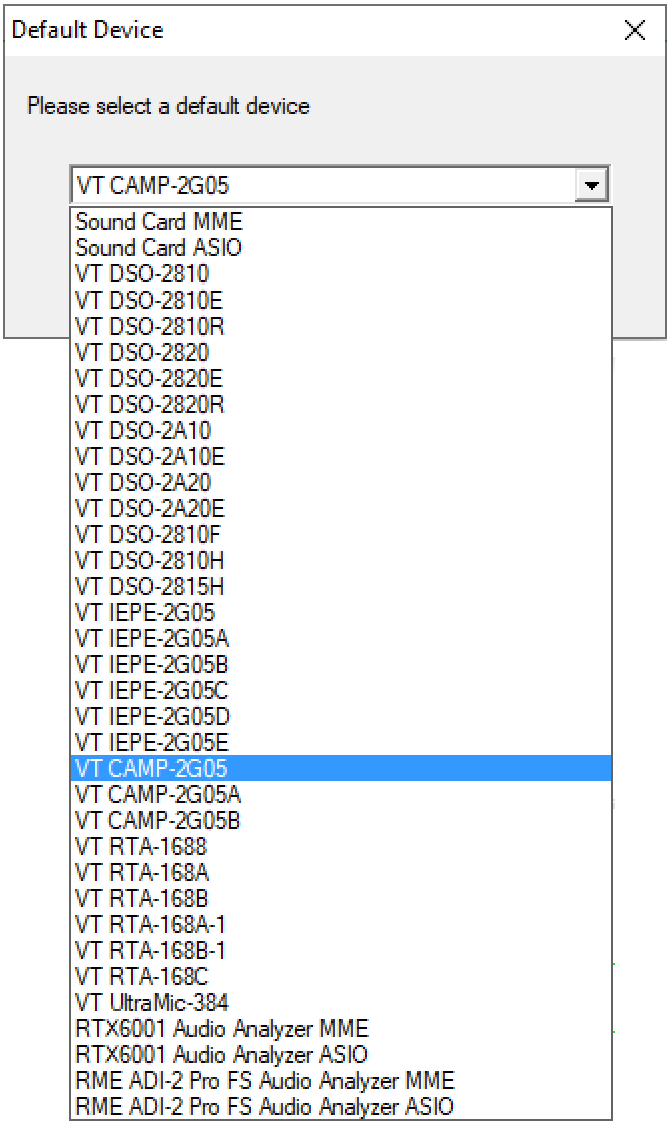
Insert the installation CD into your computer's CD-ROM drive and follow the instruction on the screen to install the Multi-Instrument software. Alternatively, you can always download the latest software from: www.virtins.com/MIsetup.exe.

By default, VT CAMP-2G05/A/B uses sound card MME driver which comes natively with all Windows versions. Thus no driver installation is required.

1.3 Start Multi-Instrument Software

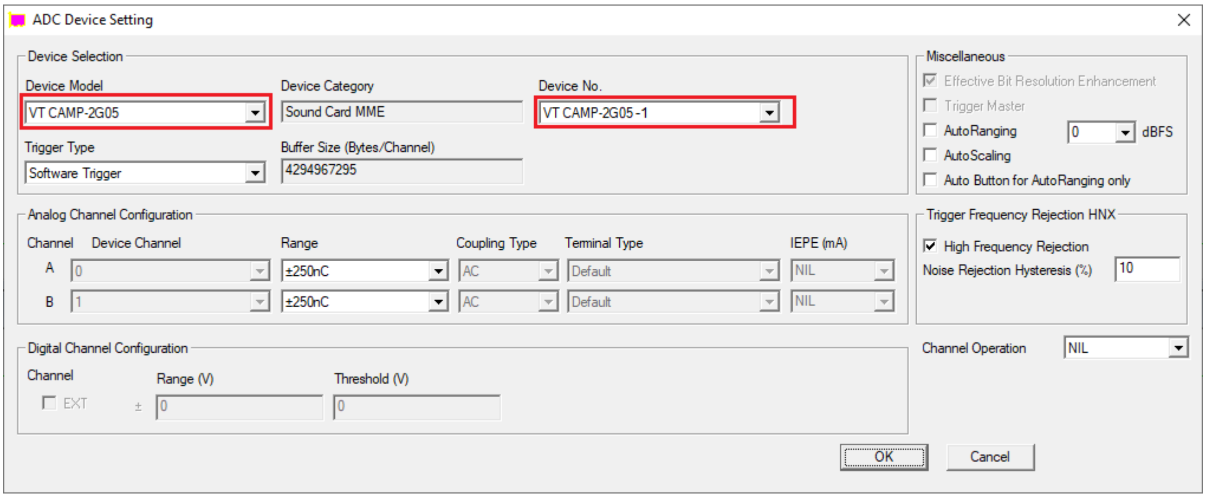
With the hardware activated Multi-Instrument license, the hardware (i.e. VT CAMP-2G05/A/B) must be connected to the computer first before the software can be launched. The LED on the front panel will turn steady green once connected.

To start the Multi-Instrument software, on Windows desktop, click the MI icon directly, or select [Start]>[All Programs]>[Multi-Instrument]>[VIRTINS Multi-Instrument]. If the software is started for the very first time, the following dialog box will pop up. Select "VT CAMP-2G05" (or "VT CAMP-2G05A", or "VT CAMP-2G05B") to make it the default data acquisition device. This dialog box can also be accessed via [Setting]>[Restore to Factory Default].

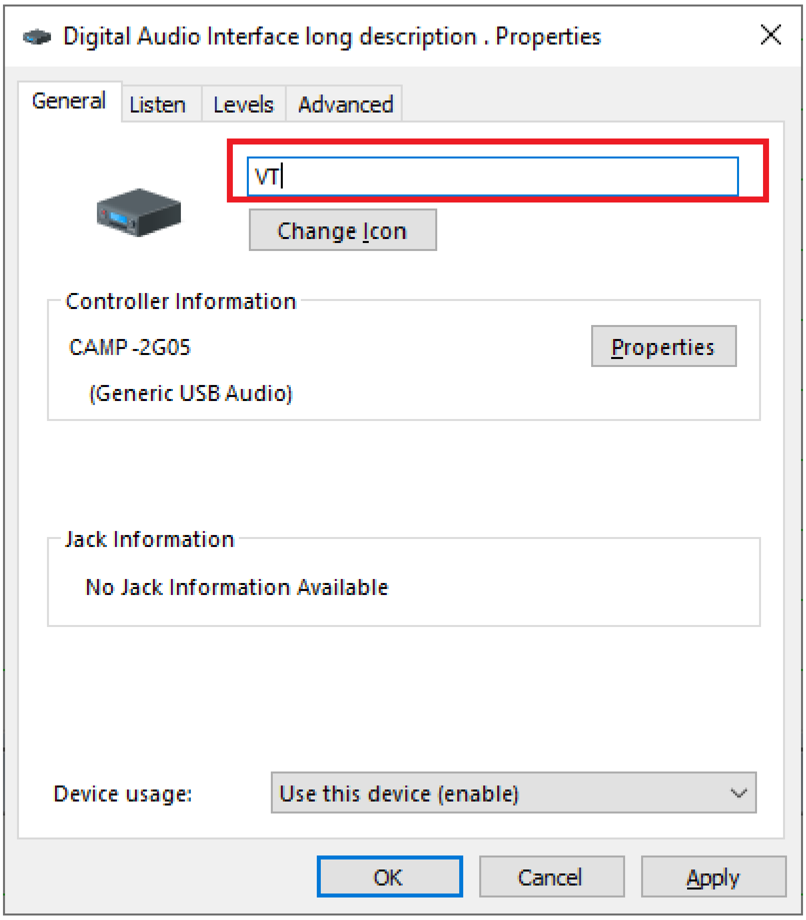


Click the round button at the upper left corner of the screen, or simply press the ENTER key, to start or stop data acquisition.

VT CAMP-2G05 can also be selected via [Setting]>[ADC Device]> "Device Model" and "Device No.", as shown below.

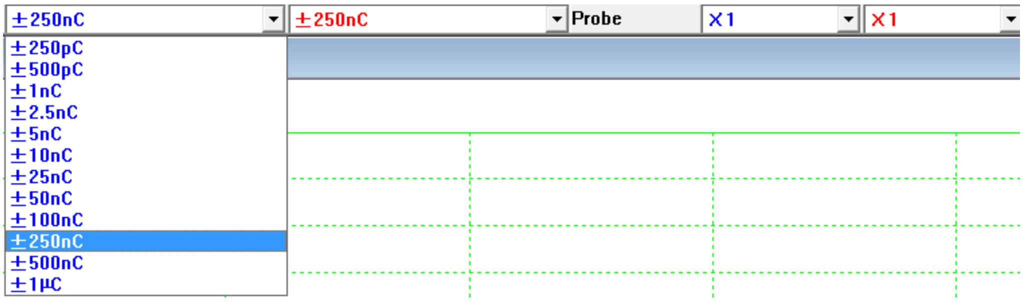


When the system language of Windows is not English, depending on the actual language used, an error message such as "DAQ device not found!" or "Fail to start DAQ!" might pop up when you launch the software or start sampling. In this case, you can go to [Windows Control Panel]>[Sound]> "Recording" and find VT CAMP-2G05 there. Then right click it and select "Property"> "General" to open the following page. Changing the highlighted long textual description to simply "VT" will solve the issue.



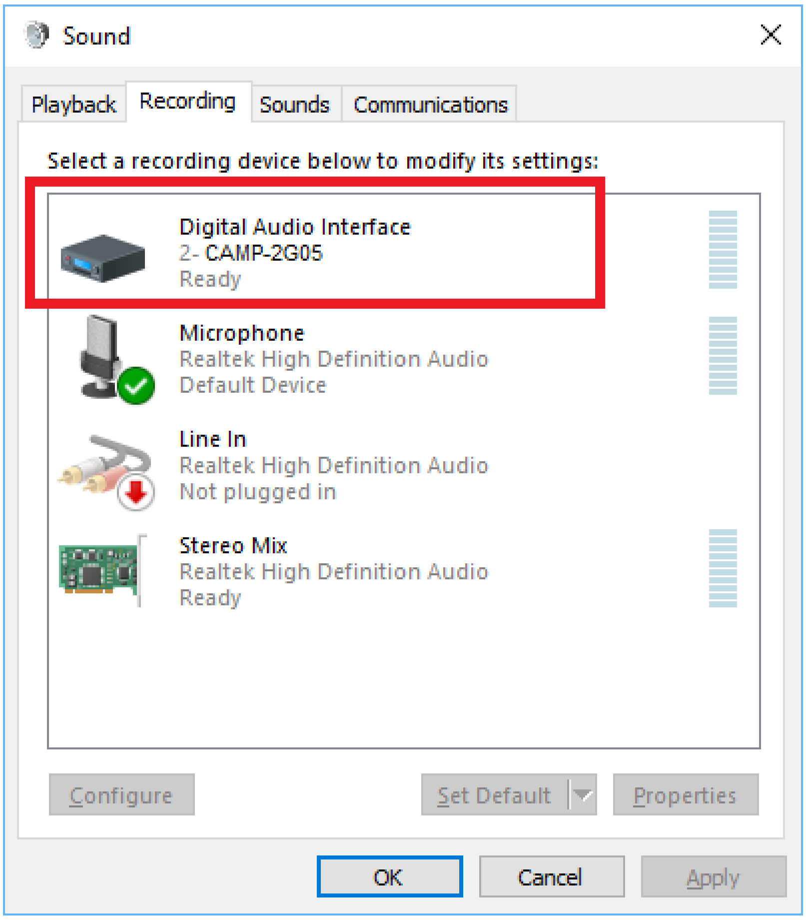
1.4 Charge Measurement Range Selection

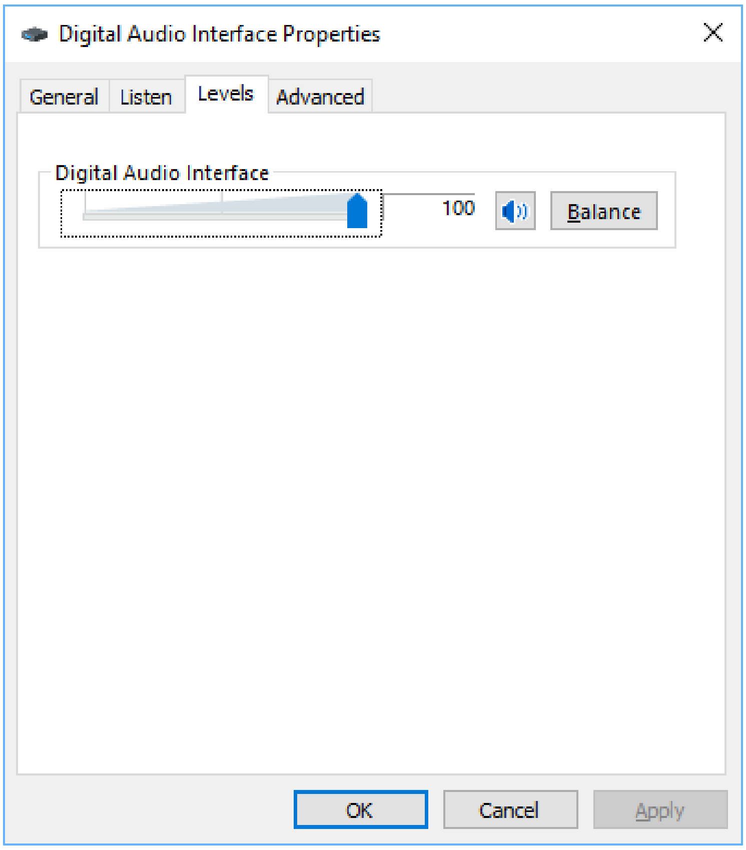
The charge measurement range can be selected in the second toolbar from the top as follows. 12 options are available (VT CAMP-2G05): ± 250 pC, ± 500 pC, ± 1 nC, ± 2.5 nC, ± 5 nC, ± 10 nC, ± 25 nC, ± 50 nC, ± 100 nC, ± 250 nC, ± 500 nC, ± 1 μC.



Please make sure that the "Probe" switch position is always at "×1" (the default selection) if there is no external attenuation switch in the charge-output sensors, which is usually the case.

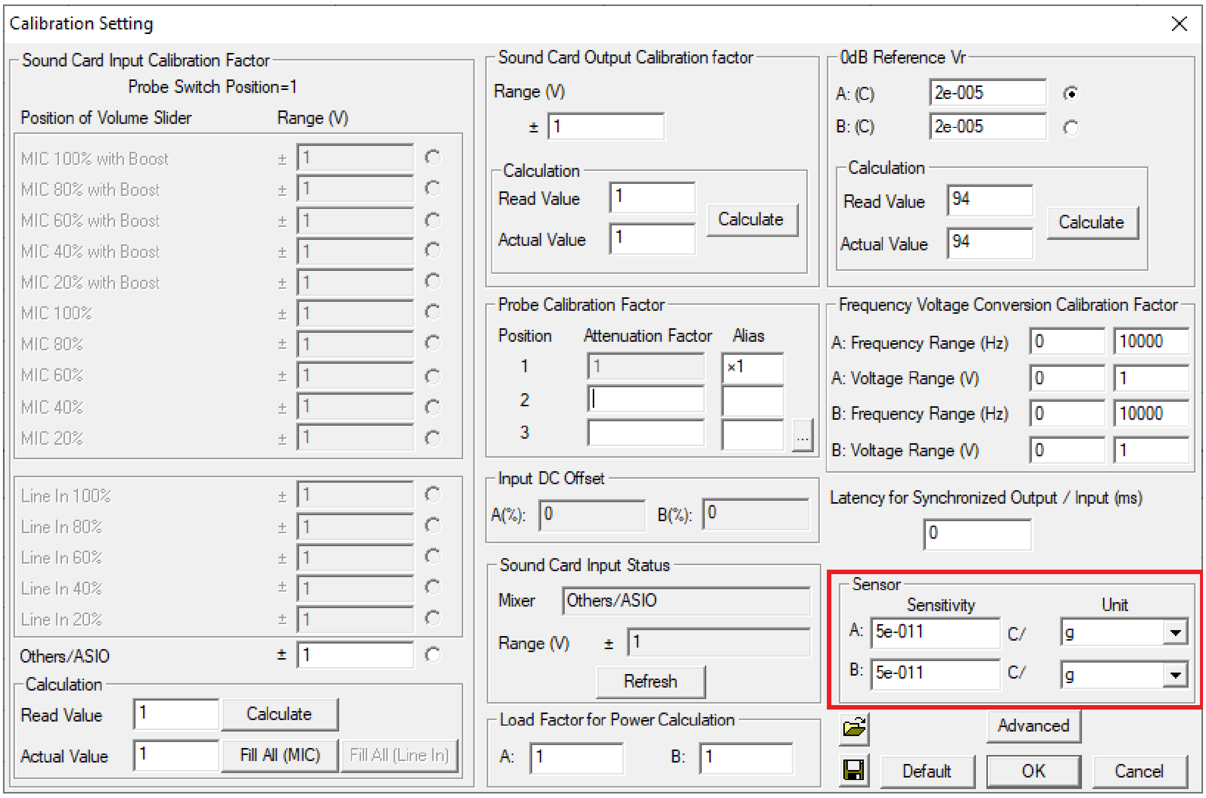
It should be noted that VT CAMP-2G05 will also be listed in the Recording Control under Windows Control Panel as follows. Thus it is possible to change the gain digitally by right clicking "Digital Audio Interface – CAMP-2G05" and select [Properties]>"Levels". However, this change will not be compensated in the software and thus you should NEVER change the gain from there. By default, the "Levels" is at 100%. It should remain as 100% in order for VT CAMP-2G05 to scale the measurement data correctly.





1.5 Sensor Sensitivity Input

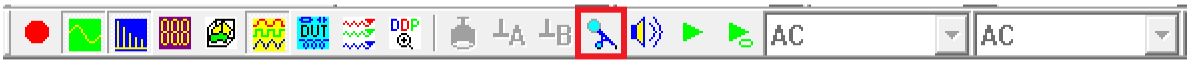
To scale the input charge to the physical quantity it measures, the sensor sensitivity needs to be entered manually via [Setting]>[Calibration]> "Sensor". For example, if the sensitivity of a piezoelectric accelerometer is 50 pC/g, then 5e-011 C/g should be entered. You can select or enter an engineering unit of any physical quantity that the charge-output sensor measures.



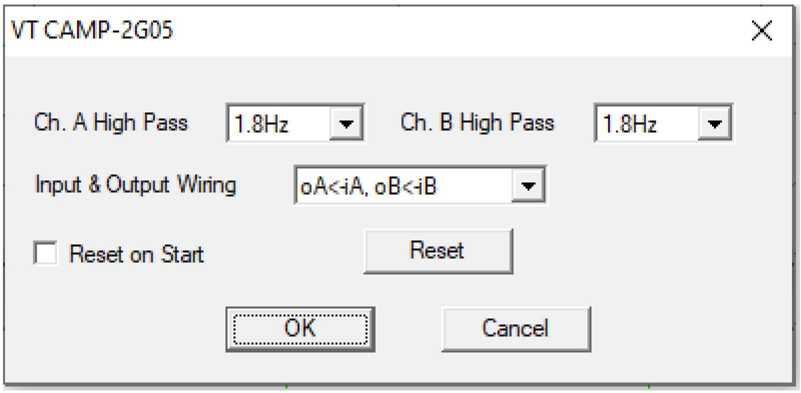
Note that in the above dialog box, the values in “Range (V)” column under Sound Card Input Calibration Factor do not affect the scaling of VT CAMP-2G05 at all.

1.6 High-Pass Filter

The front-end charge amplifier of VT CAMP-2G05 has a high-pass cutoff frequency from 0.013Hz to 0.00013Hz depending on the range selection. Its output is then AC coupled into ADC. This gives a high-pass cutoff frequency of about 0.03 Hz (-3 dB). On the top of that, the device is also equipped with a built-in adjustable high-pass filter with five options: None, 1.8 Hz, 119 Hz, 236 Hz, 464 Hz. To check or change the high pass filter setting, click the microphone button in the second toolbar from the top, as shown below.

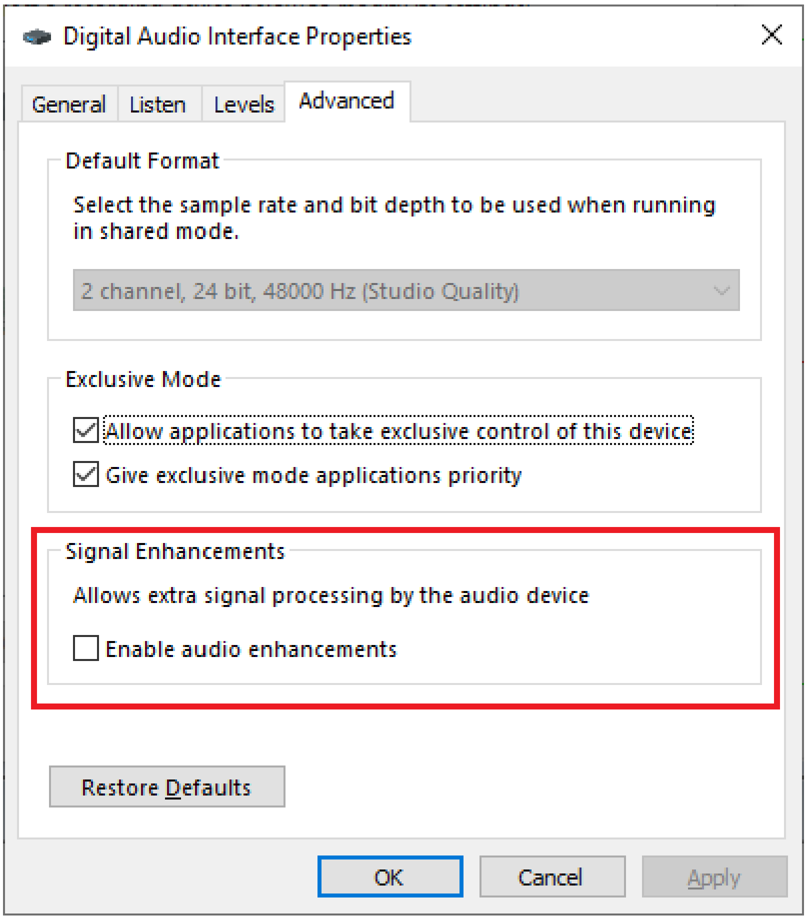


The following dialog box will pop up. This high-pass filter is set to 1.8 Hz by default after the unit is powered on. The settings in this dialog box can be saved together with a Panel Setting File in Multi-Instrument. In other words, if you load a preconfigured Panel Setting File, these settings may change.



If “None” is selected for the high-pass filter, the input will still be high-pass filtered at 0.03 Hz due to the AC input coupling of the data acquisition circuit. For the following 6 charge measurement ranges, e.g. ± 250 pC, ± 500 pC, ± 1 nC, and ± 25 nC, ± 50 nC, ± 100 nC of VT CAMP-2G05, it is recommended to use a high-pass filter with a cutoff frequency equal to or above 1.8 Hz, in order to remove any discernible DC offset.

Some Windows versions / editions come with some audio signal enhancement features which are enabled by default. These features must be disabled through the Sound Recording Control under Windows Control Panel to prevent them from altering the originally sampled data, as shown below. One of the possible problems caused by these features is the removal of the frequencies below about 20Hz.



1.7 Charge Amplifier Overload Indication and Reset

In Multi-Instrument, when the input exceeds the ADC full-scale range, the input peak level indicator at the upper right corner of the software's main window will be fully filled and turn red (see figure below). Under this situation, a higher measurement range should be selected. With the charge amplifier at the front end before ADC, it is possible for the charge amplifier to enter into its nonlinear region or even be fully saturated without driving the ADC out of its full-scale range, due to the AC coupling between them. For this reason, the output of the charge amplifier is directly monitored by an overload detection circuit. When the charge amplifier is overloaded, the LED of VT CAMP-2G05 will turn from green to yellow. The time constant of the charge amplifier ranges from 12.1s to 1210s depending on the measurement range selected. Therefore, once overloaded, the charge amplifier may take a long time to return to normal. A reset button (see figure in the previous section) is thus provided to quickly reset the charge amplifier. If the "Reset on Start" option is ticked, the charge amplifier will be reset first whenever the data acquisition starts or restarts irrespective of whether the charge amplifier is overloaded or not. On the other hand, if an overload situation is already detected, resetting will be performed automatically first upon starting or restarting the data acquisition, irrespective whether this option is ticked or not. By default, it is not ticked.

1.8 Zeroing

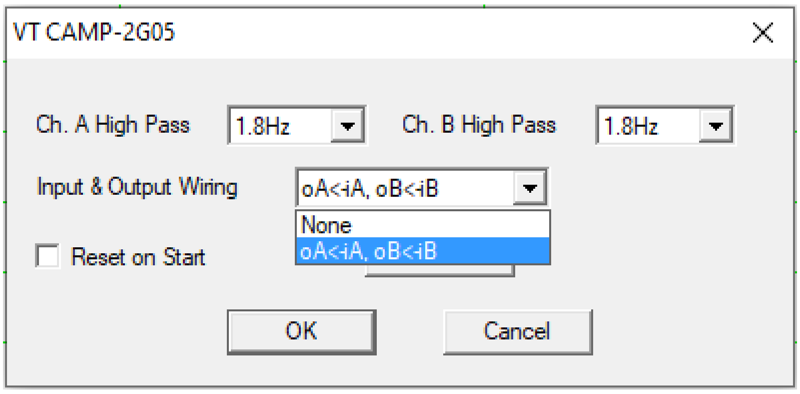
VT CAMP-2G05 exhibits extremely small DC offset and thus zeroing is generally not needed. Zeroing may be needed only under the following 6 charge measurement ranges, e.g. ± 250 pC, ± 500 pC, ± 1 nC, and ± 25 nC, ± 50 nC, ± 100 nC of VT CAMP-2G05, with the high-pass filter set to "None" (not recommended).

To perform software zeroing, disconnect all charge-output sensors from the BNC connectors of VT CAMP-2G05, switch the Trigger Mode to "Auto" (see the figure below). With the oscilloscope running, you should see a horizontal line at 0V in the oscilloscope. If not, you should click "⊥A" and "⊥B" in the toolbar and choose "Yes" to compensate the ground levels of both channels to zero. If "No" is chosen instead, the software DC compensation will be removed. Be sure to remove the software DC compensation if the charge measurement ranges are put back to the following 6 ranges, e.g. ± 2.5 nC, ± 5 nC, ± 10 nC, and ± 250 nC, ± 500 nC, ± 1 µC of VT CAMP-2G05, or a high-pass filter is selected. To make sure that the software DC compensation is inactive, go to [Setting]>[Calibration] and check the "Input DC Offset", make sure that the values are zeros for both channels.

1.9 Direct Monitoring (Stethoscope)

VT CAMP-2G05 has a ϕ3.5 stereo headphone jack in it back panel for direct monitoring of the input signal. Direct monitoring means that the input signals from the charge-output sensors are attenuated / amplified / impedance converted and sent directly to the headphone jack without going through ADC and DAC hardware as well as the computer. This direct path can be on and off from Multi-Instrument through the aforementioned high-pass filter setting dialog box as shown below. If "oA<-iA, oB<-iB" is selected in the "Input & Output Wiring" selection box, the path is established. If "None" is selected instead, the path is disconnected. The path is on by default when the unit is powered on. Thus it is possible to monitor the input signal through this jack without even running the Multi-Instrument software. The output signal from this jack is able to drive a headphone or an audio power amplifier. If the charge-output sensor is an accelerometer, then this function, in effect, converts the vibration which can only be felt by touching to an audible sound which can be heard.

Again, the settings on this dialog box can be saved together with a Panel Setting File in Multi-Instrument. In other words, if you load a preconfigured Panel Setting File, these settings may change.



Please note that measurement range selection will affect the gain of the direct monitoring function, as shown in the following table. For example, a 250 nC input signal under ± 1 μC, ± 500 nC, ± 250 nC, ± 100 nC, ± 50 nC and ± 25 nC measurement ranges will generate an output signal of 0.125V, 0.25V, 0.5V, 0.125V, 0.25V and 0.5V, respectively. Either ± 1 μC or ± 10 nC is selected by default upon power on. If the measurement range before power off is equal to or below 10 nC, then ± 10 nC will be set as the measurement range upon power on next time, otherwise, ± 1 μC will be set.

Input Charge (For Direct Monitoring only)	Charge Measurement Range Selection	Gain (Typical) (V/nC)	Output Voltage
± 1 μC	± 1 μC	1/2000	±0.5V
± 500 nC	± 500 nC	1/1000	±0.5V
± 250 nC	± 250 nC	1/500	±0.5V
± 1 μC	± 100 nC	1/2000	±0.5V
± 500 nC	± 50 nC	1/1000	±0.5V
± 250 nC	± 25 nC	1/500	±0.5V
± 10 nC	± 10 nC	1/20	±0.5V
± 5 nC	± 5 nC	1/10	±0.5V
± 2.5 nC	± 2.5 nC	1/5	±0.5V
± 10 nC	± 1 nC	1/20	±0.5V

± 5 nC	± 500 pC	1/10	±0.5V
± 2.5 nC	± 250 pC	1/5	±0.5V

(VT CAMP-2G05)

In VT CAMP-2G05A/B, for those channels with a 60dB (i.e. ±1nC, ±500pC, ±250pC, ±100pC, ±50pC, ±25pC, ±10pC, ±5pC, ±2.5pC, ±1pC, ±0.5pC, ±0.25pC) higher gain, the gain values (typical) here are 0.5, 1, 2, 0.5, 1, 2, 50, 100, 200, 50, 100, 200, respectively.

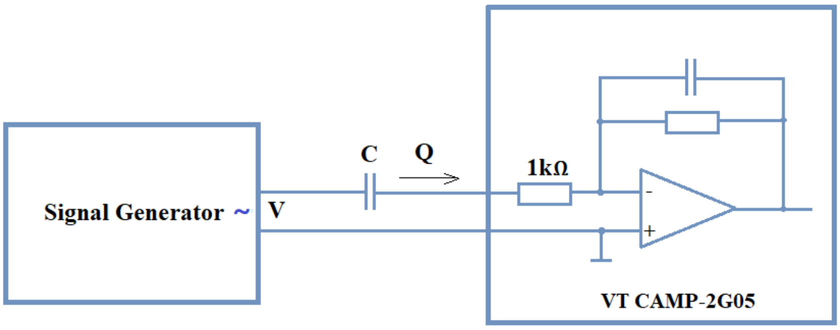
1.10 Hard Reset

A hard reset can be done by disconnecting the unit from your computer and then re-connecting it to the computer again. You can only do this with the Multi-Instrument software closed.

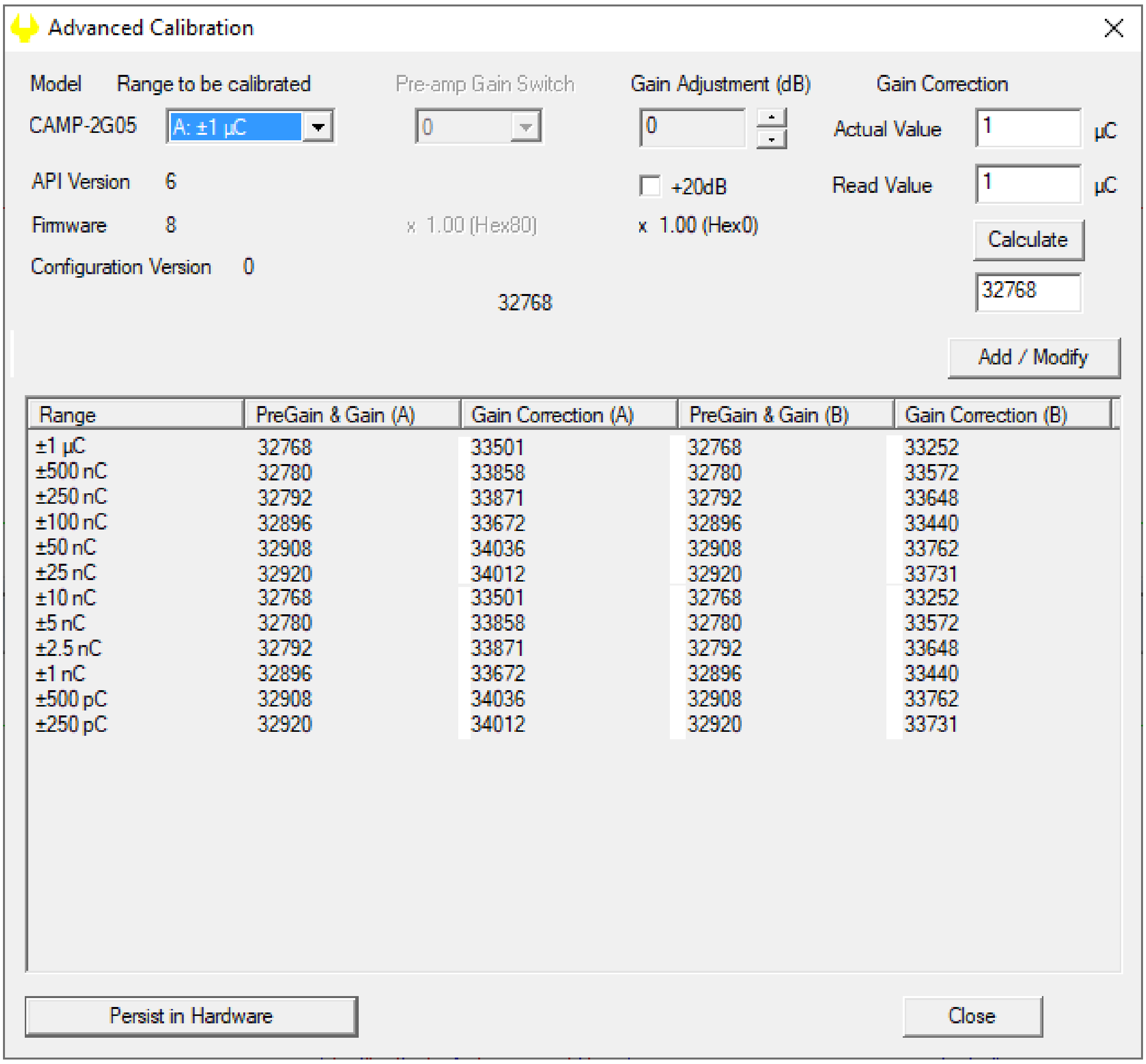
1.11 Calibration and Recalibration

VT CAMP-2G05 is individually calibrated in factory. Re-calibration is generally not required.

Recalibration can be done using a signal generator with a low output impedance (preferably ≤50Ω) and a standard high-precision capacitor (preferably better than 1%). These two can be connected in series to simulate a charge output (see figure below). Assuming the (voltage) input impedance of the charge amplifier is negligibly small, then the simulated charge can be calculated as: $Q = CV$, where Q is the charge, C the capacitance of the capacitor and V the voltage output by the signal generator. VT CAMP-2G05 has an input impedance of 1kΩ. It is used to improve the stability and limit the input current due to accidental high input voltage. However, this input impedance will reduce the simulated charge significantly as compared to the one calculated by the above formula, at high frequencies where the impedance of the capacitor C drops to a comparable level. It is thus crucial to keep the frequency of the calibration signal sufficiently low. A 10Hz~50Hz sine wave is recommended. For example, if C=0.1µF, its impedance at 10Hz is $1/(2\pi fC)$= 159kΩ, which is much higher than 1 kΩ, thus keeping the charge calculation error sufficiently low. It should be noted that the reduction of the simulated charge at high frequencies is attributed to this charge simulation method only. In the actual charge measurement, the charge is already generated by the sensor and its amount will not be affected by the 1 kΩ input impedance of the charge amplifier.



To overwrite the existing calibration data, go to [Setting]>[Calibration]> “Advanced”. The following “Advanced Calibration” dialog will pop up.



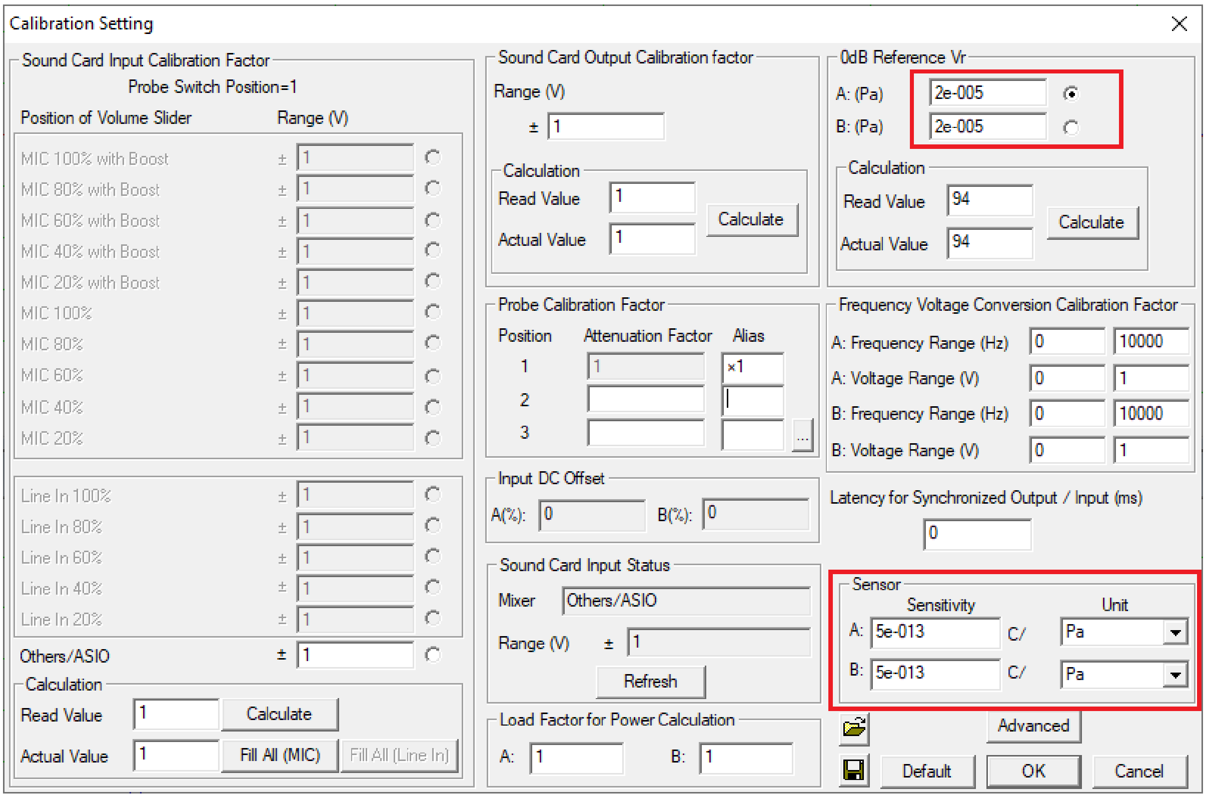
Detailed re-calibration procedure will be described separately from this document. Please contact Virtins Technology for details.

1.12 Sound Pressure Level Measurement Ranges and Calibration

If a charge-output microphone is connected to VT CAMP-2G05 to measure a sound pressure level in dBSPL, the maximum dBSPL measureable can be estimated by:

$$20 \times \log_{10}(([\text{Max. Measurable Charge}] / 1.414) / [\text{Charge-Output Mic Sensitivity}] / (20\times10^{-6}))$$

where 1.414 is used to convert the peak value to the RMS value, and 20×10^{-6} Pa is the 0 dBSPL reference in air. The sound pressure level (in dBSPL) measurement range varies with the charge measurement range.



CAMP-2G05 is charge-calibrated. If the sensitivity of the charge-output microphone is entered in the above figure, the measured data will be calibrated to sound pressure in Pa. Then 0.00002 or 2e-005 Pa (i.e. 20 μPa) should be entered in the "0dB Reference Vr" edit box in the above figure to convert sound pressure (in air) to sound pressure level in dBSPL. For sound pressure in water, 0.000001 or 1e-006 Pa (i.e. 1 μPa) should be used instead. It is also acceptable to calibrate "0dB Reference Vr" directly without first converting the measurement data to sound pressure in Pa if the sensor sensitivity is unknown. In this case, just let the sensor sensitivity to be 1 C/C.

1.13 Low-Pass Cutoff Frequency and Cable Length

The low-pass cutoff frequency of the charge amplifier inside VT CAMP-2G05 can be calculated as follows: $f_H=1/(2\pi RC_S)$, where R is the 1kΩ input impedance of the charge amplifier and C_S is the source capacitance including sensor and cable. If sensor capacitance is 100pF (typical) and the cable capacitance per unit length is 100 pF/m (typical), then for a 10m cable, the low-pass cutoff frequency would be 145 kHz which is far beyond the low-pass cutoff frequency 22.8 kHz (@sampling rate 48 kHz) of the anti-aliasing filter of the ADC inside.

A special low-noise cable dedicated for use at the input of a charge amplifier should be employed to connect the sensor to the charge amplifier in order to reduce greatly the triboelectric noise.

1.14 Non-routine Applications

The non-routine applications refer to those applications that are not considered as routine tasks of VT CAMP-2G05/A/B. With Multi-Instrument’s capability of simultaneous input and output, you can generate a stimulus to a Device Under Test (DUT) and acquire the response from it at the same time. Different stimuli can be generated and the responses can be analyzed in different ways. The characteristics of the DUT, such as frequency response and distortion, can then be obtained. You can even configure and then perform a sequence of automated test steps to evaluate a DUT using the Device Test Plan software module.

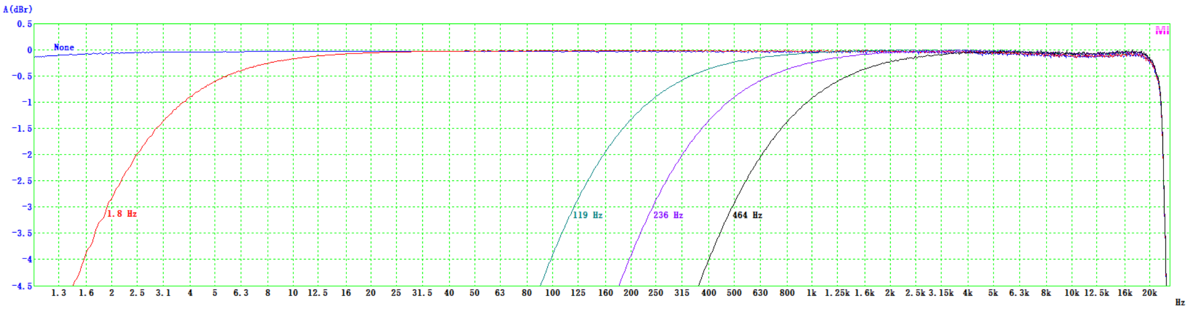
You can configure the output device via [Setting]>[DAC Device]. For example, the computer sound card can be used to generate vibration stimulus to some external devices which then generate mechanical vibration.

2 Specifications

2.1 VT CAMP-2G05/A/B Hardware Specifications

Number of Input Channels	2
Sampling Frequency	48 kHz (original), 44.1 kHz, 32 kHz, 22.05 kHz, 16 kHz, 11.025 kHz, 8 kHz, 4 kHz, 2 kHz …
ADC Bit Resolution	24 Bits (can be reduced to 16 bits or 8 bits)
Input Charge Ranges	CAMP-2G05: ± 250 pC, ± 500 pC, ± 1 nC, ± 2.5 nC, ± 5 nC, ± 10 nC, ± 25 nC, ± 50 nC, ± 100 nC, ± 250 nC, ± 500 nC, ± 1 μC CAMP-2G05A: Ch.A: ± 250 pC, ± 500 pC, ± 1 nC, ± 2.5 nC, ± 5 nC, ± 10 nC, ± 25 nC, ± 50 nC, ± 100 nC, ± 250 nC, ± 500 nC, ± 1 μC Ch.B: ± 0.25 pC, ± 0.5 pC, ± 1 pC, ± 2.5 pC, ± 5 pC, ± 10 pC, ± 25 pC, ± 50 pC, ± 100 pC, ± 250 pC, ± 500 pC, ± 1 nC CAMP-2G05B: ± 0.25 pC, ± 0.5 pC, ± 1 pC, ± 2.5 pC, ± 5 pC, ± 10 pC, ± 25 pC, ± 50 pC, ± 100 pC, ± 250 pC, ± 500 pC, ± 1 nC
Input Connectors & Interface	BNC, Single Ended
Input Coupling Type	AC (High-pass filtered at 0.03 Hz)
Input Isolation	No (Isolation can be achieved through a USB isolator)
(Voltage) Input Impedance	1 kΩ
Input High-Pass Filter	None, 1.8 Hz, 119 Hz, 236 Hz, 464 Hz
Charge Amplifier Overload Indication and Reset	Provided
Charge Amplifier Time Constants	CAMP-2G05: 1210 s (6 Higher Ranges), 12.1 s (6 Lower Ranges) CAMP-2G05A: Ch.A: 1210 s (6 Higher Ranges) 12.1 s (6 Lower Ranges) Ch.B: 1.21 s (6 Higher Ranges) 0.0121 s (6 Lower Ranges) CAMP-2G05B: 1.21 s (6 Higher Ranges), 0.0121 s (6 Lower Ranges)
Frequency Response	CAMP-2G05: 0.03 Hz ~ 22.8 kHz CAMP-2G05A: Ch.A: 0.03 Hz ~ 22.8 kHz Ch.B: 0.13 Hz ~ 22.8 kHz (6 Higher Ranges)

	13 Hz ~ 22.8 kHz (6 Lower Ranges) CAMP-2G05B: 0.13 Hz ~ 22.8 kHz (6 Higher Ranges) 13 Hz ~ 22.8 kHz (6 Lower Ranges)	
Frequency Accuracy	50 PPM	
Anti-aliasing Filter	22.8 kHz at Sampling Rate 48 kHz, proportionally adaptive to Sampling Rate Chosen	
Buffer Size	Virtually unlimited (streaming mode)	
Charge Accuracy	±0.5% at 1000Hz (FS>=250pC) ±2% at 1000Hz (FS<250pC)	
Output Connector & Interface	ϕ3.5 mm Stereo Audio Jack	
Output Voltage Range	±0.5V	
Digital Input / Output Standard	USB Audio Class 1	
Calibration	Individually done at factory, user re-calibratable	
PC Interface	USB 2.0 Full Speed / USB 1.1	
Device Category in Multi-Instrument	ADC Device	Sound Card MME
	DAC Device	Not Applicable
Power	Bus powered by USB port, no external power source required	
Power Consumption	Max. 0.5W	
Dimensions	128 mm (L) × 57 mm (W) × 24 mm (H), anodized aluminum case	
System Requirement	Windows XP, Vista, 7, 8, 8.1, 10, 11 or above, 32 bit or 64 bit	
Operating Temperature	0°C ~50°C	



Frequency Response of Built-in High-Pass Filter (sampled at 48 kHz)

2.2 Multi-Instrument Software Specifications

Please refer to Multi-Instrument software manual for detail. The following table shows the function allocation matrix for Multi-Instrument series. The Spectrum 3D Plot, Data Logger, LCR Meter, Device Test Plan, Vibrometer, Dedicated Hardware Support are add-on modules/functions and should be purchased separately, and they are only available for Multi-Instrument Lite, Standard, and Pro editions, except that the Vibrometer is only available for Multi-Instrument Standard and Pro editions.

Legend: √ - Function available *√* - Function available in Full version only*

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
General Functions							
ADC / DAC Hardware	Sound Card MME	√	√	√	√	√	√
	Sound Card ASIO						√
	Other Hardware				√	√	√
	vtDAQ, vtDAO software development kit	License automatically activated with the presence of the corresponding hardware, e.g. a USB hardkey or a VT DSO.					
File Operation	Load WAV File	√	√	√	√	√	√
	Load TXT File					√	√
	Load WAV File Frame by Frame (fore Long WAV File)					√	√
	Combine WAV Files	√	√	√	√	√	√
	Extract Data and save them into a new WAV File	√	√	√	√	√	√
	Save/Load Panel Setting	√	√	√	√	√	√
Data Export	Copy Text to Clipboard	√	√	√	√	√	√
	Copy BMP to Clipboard	√	√	√	√	√	√
	Print Preview	√	√	√	√	√	√
	Print	√	√	√	√	√	√
	Export as TXT File	√	√	√	√	√	√
	Export as BMP File	√	√	√	√	√	√
Trigger Settings	Trigger Mode	√	√		√	√	√
	Trigger Source	√	√		√	√	√
	Trigger Edge	√	√		√	√	√
	Trigger Level	√	√		√	√	√
	Trigger Delay	√	√		√	√	√
	High Frequency Rejection	√	√		√	√	√
	Noise Rejection	√	√		√	√	√
Sampling Settings	Sampling Rate	√	√	√	√	√	√
	Sampling Channels	√	√	√	√	√	√
	Sampling Bit Resolution	√	√	√	√	√	√
	Record Length	√	√		√	√	√
Calibration	Input	√	√		√	√	√
	Output			√	√	√	√
	Probe	√	√		√	√	√
	Sound Pressure Level	√	√		√	√	√
	F/V Conversion					√	√
	Latency for Sync. Output/Input						√
	Sensor Sensitivity	√	√		√	√	√
	Load Factor for Power Calculation	√	√		√	√	√
Graph Operation	Zoom	√	√	√	√	√	√
	Scroll	√	√	√	√	√	√
	Cursor Reader	√	√	√	√	√	√
	Marker	√	√	√	√	√	√
	Chart Type	√	√	√	√	√	√
	Line Width	√	√	√	√	√	√

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
	Color	√	√	√	√	√	√
	Fast/Slow Display Mode	√	√	√	√	√	√
	Refresh Delay	√	√	√	√	√	√
	Font Size	√	√	√	√	√	√
	Roll Mode					√	√
	Reference Curves & Limits					√	√
Others	Gain Adjustment	√	√	√	√	√	√
	Input Peak Indicator	√	√	√	√	√	√
	Sound Card Selection	√	√	√	√	√	√
	Sampling Parameter Auto Setting	√	√	√	√	√	√
	Multilingual GUIs	√	√	√	√	√	√
	Show/Hide Toolbar	√	√	√	√	√	√
	Lock/Unlock Panel Setting	√	√	√	√	√	√
	Hot Panel Setting Toolbar	√	√	√	√	√	√
	ActiveX Automation Server	√	√	√	√	√	√
	AutoRanging	√	√	√	√	√	√
	AutoScaling	√	√		√	√	√
	Input Channel Operation	√	√		√	√	√
Oscilloscope							
Type	Individual Waveform	√	√	√ (offline)	√	√	√
	Waveform Addition	√	√	√ (offline)	√	√	√
	Waveform Subtraction	√	√	√ (offline)	√	√	√
	Waveform Multiplication	√	√	√ (offline)	√	√	√
	Lissajous Pattern	√	√	√ (offline)	√	√	√
Inter-Frame Processing	Linear Average					√	√
	Exponential Average					√	√
Intra-Frame	Time Delay Removal					√	√
Demodulation (Intra-Frame)	AM					√	√
	FM					√	√
	PM					√	√
D i	Remove DC					√	√

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
	Rectification					√	√
	FFT Low Pass					√	√
	FFT High Pass					√	√
	FFT Band Pass					√	√
	FFT Band Stop					√	√
	FFT Frequency Response					√	√
	FIR Low Pass					√	√
	FIR High Pass					√	√
	FIR Band Pass					√	√
	FIR Band Stop					√	√
	FIR Frequency Response					√	√
	IIR Coefficients					√	√
Parameter Measureme	Reverberation / Speech Intelligibility						√
	Discontinuity						√
	Step Response						√
Others	Max, Min, Mean, RMS	√	√	√ (offline)	√	√	√
	Record Mode					√	√
	Persistence Display Mode	√	√		√	√	√
	Equivalent Time Sampling Mode	√	√		√	√	√
	Analog & Digital Signal Mixed Display				√	√	√
	SINC Interpolation	√	√	√	√	√	√
Spectrum Analyzer							
Type	Amplitude Spectrum / Power Spectrum Density / Impedance Spectrum		√		√	√	√
	Phase Spectrum		√		√	√	√
	Auto-correlation (Linear/Circular)		√		√	√	√
	Cross-correlation (Linear/Circular)		√		√	√	√
	Coherence/Non-Coherence						√
	Transfer Function / Impedance Analyzer						√
	Impulse Response						√
Intra-Frame Processing	Frequency Compensation		√		√	√	√
	Frequency Weighting		√		√	√	√
	Remove DC		√		√	√	√
	Smoothing via Moving Average (Linear/Octave)		√		√	√	√
In te	Peak Hold		√		√	√	√

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
	Linear Average		√		√	√	√
	Exponential Average		√		√	√	√
Parameter Measurement	THD,THD+N,SNR, SINAD,Noise Level, ENOB		√		√	√	√
	IMD/DIM		√		√	√	√
	Bandwidth		√		√	√	√
	Crosstalk		√		√	√	√
	Harmonics & Phase		√		√	√	√
	Energy in User Defined Frequency Band		√		√	√	√
	Peak Detection, SFDR, TD+N		√		√	√	√
	Wow & Flutter						√*
	Sound Loudness						√
	Sound Loudness Level						√
	Sound Sharpness						√
	Total Non-Coherent Distortion + Noise						√
	GedLee Metric						√
FFT	FFT Size 128~32768		√		√	√	√
	FFT Size 65536~4194304						√
	Intra-Frame Average		√		√	√	√
	Window function		√		√	√	√
	Window Overlap		√		√	√	√
Others	Octave Analysis (1/1, 1/3, 1/6, 1/12, 1/24, 1/48, 1/96)		√		√	√	√
	Linear / Log Scale for X and Y		√		√	√	√
	Peak Marker / Label		√		√	√	√
Signal Generator							
Waveform	Sine			√	√	√	√
	Rectangle			√	√	√	√
	Triangle			√	√	√	√
	Saw Tooth			√	√	√	√
	White Noise			√	√	√	√
	Pink Noise			√	√	√	√
	MultiTones			√	√	√	√
	Arbitrary Waveform			√	√	√	√
	MLS			√	√	√	√
	DTMF			√	√	√	√
	Musical Scale			√	√	√	√
	Wave File					√	√
	Play Waveform in Oscilloscope	√	√	√	√	√	√
	Cyclic Play Waveform in Oscilloscope	√	√	√	√	√	√
S w	Frequency Sweep (Linear/Log)			√	√	√	√

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
	Amplitude Sweep (Linear/Log)			√	√	√	√
	Forward + Reverse Sweep			√	√	√	√
Burst (Mask)	Normal Phase			√	√	√	√
	Locked Phase			√	√	√	√
	Window-Shaped Burst			√	√	√	√
	On/Off Amplitude Ratio			√	√	√	√
Fade	Fade In			√	√	√	√
	Fade Out			√	√	√	√
Modulation	AM			√	√	√	√
	FM			√	√	√	√
	PM			√	√	√	√
Others	Software Loopback (all channels)			√	√	√	√
	Software Loopback (1 channel)				√	√	√
	Sync. with Oscilloscope						√
	Save as WAV file			√	√	√	√
	Save as TXT file			√	√	√	√
	DDS				√	√	√
	DC Offset				√	√	√
Multimeter							
Type	RMS					√	√
	dBV					√	√
	dBu					√	√
	dB					√	√
	dB(A)					√	√
	dB(B)					√	√
	dB(C)					√	√
	Frequency Counter				√	√	√
	RPM					√	√
	Counter					√	√
	Duty Cycle					√	√
	Frequency/Voltage					√	√
	Cycle RMS					√	√
	Cycle Mean					√	√
	Pulse Width					√	√
Settings	Counter Trigger Hysteresis				√	√	√
	Counter Trigger Level				√	√	√
	Frequency Divider				√	√	√
DDP (Derived Data Point) Viewer							
Function	DDP & UDDP display						√
	HH, H, L, LL Alarm						√
	Set Display Precision						√

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument Standard	Multi-Instrument Pro
	Define UDDP						√
	Alarm Sound						√
	Alarm Acknowledge						√
	Inter-frame Linear / Exponential Average						√
DDP Array Viewer	Harmonic Frequencies, RMS, Phases Report						√
	Octave Bands, RMS Report						√
	Peak Frequencies, RMS, Phases Report						√
	Frequency Bands, RMS Report						√
	Reverberation / Speech Intelligibility Report (1/1 Octave)						√
	Reverberation / Speech Intelligibility (1/3 Octave)						√
Derived Data Curve (DDC)							
Function	Energy Time Curve (Log-Squared)						√
	Energy Time Curve (Envelop)						√
	Energy Time Curve (dBSPL)						√
	Impulse Response Schroeder Integration Curve						√
	Step Response Curve (via Impulse Response Integration)						√
	Frequency Time Curve						√
	X-Y Plot						√

Legend: Blank - Function available if purchased Shaded Blank - Function NOT available for that license level

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument	Multi-Instrument Pro
Spectrum 3D Plot							
Type	Waterfall Plot (Inter-frame, STFT)						
	Waterfall Plot (Intra-frame, STFT)						
	Waterfall Plot (Intra-frame, CSD)						
	Spectrogram (Inter-frame, STFT)						

		Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument	Multi-Instrument Pro
	Spectrogram (Intra-frame, STFT)						
	Spectrogram (Intra-frame, CSD)						
Settings	Spectrogram Color Palette						
	Waterfall Color Palette						
	Waterfall Tilt Angle						
	Waterfall / Spectrogram Height						
	Linear / Log Scale for X and Y						
	Number of Spectral Profiles (10~200)						
Others	3D Cursor Reader						
	Octave Analysis (1/1, 1/3, 1/6, 1/12, 1/24, 1/48, 1/96)						
	Spectrogram Smoothing						
Data Logger							
Real Time Logging							
Load Historical Log File							
Three logging methods (Fastest, Time Interval, Update Threshold)							
246 derived data points available for logging							
Up to 8 × 8 = 64 variables can be logged simultaneously							
LCR Meter							
High Impedance Measurement							
Low Impedance Measurement							
Up to 8 X-Y Plots (Linear/Log)							
Device Test Plan							
25 Instructions							
Create/Edit/Lock/Execute/Load/Save a Device Test Plan							
Up to 8 X-Y Plots (Linear/Log)							
Device Test Plan Log							
Automatic Mutli-Step Generation							
User Log In / Out							
Volatile & Non-volatile Variables							
Vibrometer							
RMS, Peak/PP, Crest Factor for acceleration, velocity, displacement (in Multimeter)							
Waveform conversion among acceleration, velocity and displacement (in Oscilloscope)							

	Sound Card Oscilloscope	Sound Card Spectrum Analyzer	Sound Card Signal Generator	Multi-Instrument Lite	Multi-Instrument	Multi-Instrument Pro
SI / English units						
Dedicated Hardware Support						
RTX6001 Remote /Local Control						

2.3 Software Development Interface Specifications

Multi-Instrument provides the following secondary development features:

1. Multi-Instrument can work as an ActiveX automation server so that an external program can access the data and functions that Multi-Instrument exposes. You can integrate Multi-Instrument into your own software seamlessly via the ActiveX automation server interfaces exposed by Multi-Instrument.

   Please refer to: *Multi-Instrument Automation Server Interfaces*

   Download link:
   http://www.virtins.com/Multi-Instrument-Automation-Server-Interfaces.pdf

   The above document and the sample automation client programs in Visual C++, Visual Basic, Visual C# and Python can be found in the AutomationAPIs directory of the software.

2. You can use the vtDAQ and vtDAO interface DLLs supplied in this software to allow your own back-end software to interface to sound cards, NI DAQmx cards, VT DSOs, VT RTAs, VT IEPE, VT CAMP, etc.. You can also develop your own vtDAQ and vtDAO compatible DLLs to allow Multi-Instrument to interface to your own hardware.

   Please refer to: *vtDAQ and vtDAO_Interfaces*

   Download link:
   http://www.virtins.com/vtDAQ-and-vtDAO-Interfaces.pdf

   The above document and the sample DAQ and DAO back-end programs and sample vtDAQ compatible DLL in Visual C++, Visual C# and Labview can be found in the DAQDAOAPIs directory of the software.

3. Virtins Technology's Signal Processing and Analysis (vtSPA) Application Programming Interfaces (APIs) provides a suite of generic APIs for data processing and analysis. It contains some unique features / algorithms originated and only available from Virtins Technology.

   Please refer to: *Signal Processing and Analysis (vtSPA) Interfaces*

Download link:
http://www.virtins.com/Signal-Processing-and-Analysis-APIs.pdf

The above document and the sample programs in Visual C++ and Visual C# can be found in the DAQDAOAPIs directory of the software.

Furthermore, Multi-Instrument is well prepared to be rebranded for OEM services. Its look and feel can be readily changed through configuration without even reprogramming. Contact Virtins Technology if interested.

3 Multi-Instrument Software License Information

3.1 License Types

The License of Multi-Instrument software has six levels and six add-on modules/functions. The six levels are: Sound Card Oscilloscope, Sound Card Spectrum Analyzer, Sound Card Signal Generator, Multi-Instrument Lite, Multi-Instrument Standard, Multi-Instrument Pro. The six add-on modules/functions are: Spectrum 3D Plot, Data Logger, LCR Meter, Device Test Plan, Vibrometer, Dedicated Hardware Support.

The license contained in the standard VT CAMP package is a hardware activated Multi-Instrument Standard license, without any add-on modules/functions. No softkey (activation code) and USB hardkey (USB dongle) are provided in this type of license. The software will run under the licensed mode as long as the VT CAMP unit is connected to your computer before you start the Multi-Instrument software.

Note: If the software is started without the VT CAMP unit connected to the computer, it will enter into 21-day fully functional trial mode, unless the software is activated by a softkey (activation code) or a hardkey (USB dongle), which are NOT included in the standard VT CAMP package and should be purchased separately as a brand-new license if needed. In other words, the VT CAMP hardware should always be connected to the computer in order for the Multi-Instrument software to work under the licensed mode, even though you might just want to use your computer sound card for ADC and DAC.

3.2 License Upgrade from one level to another

You can purchase an upgrade of the license, e.g. from Multi-instrument Standard to Multi-Instrument Pro + Data Logger, at any time if necessary. After you purchase the upgrade, a small upgrade package file will be sent to you via email. You can then use it to upgrade the license bundled within the VT CAMP unit by selecting [Start]>[All Programs]>[Multi-Instrument]>[VIRTINS Hardware Upgrading Tool] on your Windows desktop.

3.3 Software Upgrade in the same level

Software upgrade in the same level (if the hardware is still supported by the new version), e.g. from Multi-Instrument 3.0 Standard to Multi-Instrument 3.1 Standard, is always FREE. You just need to download the new version from our website and install it on any computer.

Thus, please do visit frequently our website to see if a new version or build is available.

4 Extended Use of Multi-Instrument Software

Multi-Instrument is a powerful multi-function virtual instrument software. It supports a variety of hardware ranging from sound cards which are available in almost all computers to proprietary ADC and DAC hardware such as NI DAQmx cards, VT DSO units, and so on. Furthermore, the ADC and DAC device can be chosen independently in Multi-Instrument. For example, you can use VT CAMP for data acquisition and use your computer's sound card for signal generation simultaneously.

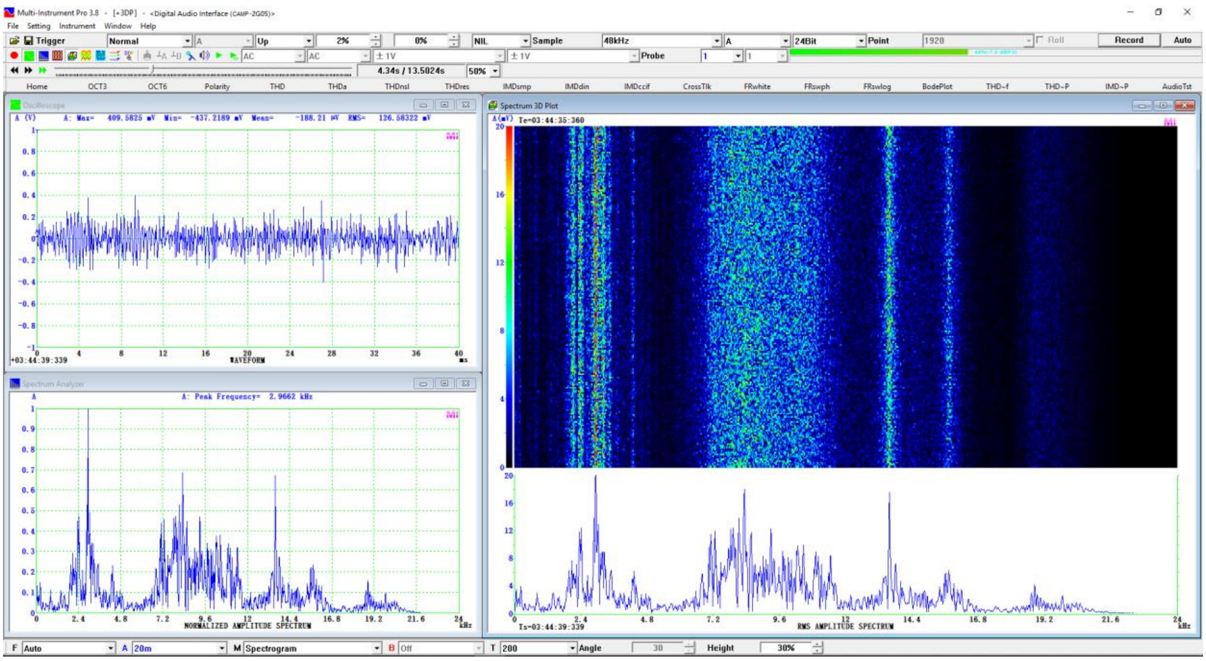
You can change the ADC device via [Setting]>[ADC Device]>[Device Model]. For example you can also use your computer's sound card as the ADC device.

You can choose a DAC device via [Setting]>[DAC Device]>[Device Model]. For example, you can use your computer's sound card as the DAC device and thus make full use of the signal generator function of Multi-Instrument.

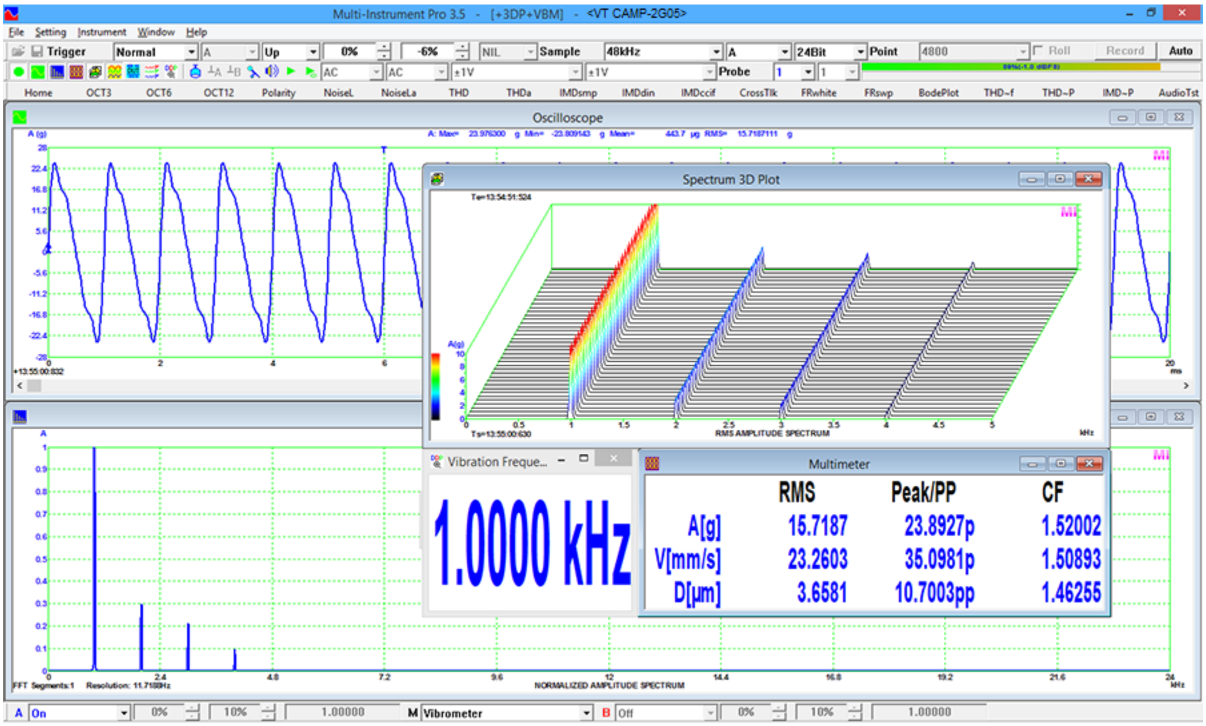
If you want to use the sound card as the ADC/DAC device, you may need to purchase the dedicated sound card oscilloscope probe kit from Virtins Technology separately, or you may make the connection by yourself.

5 Measurement Examples

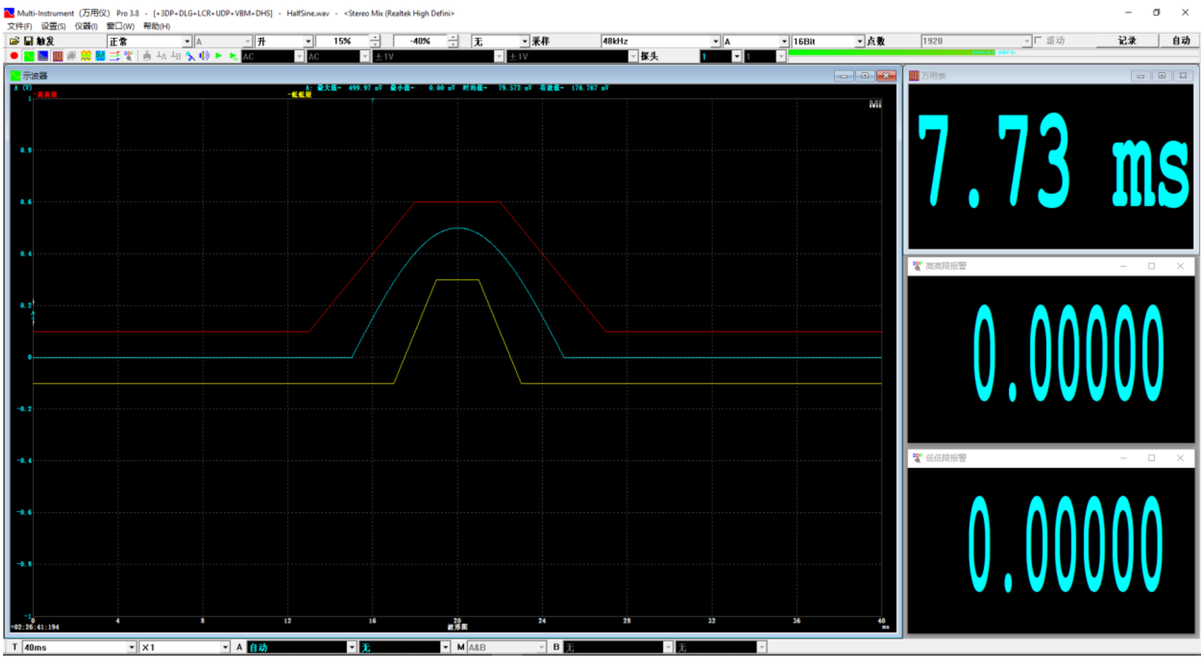
5.1 VT CAMP-2G05 with Multi-Instrument Pro + Spectrum 3D Plot



5.2 VT CAMP-2G05 with Multi-Instrument Pro + Spectrum 3D Plot + Vibrometer



5.3 Half-sine Shock Test



6 Safety Instructions

- Always keep in mind that the input of VT CAMP is NOT galvanically isolated from the computer connected.
- It should be noted that for many computers (typically desktop PCs or laptop PCs with a built-in AC power supply adapter), the ground of the BNC is connected to mains earth. This is not a problem if the sensors connected are floating (i.e. isolated from earth). Otherwise, you MUST make sure that the ground of the BNC is connected to a point that is also at earth potential.

7 Warranty

Virtins Technology guarantees this product against defective materials and manufacturing defects for a period of 12 months. During this period of warranty, a replacement of the faulty part will be shipped to the buyer's address free of charge upon receiving and verifying the returned faulty part. The Warranty is only applicable to the original buyer and shall not be transferable. The warranty shall exclude malfunctions or damages resulting from acts of God, fire, civil unrest and/or accidents, and defects from using wrong electrical supply/voltage and/or consequential damage by negligence and/or abuse, as well as use other than in accordance with the instructions for operation. The Warranty shall immediately cease and become void if the hardware is found to have been tampered, modified, repaired by any unauthorized person(s). Decisions by Virtins Technology on all questions relating to complaints as to defects either of workmanship or materials shall be deemed conclusive and the buyer shall agree to abide by such decisions.

8 Disclaimer

This document has been carefully prepared and checked. No responsibility can be assumed for inaccuracies. Virtins Technology reserves the right to make changes without prior notice to any products herein to improve functionality, reliability or other design aspects. Virtins Technology does not assume any liability for loses arising out of the use of any product described herein; neither does its use convey any license under its patent rights or the rights of others. Virtins Technology does not guarantee the compatibility or fitness for purpose of any product listed herein. Virtins Technology's products herein are not authorized for use as components in life support services or systems. Virtins Technology should be informed of any such intended use to determine suitability of the products.