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OG4600A1  
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## OPERATING GUIDE

### 4600A1 IEPE VIBRATION RECORDER





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The Dytran 4600A1 VibraCorder is a miniature multi-channel datalogger designed for use with IEPE sensors. The 4600A1 is designed to provide conditioned IEPE power to external sensors and record data from these sensors for up to 15 hours. The included software allows the user to configure the dataloggers acquisition settings and to view recorded data from the internal SD card. The 4600A1 utilizes a unique optical synchronization method that allows multiple units to record simultaneously when stacked on top of each other.

## I. Device Features

-System components:

4600A1 vibration recorder

MicroSD card (Micro SDHC “SanDisk Extreme” with 32Gbytes data space is recommended)

Software Toolkit (stored on supplied Micro SDHC)

-4600A1 is powered by a 3.7V rechargeable Li-Po battery.

-Micro USB charging, time setting, and Device information access.

## II. Software Features

- Immediate data retrieval from the SD card to the PC
- Easy cursor operation for data selection, zoom, and cursor alignment
- One press of a button snapshot
- Data overlay
- Filtering
- Oversampling
- Time Synchronous Averaging
- FFT analysis
- Data export

## III. Acronyms used in this manual

GUI - Graphical User Interface

FFT - Fast Fourier Transform

JPG - Joint Photographic File format

ASCII - American Standard Code for Information Interchange

TDMS - Technical Data Management Solution (Binary and ASCII file saving option for smaller file sizes with stored header information)

UFF58 - Universal File Format 58 (purely binary file format for data recording)

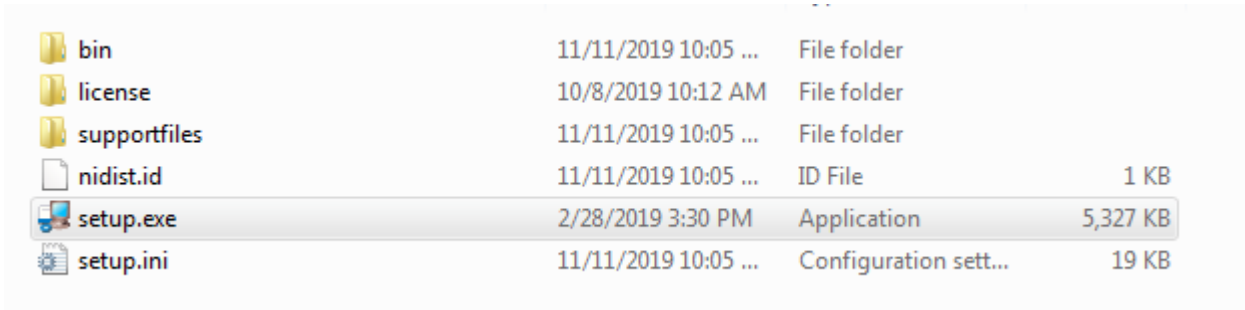
MAT - MATLAB® Compatible data file

#### IV. Minimum System Requirements

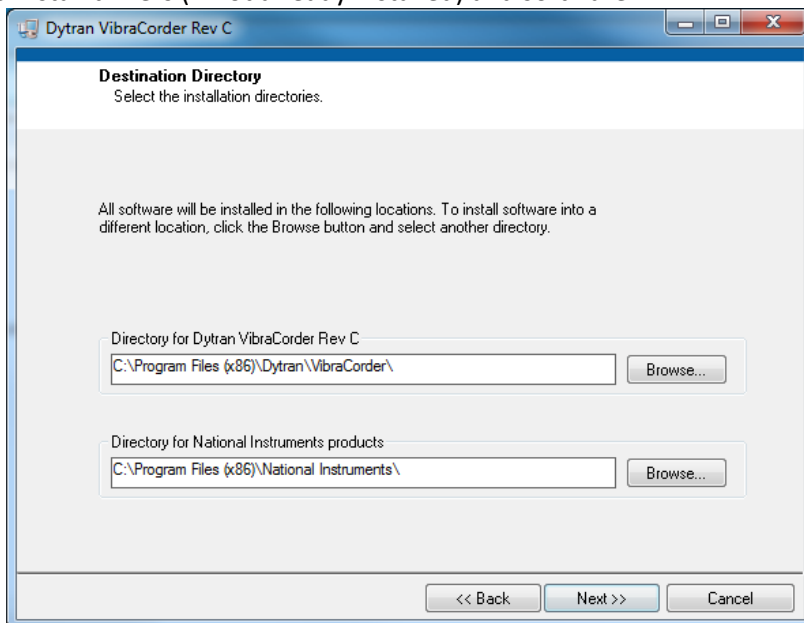
- Desktop or a Laptop x86 based personal computer
- Operating System: Windows 7/8/10 32-bit
- CPU: Intel i3 or better
- RAM: 1 GB
- Hard Disk space: 1 GB
- USB 2.0
- Display Resolution 1280×780.

#### V. Installation

1. Run setup.exe



2. Click next to install drivers (if not already installed) and software.



**Figure 1: Install Destination Directory**

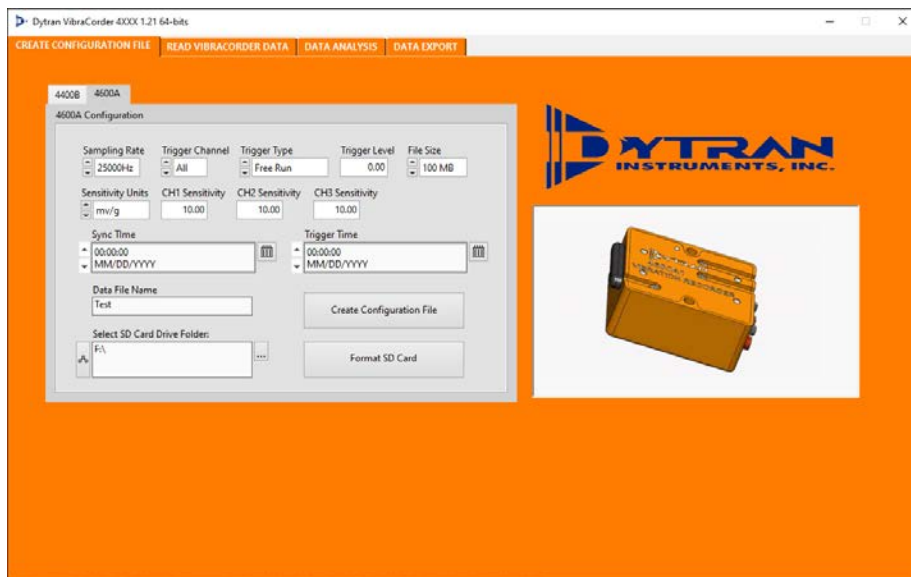
3. If asked, reboot your PC by clicking on "Restart".

## VI. Operation

1. After the computer is restarted, the user will find the “9007 *VibraCorder*” icon in the Windows menu, as shown in Figure below. A Shortcut will also be created on the Desktop for ease of access.



**Figure 2: VibraCorder Icon.**



**Figure 3: 9007 Software**

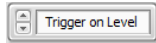
2. Insert the microSD card into the slot and launch the software.
3. Create configuration file – this tab allows the creation of the configuration file for the data acquisition, select the 4600A tab to enter the 4600A software. When the software background is orange, the user is in the 4600A section of the software. When the software background is blue, the user is in the 4400B section of the software.

3.1 It is recommended to format your microSD card before every use. Use the microSD card drive navigation window to select the card and press “Format SD card” button.

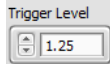
3.2 Select data acquisition parameters:



allows for continuous recording which is started and stopped by the user pressing the “Record” button.



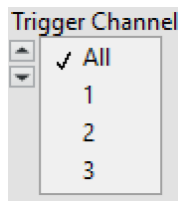
acquisition records events defined by acceleration level. Prior to triggering the device records 256 samples per axis of pre-triggered samples and 10,240 samples per axis of post triggered samples. Each event is saved in separate files with the time stamp of the triggered event.



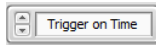
is used to setup the trigger level



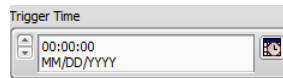
trigger channel allows the selection of the channel to apply the triggering level to (or if “Any” is selected the device will trigger if any of the channels cross the threshold)



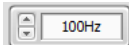
**Figure 4: Trigger channel selection**



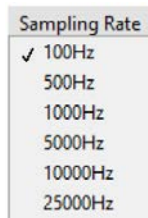
selection allows the recording to start on a user selected time (any time up to 24 hours into the future). User shall use the menu shown below to setup time (hours, minutes, and seconds) for the recording to start



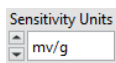
**Figure 5: Trigger time selection**



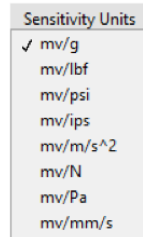
Six different sampling rates are available. See section on anti-aliasing filters to determine the usable bandwidth of the measurements



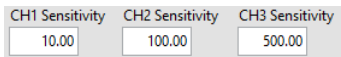
**Figure 6: Sampling rate selection**



Eight different sensitivity units are available for use with IEPE accelerometers, velocity sensors, force sensor and pressure sensors in Metric and Imperial units.

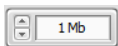


**Figure 7: Sensitivity unit selection**

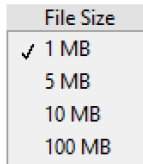


select the sensitivity value for the three channels corresponding to the sensitivity units selected above. Allowable values are within the range of 0.2 to 5000.

3.3 Select measurement file attributes:



selects the size of the measurement file.



**Figure 8: File size selection**

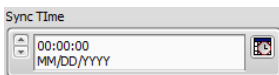
The device will break the measurement into the files of approximate size selected by the user. Once the collected data crosses over the threshold, the new file with the consecutive number is created.



allows the user to name (4 characters allowed) the file. The full file name contains 8 characters. The first 4 are user selected (if nothing is selected, the generic word "TEST" is used). The last 4 characters are the file counter "#000" followed by extension .TXT.

In this manner, the generic file name (if user selects nothing in the "File name" field) is "TEST#001.TXT" thru "TEST#999.TXT". If the name field is filled up as shown above, the file naming shall be "abcd#001.TXT" thru "abcd#999.TXT". The number of files allowed per single recording is 999. The recording will stop, and the unit will shut itself down once this number is reached.

3.4 Setup synchronization time:



optional field that allows to set the time on the device's RTC from the microSD card. Select time and date desired to be set on the device (typical selection is couple of minutes into the future that would allow to create config file, place the card into the device and start the device in configuration mode)



- 3.5 After the desired acquisition parameters are selected, press “Create configuration File button”
- 3.6 Safely eject the microSD from the slot
4. Insert the microSD card into the 4600A1 microSD card slot and, for normal operation, press the “Power” button.
  - 4.1 The firmware of the VibraCorder will verify the microSD card operation. The orange light of “HARDWARE CHECK/READY” LED will blink several times checking various parameters of the card, config file, and config file content. The orange light will stay blinking in accordance with the troubleshooting table in the Appendix A if any errors are detected. Otherwise, the green light on the “Recording” indicator shall lit. The green light will stay lit until the user presses “Record” button if “Free run” or “Trigger on Time” modes are selected or will switch to blue immediately as the unit starts sampling waiting for event. **Although, multiple types of cards might be acceptable for use with the VibraCorder, Dytran Instruments, Inc. recommends using MicroSDHC SanDisk Extreme type.**
5. Press “Record” button to start recording if using “Free run” mode.
  - 5.1 The “RECORDING STATUS” LED will turn orange.
  - 5.2 Press “RECORD” button to stop recording. The file with the acceleration data shall be closed, the device will select next available file name and the device will return to the state described in 4.1 above.
  - 5.3 To start a new recording the user must press “Record” button again and the new file will be started. If the test is complete, the MicroSDHC card can be removed from the device. It is recommended to shut the power to the device before removing the card.
6. Insert the microSD card into PC and click on “READ VIBRACORDER DATA” tab.
  - 6.1 Press “READ SD CARD DATA” button and navigate to the data file using explorer window. Double click on the file.
  - 6.2 Each axis has a set of data manipulation buttons: “CURSOR HOME”, “TIME ZOOM”, “TO ANALYSIS”, and “AUTOSCALE”. These buttons can be utilized for data examination and event selection.
  - 6.3 Additional data files can be overlaid using “OVERLAY DATA” button. Once pressed, it will prompt the user to select additional data files. If one data file is greater than another, the missing data will be padded with 0s. “REMOVE DATA” button will remove the latest added data.
  - 6.4 If one particular event is selected using cursors on any axis, the other two axis data for the same time interval can be selected by the user using “ALIGN CURSOR TO X POSITION”, “ALIGN CURSOR TO Y POSITION”, or “ALIGN CURSOR TO Z POSITION”.
  - 6.5 Data snapshot can be taken in JPEG format for any axis using “SNAPSHOT” buttons.



6.6 The data table below shows the immediate cursor information for each axis: delta T, Frequency (Calculated based on cursor positions when they are located on one period), RPM (Calculated based on cursor positions when they are located on one period), and RMS value of the signal between cursors. See *Figure 10* for example:



**Figure 9: Channel three data of 1882 RPM (31.4 Hz) Engine Vibration at 1.326 g RMS.**

6.7 “CLEAR PLOTS” button will clear all the data from the plots.

7. By pressing “TO ANALYSIS” button from any axis, the currently selected data between the cursors will be exported to the “DATA ANALYSIS” tab with corresponding data from other two axes.

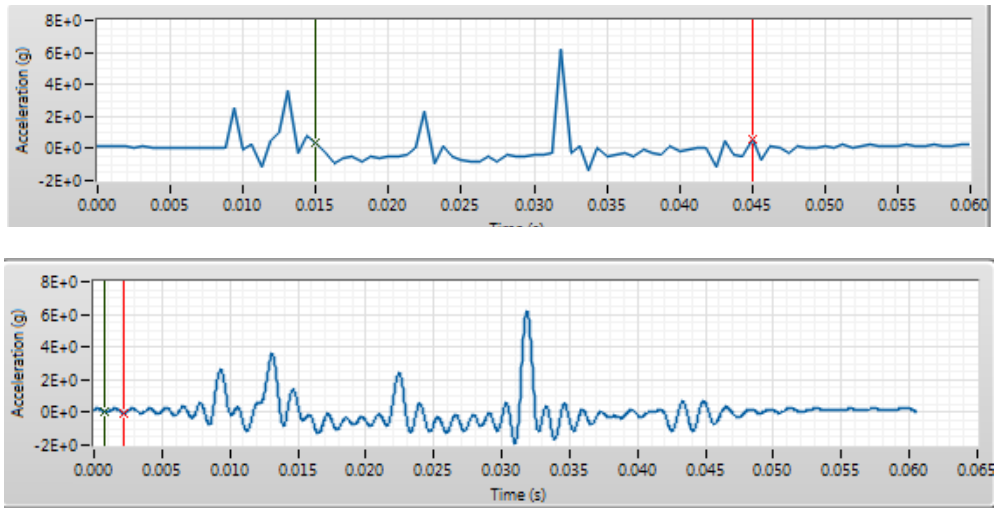
7.1 The software will prompt the user to either append a data set or create a new one. This feature allows data split between two files to be combined. When Append is selected, the new trace will be added at the end of the old trace. When New is selected, all the previously displayed data shall be erased and substituted with the newly imported data set.

7.2 “RELOAD SELECTED DATA” button shall reload the original set of data into the analysis window.

7.3 “LOW PASS FILTER” and “HIGH PASS FILTER” buttons shall apply specified filter to the data, user shall be prompted for corner frequency and filter order. Butterworth topology is used.

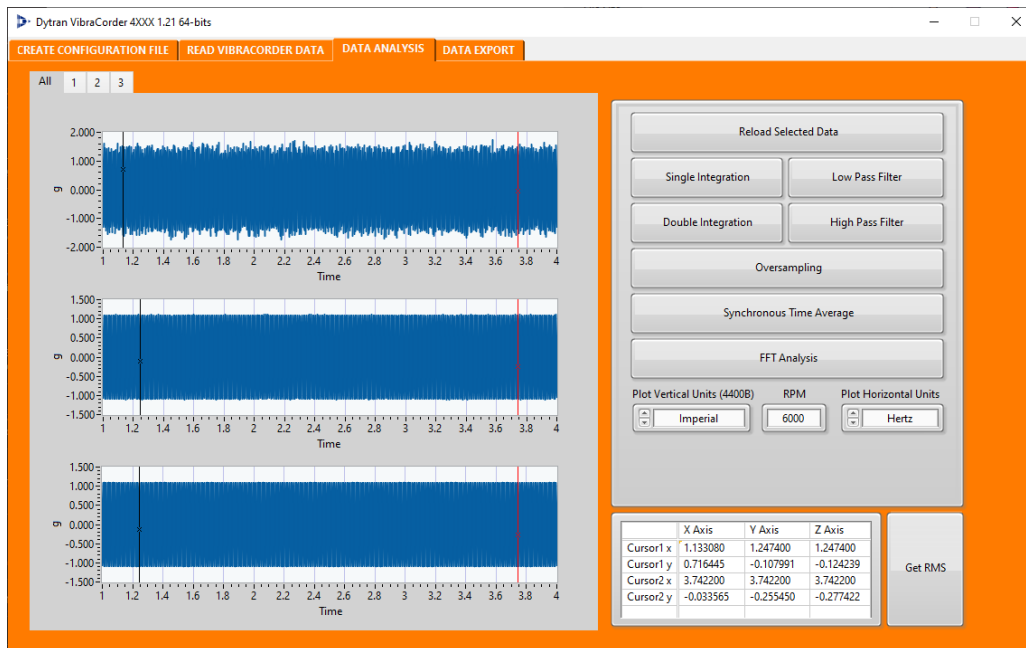
7.4 “SINGLE INTEGRATION” and “DOUBLE INTEGRATION” buttons will apply either single or double numerical integration. The software shall automatically apply a high pass filter before performing integration (to avoid any data run off). User shall be prompted for corner frequency of the filter.

7.5 “OVERSAMPLING” button shall perform non-linear interpolation on the data set, calculating additional data point in between the existing one. The user will be prompted for the oversampling frequency:

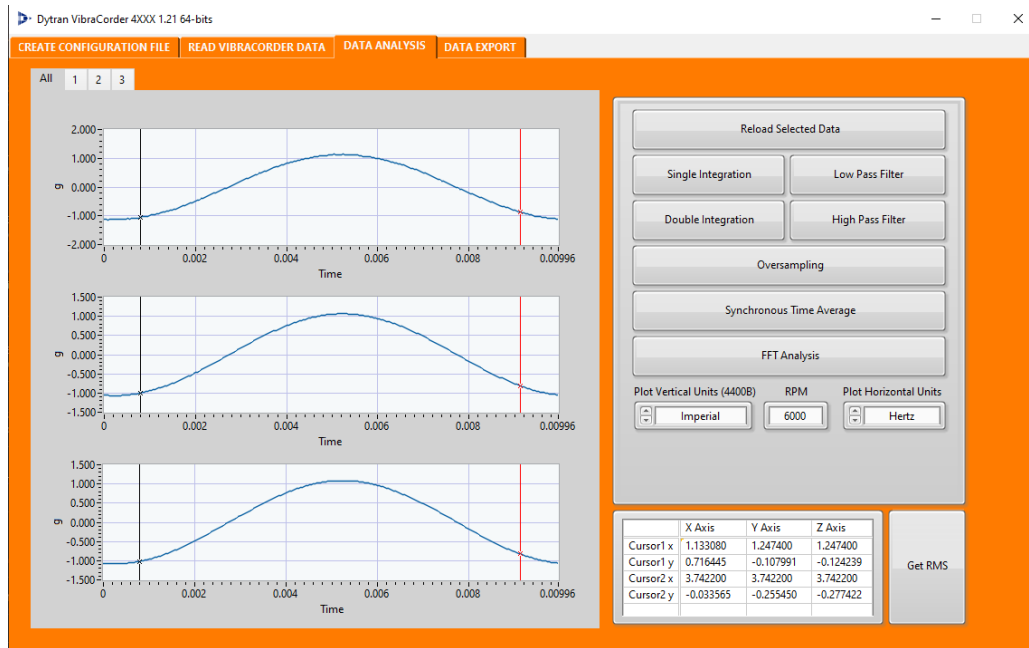


**Figure 10: Same data set before and after oversampling with 32,000Hz frequency**

7.6 “TIME SYNCHRONOUS AVERAGE” button shall perform time domain averaging on the set of data using a user entered RPM value. The data set will be chopped using frequency from RPM window and averaged with each other. The user shall be prompted for number of periods to display:



	X Axis	Y Axis	Z Axis
Cursor1 x	1.133080	1.247400	1.247400
Cursor1 y	0.716445	-0.107991	-0.124239
Cursor2 x	3.742200	3.742200	3.742200
Cursor2 y	-0.033565	-0.295450	-0.277422



**Figure 11: TSA analysis results for one period**

- 7.7 “FFT ANALYSIS” button will perform Fast Fourier transform.
  - 7.8 “PLOT VERTICAL UNIT” for use with 4400B only. Output units defined by user configuration.
  - 7.9 “RPM” control requires user input for TSA calculations and cursor location.
  - 7.10 “PLOT HORIZONTAL UNITS” allows the change between Hertz, Orders, and RPM for FFT plots.
  - 7.11 “GET RMS” button shall show the RMS signal value for each channel.
- 8. “DATA EXPORT” tab allows the export of the data to conventional file formats: *.csv*, *.mat*, *.tdms*, *.uff*, and *.sqlite*
    - 8.1 User shall define the location of the file on the PC using the explorer.
    - 8.2 If “EXPORT ALL RAW DATA” is checked, the software will export all the raw data from the measurements file. If the “EXPORT ALL RAW DATA” is not checked, the software will export only the content of the analysis screen.

## VII. Mechanical configuration and mounting

1. Refer to 127-4600A1 drawing for physical dimensions of the device.
2. The mounting provisions consist of 2 mounting holes, 0.20” in diameter. Two 10-32 socket head screws are supplied with the device. In order to mount the device, reference mounting considerations located on the 127-4600A1 outline/installation drawing.
3. Alternative method of mounting is four magnets embedded into the mounting surface of the VibraCorder.



## VIII. Data recording considerations

The VibraCorder is designed to be powered with a rechargeable Li-Po battery. The minimum continuous recording time is defined as 15 hours. The recording will be automatically broken down to multiple files of the user selected size. No data shall be lost between files (internal buffer shall store information during new file creation process). That means if the recorder is left in free run or time triggered mode, it will record the data TEST#001.txt (in this example, the first four characters of the file name are generic – if user selects nothing in the file name field during the config.txt creation), then it will close TEST#001.txt, open new file TEST#002.txt and continue the recording. It will execute that operation every time the specified file size is reached until it reaches TEST#999.txt or the battery runs out. In case the battery runs out earlier than TEST#999.txt file name is reached, the VibraCorder will close the current acquisition file and shut itself down.

The tables below show LED troubleshooting codes for any possible issues during the start-up:

Table 1: Possible startup issues:

orange light blinks:	0.1 sec	Insert the card
	0.2 sec	Config file contains improper settings
	0.5 sec	Config file not found
	0.7 sec	Config file corrupted
	1 sec	Incompatible card

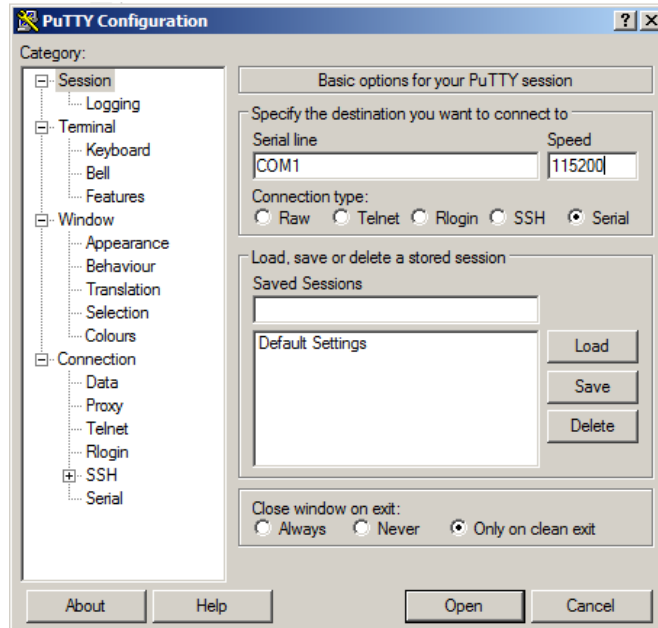
Table 2: File name issues

Blue left blinks	0.2 sec	File name overflow
	0.5 sec	Improper run type

## IX. Serial Interface

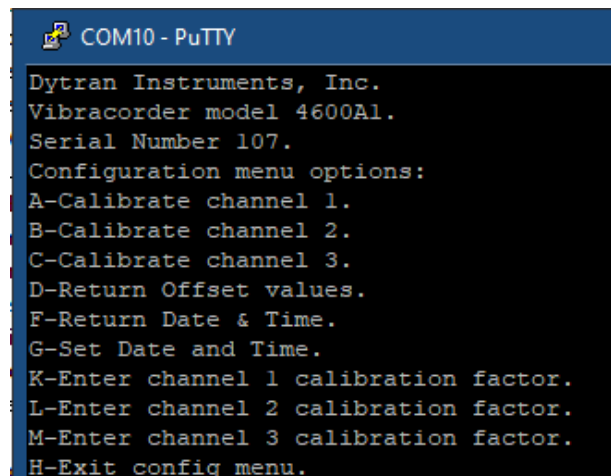
The device has a built-in serial interface for calibration and settings. Any terminal application can be used to access the communication protocol. In order to access the settings mode, the following steps must be taken:

1. Connect the device to a PC with terminal application installed. The device must be powered off
2. After the USB interface enumerates the device, check the device manager to identify the virtual COM port number assigned to the device by the PC
3. Setup serial communication parameters as shown below



**Figure 12: Serial baud rate settings**

4. Press “Open” to open the terminal.
5. Press and hold “Record” button on the device while it’s powered off and press the “Power” button
6. Once the user releases the “Record” button, the terminal shall show the following menu:



**Figure 13: Serial baud rate settings**

By following the menu options and instructions the user can display current time and date stored on the device, setup new time and date, display current offsets and calibration factors, and calibrate the unit using 1 g gravitational field.



## X. Time and Date Setup, MicroSD card method

As it was mentioned in 3.4 above, there is a second method of setting up time and date on the device. Using the config.txt file, the user can record the desired time and date setting on the MicroSD card (usually one would record current date and time which is in near future – couple of minutes ahead), and by following these steps transfer those settings into the device RTC:

- 1) Record time and date in the “Synchronous time” field of the SD card
- 2) Create config.txt file
- 3) Insert the card into the device while it’s powered off
- 4) Press and hold “Record” button
- 5) Press the “Power” button
- 6) Release the “Record” button. The “Recording” indicator should light solid blue
- 7) Press “Record” button again

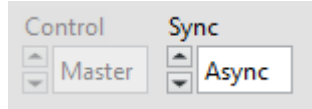
As the user performs step 7 from above, the “Synchronous” time from the card is recorded to the RTC.

Using this method, it is possible to synchronize two or more units. In order to do that, the same time must be recorded into “Synchronous time” on two or more MicroSD card, the cards must be inserted into the devices intended to be synchronized and the steps outlined above must be performed on each device up until step 7. When all the devices intended for synchronization have the solid blue light on (after step 6), the user must connect all the devices intended for synchronization with synchronization cable and press the “Record” button on one of the devices. The synchronization cable shall reproduce the button push on all the devices daisy chained together and the RTC timing shall be synchronized.

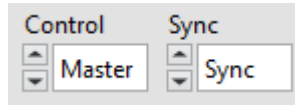
## XI. Recording Synchronization Start versus Recording Synchronization Clock

The synchronization connector described above can also be used to synchronously start the recording on multiple units or to synchronize its sampling clocks. When the recordings are started synonymously on two or more units, each of them still uses its own internal clock to sample. This mode is referred to as “synchronous acquisition start”. When the “synch” option is selected during the config file creation and units are designated as master and slaves, the slave units use the clock input via synchronization cable or the optical input to obtain the sampling clock. This mode is referred to as “synchronous sampling”.

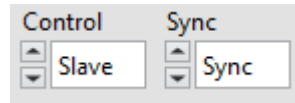
To start the recording at the same time (“synchronous acquisition start” mode, each unit would still use its own clock for sampling) this feature, the user must connect the units using the synchronization cable, power them up (make sure the recording mode is free run on all the units), and press “Record” button on one of the units connected. The config files on both units must be:



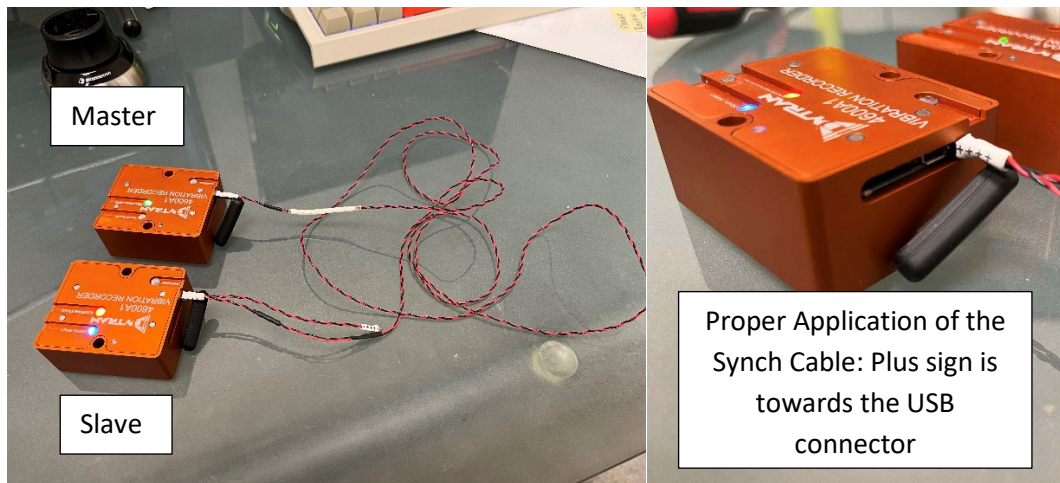
This technique will assure the recording start at the same time, but due to the slight difference in internal oscillator characteristics, the number of samples will drift apart with time. To assure the simultaneous sampling, the synchronization technique must be used. To do that, one of the units must be designated as master and its configuration file shall be as following:



The rest of the units must be designated as slaves and their config files shall be set as following:



An important thing to remember is that this only works in “Free run” mode. If everything is configured as explained above, after the units are turned on, the master will show a green light once it’s ready to record while the slave unit(s) will show orange on the right with blue on the left to designate its slave configuration:

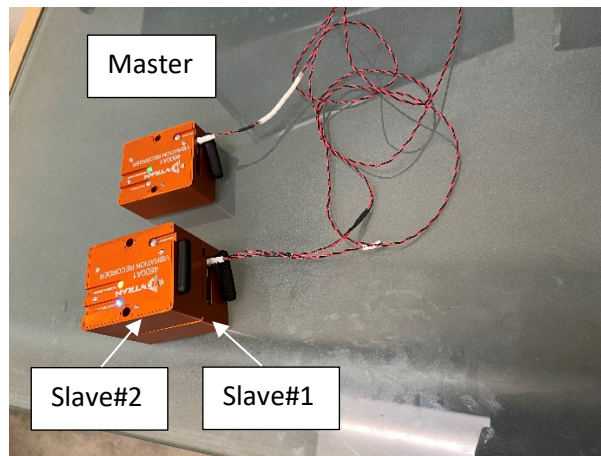




By pressing the record button on the master unit the acquisition will start on both master and slave. To stop, press the record button again on the master units and the slave unit will stop by itself within 100 ms.

The 4600A1 also includes an optical synchronization method. This allows synchronization between multiple 4600A1's while maintaining the recorders ingress protection. Each 4600A1 has an optical emitter on the top and an optical receiver on the bottom. When stacking the 4600A1's the magnets imbedded in the unit will align the emitter and receiver. With the units in free run mode select the "Record" button on the lowest unit in the stack all subsequent units will trigger synchronously. When using the optical method for simultaneous acquisition start, it will work exactly like the synchronization cable technique described above. However, when using optical synchronization for the simultaneous sampling, one must remember that the optical simulations sampling works up to 10kHz sampling rate. When there is a need to synchronize 25kHz acquisitions the user must use the synchronization cable instead.

The synchronous connector and optical input/output are hardware connected. This allows the hybrid usage of this daisy chaining mechanism. It means the synchronization signal can be supplemented with either synchronization cables or optical input/output within the same setup. The one important thing to remember is that when it comes to optical input/output the input is always on the bottom of the unit and the output is always on the top. These functions are not switchable or interchangeable.



The Figure above shows daisy chaining of three units using hybrid arrangement of synchronous cable and optical input/output.

NOTE: It is highly recommended to plug in synchronization cables once the units are turned on and booted.





## XII. File Structure

The measurement file consists of two parts: the file header and the data. The header of the file consists of 96 bytes and is at the beginning of the file. The header has the following structure:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
File Name	RESERVED											A	M	E	#		
	Sampl.R.	Trigger Level		Trig.Axis	Run Type	Battery Level		File Size	Model	Letter	Range	Serial Number		RESERVED			
Synch Time	Month	Date	Year	Hour	Minute	Second	X offset		X sens	Y offset		Y sens		RESERVED			
Trig.Time	Month	Date	Year	Hour	Minute	Second	Z offset		Z sens	MASTER	SYNCH						
	CAL FACTOR X		CAL FACTOR Y		CAL FACTOR Z		RESERVED										
	RESERVED											7	26	81			

**Figure 14: File structure**

The first 12 bytes of the header are reserved and shall be disregarded.

Bytes 12 thru 15 contain 4 user selectable characters for the file name

Byte 16 contains Sampling rate information and shall be decoded in accordance with the table below:

Table 3: Sampling rate code

Sampl.R.	Code	Value
	0	100Hz
	1	500Hz
	2	1,000Hz
	3	5,000Hz
	4	10,000Hz
	5	25,000Hz

Bytes 17 and 18 contain Trigger level settings where byte 17 includes the whole part and byte 18 has the decimal part of the level designation

Byte 19 has the triggering axis information

Table 4: Triggering axis

Trig.Axis	Code	Value
	0	Any
	1	X
	2	Y
	3	Z

Byte 20 shows run type mode

Table 5: Run Type

	Code	Value
Run Type	0	Free Run
	1	Trigger on Level
	2	Trigger on Time

Bytes 21 and 22 have battery level information at the beginning of the file creation. The 12-bit number corresponds to the output of the ADC. The number has 2048 offset and can be converted to the actual battery voltage using the following formula:

$$V_{bat} = (\text{BatteryLevel} - 2048) * 0.002170$$

Byte 23 is the file size designator

Table 6: File size

	Code	Value
File Size	0	1 Mbyte
	1	5Mbyte
	2	10MByte
	4	100MByte

Bytes 24 to 29 contain model and serial number information

Bytes 32 to 37 contain Synchronous Time settings

Bytes 48 to 53 contain Trigger Time settings

Bytes 38 to 45 and 54 to 57 contain offset and sensitivity information

MASTER	SYNCH
--------	-------

Master(0)/Slave(1) selector used to designate master versus slave operation mode when used synchronously (when SYNCH byte is set to 1). When SYNCH selector is at 0, the MASTER/SLAVE settings is disregarded.

The last three bytes of the header contain static verification code 0x071A51h

Starting at byte 97 the user can access an actual sampled data. The sampled data comes in 8 byte blocks with Byte 0 and 1 of each block being 0s, bytes 2 and 3 is the sampled data for axis X, bytes 4 and 5 is the sampled data for axis Y, and bytes 6 and 7 is the sampled data for axis Z. The sampled data for each axis is 16-bit unsigned integer.

To display the data, the user must subtract the offset found in the header and divide by the sensitivity value and multiply by the correction factor. The correction factor is obtained by dividing the U16 value from the fields below:



CAL FACTOR X	CAL FACTOR Y	CAL FACTOR Z
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By 32768. The resultant double is the correction factor.

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