# Brüel & Kjær Pulse Labshop Primer



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# Brüel & Kjær Pulse Labshop Primer

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# Communication between the Pulse Front-end and the PC

## **Configuring Pulse IP Addresses**

The Pulse Front-end communicates with the PC using an Ethernet connection. The communication protocol used is the same as that used to connect your PC to a network. In fact, it is possible to connect multiple Pulse units to a single PC using an Ethernet hub or to set up communication with the Pulse Front-end over a standard network, though this will not be discussed here.

Before the PC can communicate with the Front-end, the PC that the system is to be connected to must know what IP address that the Pulse Front-end is using. It may turn out that the PC was last connected to the Pulse Front-end that you wish to use. In this case this process can be skipped.

The following steps describe the process of setting up the PC to communicate with the Pulse Front-end using the 'Pulse Front-end Setup' Program.



1. Load 'Pulse Front-end Setup' Program.

2. Each Pulse system has a label specifying the IP Address or a name for the Pulse Front-end that should be used with this system. Either look for this IP Address or this name in the 'Existing configurations' box and select it. In this case the IP address for this Pulse Front-end is 10.10.10.12, this has been selected. When this has been selected, press the 'Connect' button.

PULSE Front-end Setup		×
	PULSE Front-end Setup	
	Set the PC IP address. (10.10.10.50)	Set IP
Mars	Name:	
	<enter configuration="" for="" name="" new=""></enter>	New
Moon	Existing configurations:	
	10.10.10.12 (Current) Aero_Casey_2_Units	Connect
Jupiter	D Hanson 2 Units D. Hanson Single Unit	Reconfigure
lower set	D. Hanson Single Unit Uld Front End Factory configuration	
Pluto	Jason_single_unit single_in_11	
ERVICE CONTRACTOR	4 <b>•</b>	Delete
Brüel & Kjær ⇒		
	< Back Next > Finish	Exit

3. The next screen lets you start a Front-end configuration check. Run this check by pressing the 'Next' button.

Front-end Setup	
	Front-end configuration check
	Connecting to the Front-end using the network
Point-to-point	When you press 'Next', the program attempts to establish a network connection to the Front-end.
In-house Network	Front-end IP Address: 10 . 10 . 10 . 12
Brüel & Kjær 🛶	

4. The next screen tells you that you have been successful in setting up communication between the Pulse Front-end and the PC. Click finish and exit the program. The equipment is now ready to start taking measurements. This procedure has to be done after every time the PC is switched off even if the Pulse Front-End was not unplugged from the PC.

PULSE Front-end Setup	×
	Front-end setup finished Your Front-end has now been set up. You are now ready to use your PULSE system.
	The Firont-end setup is summarised below. PCI Praddress: 10.10.10.50 Front-end type: IDA/DA/e Frame IP address: 10.10.10.12
	DAE Synchroniastion Unit: 1 00-0000 6/1-Ch Input/Output Module: 1 00-0000 222:0005 5/4) Inferitore Module: 2 12:0000 PowerSupply: 0.00-0000 ¥
Brüel & Kjær 🐲	
	< Back Next> Finish Exit

#### If it wasn't quite that easy...

There are a number of things that can go wrong setting up communication between the Pulse Front-end and the PC. The following gives a quick guide to solving these problems.

- The PC may not be configured with a valid IP Address to communicate with the Front-end successfully. Try setting the IP address on the PC as following using the control panel and network connection. (Details are not given here on how to do this as it varies with Operating System.)
  - IP Address : 10.10.10.50
  - Subnet Mask : 255.255.0.0
  - Preferred DNS: 172.36.0.250
  - $\circ$  Other values are not important.

- The IP address or name of the Pulse Front-end may not match the IP address stored in the Front-end. It is possible to change this IP address using the 'Pulse Front-end Setup' Program and an RS-232 connection. Detail of how to do this are not given here as this should not have to be performed regularly, nor by the in-experienced user.
- A cross-over Ethernet cable must be used, unless a network hub is in use.

## **Basic measurements**

Although, Pulse comes with numerous built-in setups for measuring various situations, for example Modal Test Consultant is a powerful template performing modal analysis, it is important to understand how to setup these templates, so that the user can understand how to modify these pre-set configuration if necessary, or how to setup templates that are not provided.

# **Time Signal and Spectrum Analysis**

The most basic Sound and Vibration measurements that can be made are Time Signal and Spectrum analysis. The following section gives instructions on how to setup a simple measurement of the vibrations associated with tapping a beam.

## **Equipment Setup**

The following equipment is required for this demonstration.

- 1x Pulse Front-end.
- 1x Pulse Front-end power supply.
- 1x PC with Pulse Labshop installed.
- 1x Ethernet crossover
- 1x Pulse Dongle.
- 1x B&K 2635 Charge Amplifier.
- 1x B&K 4393 Accelerometer.

It is possible to substitute another type of Charge Amplifier and/or accelerometer if these are not available.

This equipment should be connected as shown below.



The accelerometer can be attached to anything that the vibration spectrum or time response can be measured. A simple setup may involve mounting an accelerometer to a table and the response of the tapping the table can be measured. The results given in this document have been measured using a suspended beam.



## Setting up the template in Labshop

The following describes how to setup a Pulse Labshop template to measure the time signal and spectrum response of an accelerometer mounted on a beam that is tapped with a finger.

1. Load the 'Pulse Labshop' program.



2. Create a blank project by selecting 'Create blank project' and then clicking 'Ok'.



3. In order to setup a template, there are four important windows. These are opened by selecting 'Organizer' from the menu and then clicking on each of the four window titles listed below.

File	Edit	View	Organiser Tas	k Measuremer	nt WorkBook
D	<b>2</b>		Configuration	n Ctrl+1 🥐	
		ILSAL DI	Measuremen	t Ctrl+2	
			Function	Ctrl+3	
			Display	Ctrl+4	
			Message Vier	4 Ctrl+5	
			WorkBook	Ctrl+7	
			Report	Ctrl+8	
			Component	Ctrl+9	
			Task	Ctrl+0	

• Configuration

This window contains details of the inputs and outputs on the Pulse Front-end and to specify what instruments are connected to this Front-end.

• Measurement

This window is used to setup signal grouping and to specify which analysers are to be used.

• Function

This window is used to setup the outputs from the analysers and how they are to be used.

Display

This window shows which measurements are currently displayed and allows modifications to be made to the way the measurements are displayed.

4. The four windows mentioned previously are very important for setting up the Pulse Labshop template. It is important that they are easily accessible. It is therefore recommended that these windows be setup as shown below. This configuration follows the flow that the setup process uses.

1.e. Configuration $\rightarrow$ Measurement $\rightarrow$ Function $\rightarrow$ Displa	i.e.
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🙀 Brüel & Kjær - PULSE LabShop Versio	on 9.0 - Project1			_ <u>_</u> ×
File Edit View Organiser Task Measur	rement Configuration WorkBook Repor	: Tools Window Help		
Configuration Organiser	💶 🗖 🗙 📄 Measurement Organi	er _ 🗖 🗙 fix Funct	tion Organiser	🗙 Display Organiser
E: Tube France Type 5500 (frame 1)	Composition of the second seco		j Function Grane	Control of the second sec
For Help, press F1	t1. Microsoft W	151		
Marcare       🗠 🖉	ar - maradare man jing bruei & kjær - Pi	L3E L		1200 P

5. When creating a new blank template, Pulse Labshop automatically sets up signals and attaches then to each of the Front-end inputs. In this case, only one input is going to be used. Therefore, all the signals that have setup by Pulse need to be removed. This is done by selecting Configuration → Remove → All Signals. This step can be thought of as resetting the Front-end ready for a new program.



6. The next step is to expand the information in the configuration organizer. This is done by clicking on the ⊞ icons. This window shows all the all the input and outputs that are available on the Pulse Front-end. The Pulse Front-end consists of two basic components. Firstly, there is the Pulse Frame, this is the black box that contains the electronics, and these frames come in various different sizes. Different electronic modules are connected into the Pulse Frame during manufacture. These modules contain the various acquisition hardware modules.

The LAN Interface Module Type 7533 is common to most Pulse Front-ends. This is the unit that allows communication between the PC and the Pulse Front-end. This module also contains a number of low speed inputs that sample at 10 Hz. Generally, these inputs are not used. It is also possible to get LAN Interface Modules that include input and output hardware. The other input module/s can be used for data acquisition and signal generation. These modules come in various different configurations. As the inputs on the LAN Interface module are not going to be used close them by selecting clicking on the ⊟ icon.



7. In order for measurements to be made with Pulse, a transducer has to be connected to one of the inputs shown in the configuration organiser. This is done by right clicking on the input that the transducer will be connected to and then selecting 'Select Transducer'.



8. This brings up the 'Database Administrator' window. Using this window, it is possible to attach many different types of transducers to the input. In this case an accelerometer is going to be used for the measurement. This is selected under family.

Database Adm	inistrator						×
Transducer Serial No: Nom.Sensitivity: CCLD: Weight: Description:	10 mV/ms^2	Family: Type: Name:	Accelerometer Accelerometer Ausliary Coupler Force Hydrophone Microphone		OK iransducer Ty iransducer Find Correction Curve	Clear pe	Cancel
Accredited Calit	pration <pre>cnumber&gt; mV/ms^2</pre>				800m -		<b>_</b>
This is a comme	ent field	Time: 8/;	29/2005 5:19:59 PM	-	400m- 0_	400m	800m
Sensitivity:	<number> mV/ms^-2</number>	Time: 8/2	29/2005 5:19:59 PM	T	his is a comm	ent field	

9. The next step is to select the name of the transducer that is to be used. In this case a Type-4393 Accelerometer is to be used, with this connected to a Type-2635 Charge Amplifier. The 4393+2635 configuration should be available under type, select this. If it is not available, you will have to either setup this configuration using the section in this guide, 'Setting up Transducers', or modify the setting of an existing transducer for this setup.



10. Now that the transducer is connected in the software, a signal needs to be allocated to this transducer. This is done by right clicking on the transducer and selecting 'Add Signal'.

🛄 Brüel & Kjær - PULS	E LabShop Version 9.0 - Project
File Edit View Organis	ser Task Measurement Configu
🗅 🚅 🔛   🐰 🖻	🖻   ∂ 🖪 💡 🕅 🔳 👘
	IOD
Configuration Organ	niser 💶 🛛 🗶 🚺
□ 1048 Frame type □ 1048 Frame	Module Type 7533 (slot 1) Output Module Type 3032 (slot Edit Label Ctrl+R Delete
P Input 5	Edit Pronerties
	Global Calibration

11. This signal can be given a name by right clicking on it and selecting 'Edit Label'. The name in this case should be 'Accelerometer', but any name can be used.



12. The 'Configuration Organizer' window should now look as shown below.



13. To make the changes that have been made to the 'Configuration Organiser' applicable to other windows it is necessary to click the 'Activate Template' button or press F2.

This button is used to apply many changes that can be made to this and other windows. If changes are made to the template, but they don't appear to have taken effect, use this button to update all of the information in the template.



14. For the moment, work in the 'Configuration Organizer' window is complete. The next steps involve using the 'Measurement Organizer' window. The list in the 'Measurement Organizer' should be expanded by clicking on the ⊞ or by right clicking the text 'Measurement Organizer' and selecting 'Expand all'.



15. It is now required to setup signal groups. Signal groups are required because they the analysers that will be used shortly to accept multiple signals. It is only possible to feed a signal into a Pulse Analyser by grouping it first. This step may seem a bit pointless when there is only one signal, but the need for this step will become clear when multiple signals are being used. In this case, right click 'Groups' and select 'New Group'.



16. It is possible to rename this signal group by right clicking the group and selecting 'Edit Label'.

17. Any name can be used for this group, but in this case the name 'Accelerometer Group' is suggested.



18. Now a signal must be added to this signal group. This is done by right clicking the signal group label and selecting 'Insert Signal'  $\rightarrow$  'Accelerometer'.

Measurement Organiser		_ 🗆 🗵	f(x)Function Organis
🖃 🗊 Measurement Organiser			🖃 🛅 Function Orga
🖻 📳 Working			- 🔛 Function G
🖃 📷 Frontend			
🕀 🔛 Signals			
E 🛞 Groups			
Acceleror	Expand All		1
Setup	Collanse		
	Edit Label	Christ	
	Earceaber	Guille	
	Insert Signa	•	Accelerometer
	Delete		
	Properties		
-			

19. The type of analyser that will be used needs to be set. In this case, the time domain and frequency spectrum of the signal is required. An 'FFT Analyser' is appropriate for this type of analysis.

To insert this type of analyser into this template, right click on 'Setup', then select 'Insert'  $\rightarrow$  'FFT Analyser'.



20. This analyser now needs to be told which signals to analyses. This is done by connecting this analyser to 'Accelerometer Group'. To do this right click 'FFT Analyser' and select 'Insert Group' → 'Accelerometer Group'.

🗧 Measurement Organis	ier 🛛	-OX	f(x)Function Organiser
🖃 📅 Measurement Organi	ser		E E Function Organiser
🖻 🚰 Working			
🖃 🛅 Frontend			
🗄 🛅 Signals			
🖻 🛞 Groups			
E 🛞 Accel	erometer Group		
	ccelerometer		
E Setup			
- EFT Ana	Expand All		1
🍟 Input (Input	Collanse		
	Edit Label	Ctrl+R	
	Hildiyzor		-
	Select Groups		
	Insert Group	Þ	Accelerometer Group
	Delete		
	Properties		
	Document	•	
	Monitor all Signal	5	
l ,			ť l

21. Quite a few changes have been made since the template has been updated. Click the 'Activate Template' button now, or press 'F2' to carry the changes that have been made over to the 'Input' section of the 'Measurement Organiser'.



22. The details of the 'FFT Analyser' and input signal are now in the available in the 'Input' section. Remember to click the 'Activate Template' button regularly so that changes are updated throughout the template.

Measurement Organiser	- O ×
🖃 📅 Measurement Organiser	
🖻 🚰 Working	
E Frontend	
🕀 😭 Signals	
🖻 🛞 Groups	
🖃 🎇 Accelerometer Group	
Accelerometer	
😑 📳 Setup	
🖃 🔛 FFT Analyzer	
🗄 🐯 Accelerometer Group	
🖻 🍙 Input (Input)	
主 📨 Input	
1	

23. Now the 'FFT Analyser' needs to be set up. This process is started by right clicking 'Setup' and selecting properties.

🗧 Measurement	Organiser	I										
E 🗇 Measuremen	t Organiser											
🔄 📳 Working												
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E Signals												
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	🖏 Accelerometer Grou	IP I										
	C 💫 Accelerometer											
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主 🗠	🗄 🖾 Insert 🕨											
	Properties											
	Document	•										

24. A number of different controls are available here controlling how the measurement are taken and stored. For this demonstration on the trigger will be used.

A trigger is some condition that has to be satisfied before a measurement will be taken. In this case the trigger will be when the signal or acceleration exceeds a certain level. This way the measurement will only be taken when after the beam has been tapped.

To do this, enter a new trigger name, in this case 'Trigger 1' and click the 'New' button.

🛱 Setup	
Measurement Control Environment Settings Multi-buffer 1 Multi-buffer 2 Multi-buffer Trigger	Time/Date Sync r3 Multi-buffer 4
Trigger 1	New
Manual 1 Manual 2 Manual 3	Eemove Graphical Setup
Trigger Lype:     Divider:     Del       Manual     1     0	lay: Delay Unit:
Trigger Buton Connection	

25. Now change the 'Trigger Type' to 'Signal'.

	III I-Line Frontand
🖥 Setup	_ 🗆 🗙
Measurement Control   Environmen Multi-buffer 1   Multi-buffer 2   M Trigger	:Settings   Time/Date Sync   fulti-buffer 3   Multi-buffer 4
Trigger Name: Trigger 1	New
Manual 2 Manual 3 Trigger 1	<u>Remove</u> <u>Graphical Setup</u>
Trigger Lype: Divider Manual T Signel Generator	: Delay: Delay Unit:
Manual External Time Tacho	

26. The easiest way to set the trigger level is to click the 'Graphical Setup' button.

III Islami Frontend
🖥 Setup 📃 🔍 🗶
Measurement Control Environment Settings Time/Dale Sync Multi-buffer 1 Multi-buffer 2 Multi-buffer 3 Multi-buffer 4 Trigger Trigger Name:
Trigger 1 New
Manual 2 Manual 3 Trigger 1
Trigger Iype:     Divider:     Delay:     Delay Unit:       Signal     ▼     1     0     s     ▼
Signat Slope:
Reference Level 10 U Husteresis 5
Max. Input Level Hold Off: 0.1 s

27. This program takes a measurement and then allows the trigger levels to be set based on this measurement. Click the 'Start' button and then tap the beam with a small amount of force.



28. The response of this beam to this tap is shown on the graph. Now set the trigger level such that the initial response exceeds this level. The trigger level is shown on the graph as the green line. The trigger level can be adjusted by either entering a value in the green box, 'Level', or graphically moving it with the mouse.

The blue line or 'Hysteresis' level indicates the amount that the signal level must change by after the trigger is activated for that trigger to still be valid. A very large 'Hysteresis' level may mean that it is very difficult to activate the trigger.

When the trigger level is correctly set, press 'Ok'.



29. From the previous graph in the trigger window, it can be seen that by the time that the trigger is activated, some of the initial parts of the signal have been lost. It is therefore necessary to take the measurement on some of the data before the trigger is activated. This is done by putting a negative value into the delay field. In this case a delay of  $-\frac{1}{2}$  a second is used. Note that this value is automatically changes to 500 milliseconds by Pulse Labshop.

Click the 🗷 button in the top left hand corner of the 'Setup' window to close it.

🖥 Setup 📃 🗔 🔪
Measurement Control Environment Settings Time/Date Sync Multi-buffer 1 Multi-buffer 2 Multi-buffer 3 Multi-buffer 4 Trigger
Trigger Name:         New           Manual 2 <u>Remove</u> Manual 3 <u>Remove</u>
Trigger Type:         Drider:         Delay Link           Signal         1         500m         s           Signal         Signal         Signal         Signal
Accelerometer         Positive           Reference Level         Level:         1         % = 70.7m V           7.071         V         Mathematic Total are and with the second area of the
Hold⊡ff: 0.1 \$

30. Now that the trigger has been configured, it is now necessary to configure the FFT analyser. Right click 'FFT Analyser' and select properties. This brings up the configuration for the FFT Analyser. Using this window it is possible to control a number of aspects of the FFT Analyser, including the resolution or number of lines used by the analysis, the frequency span of the analysis, type of averaging used and triggers can be applied.

The analysis that will be used here will only look at frequencies up to 1.6 kHz. Set the frequency span to 1.6 kHz and also select 1600 lines so that the measurement resolution will be 1 Hz.

🛱 FFT Analyzer	
Set-up Trigger Time Spec	tra Slices Slice Setup
Frequency Lines: 1600 Spar: 20 1.6k Hz V di: 1 Hz	Analysis Mode Baseband
T: 1 s dt: 244.1u Averaging Domain © Spectrum Averaging © Signal Enhancement	Averaging Mode: Exponential Averages: 10
Overlap For fixed overlap set Record Trigger to Free Run on Trigger-tab.	Qverload: Reject

31. Click on the 'Trigger' tab to bring up the trigger tab for the 'FFT Analyser'. The trigger defined previously was called 'Trigger 1'. Set both 'Start Trigger' and 'Record Trigger' to 'Trigger 1'.

Close this window by clicking on the  $\boxtimes$  button in the top right hand corner. The FFT Analyser is now set up. Click 'Activate Template' or press F2 to make sure the changes are applied to the template.

FFT Analyzer			
Set-up Trigger Tim Start Trigger:	s   Spectra	Slices   Slice Se	Hup
Record Ingger		Avgrage Trigger:	
L tearri		Undo Lost Av	/erage

32. It is now time to move across to the 'Function Organiser' window. This window is used to control which measurements are to be recorder by the analysers. Expand 'Function Organiser' and right click 'Function Group'. Select 'Insert'. This will add a new measurement.

f(x)Functio	n Organiser		<u> </u>
🖃 🛅 Fun	ction Organiser		
	Expand All		
	Collapse		
	Edit Label	Ctrl+R	
	Insert		
	File Open		
	Delete		
	Properties		
	Copy Function Group		
	Play		
	Save	•	
	Show as	•	

33. Pulse Labshop inserts a default measurement based on previous setting for the template. In this case, a time response is required, so right click the created function and select properties, so that the function can be changed to a time response.



34. This brings up the functions property window. Change the function from 'Auto spectrum' to 'Time'.



35. Insert another function, as per the previous instructions. Again right click the function and change the Function type to 'Auto spectrum'.



36. A plot of the resulting measurement is easily taken by again clicking on each of the created functions and selecting 'Show as'  $\rightarrow$  'Classic Display'. Do this for both the 'Time' and 'Auto spectrum' functions.

f(x)Function Organiser			IX	Display Org
E E Function Organiser				🖃 🄛 Display
E E Function Group			.	Disp
E Intervorente	Expand All			
Autospectrum	Collapse			
	Edit Label	Ctrl+R		
	Insert	•		
	Delete			
	Properties			
	Сору			
	Paste			
	Play			
	Save	•		
	Show as	Þ	Clas	sic display
· ·			Mod	lern display
		-		

37. There should now be two windows that will display the results of the time and Autospectrum measurements. This means that there are now six windows open and switching between these windows could be confusing. It is possible to set up task displays so that it is easy to switch between different parts of the template.

		X 🖻 🖻	6	<b>? №</b>		ык коры	U UISpidy		X 🖻 I	8   🖺	ti B	8   🕵	<b>f</b> (x)	🔛 🚥	1 <b>.</b> •g	] 🖌 🖉	*	U JU	1	∿∎	<b>2</b>	4	$r_1 r_2 r_3   \mathbf{\Phi}  $	• 🕺 🛅
		IM 10 I		_	_	_	_	_	_	_	_	_	_	_	_	_	_	_		-				
ín 🚺	Autos	pectrum(Ac	celeromet	er) - Inpu	:	-	_		_	-	_									-	کر لیاں۔ 10ء			
[0	B/1.00	m/s²]							Au	tospectrur	n(Accelero	ometer) - In	put											
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	-10-			2					5			1.										_ [		
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	-30-									_					_				_			_		
	-40 -														_									
	-50-					_					_				_				_			_		
	-60-						-				-									-				
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											[Hz]													
- 1.1-1-															_	_			<u> </u>					

38. Turn on the task bar by selecting 'View'  $\rightarrow$  'Task Bar'.



39. This will open the task bar on the left hand side of the screen. Right click on this task bar and select 'Add Task'.

🛄 E	Brüel 8	k Kjær - PULSE LabShop Version 9.0 - Pro
File	Edit	View Organiser Task Measurement Wo
] C	) 🖻	🖬   X 🖻 🖻 🎒 🎝 💔 📰
5	Tas	k list 📙 Time(Accelerometer) - Input
Ň		n Autospectrum(Acceleron
-		✓ Large
		Small
		Add task
		Delete task
		Save Active Task Layout
		Move group up
		Move group down
		Insert workbook
		Add group
		Delete group
		Rename group
		-40

40. Name the task display that you are creating. The first one that will be created here will be to display the configuration windows. Type 'Configuration' and press the 'Ok' button.

Rename task	×
Enter task name	
Configuration	
ОК	Cancel

41. This will create a 'Configuration' button. The icon for this button can be changed by right clicking the button and selecting 'Change Icon'. Click the configuration button so that it is highlighted as shown below.



42. Organise the windows so that you can see all of the four configuration windows and then select 'Task' → 'Save Task Layout'. This saves this display to the configuration button, now when ever this button is pressed these four windows will come up. Before trying this out, firstly set up another task button that will display the time and Autospectrum plots.



43. Right click the Task Bar again and select 'Add Task'. Name this new task 'Display'.

Rename task	×
Enter task name	
Display	
ок	Cancel

44. Now bring up the two results windows. Use the 'Window' menu to bring 'Time' and 'Autospectrum' to the front windows.

Tools	Window	Help	
	Casca Tile Ho Tile Ve Arrang	de vizontally rtically ge Icons	
t	<ul> <li>✓ 1 Displ 2 Fund 3 Mea</li> <li>4 Time</li> <li>5 Auto</li> <li>6 Confi</li> </ul>	lay Organiser tion Organiser surement Organiser (Accelerometer) - Input ispectrum(Accelerometer) - Input iguration Organiser	I
	E	E 🕅 Analyzer	

45. Rearrange these windows so that both results will be clearly visible. Select the 'Display' task button and then select 'Task' → 'Save Task Layout' from the menu.

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File Edit View	Organiser	Task Measur	rement Wo	rkBook Re	eport Displ	ay Tools V	Vindow H	elp											
🗋 🗅 🚔 🔛 🛛	š 🖻 📾	Previous ta	ısk														1	↓   *	! 🖌 🛛 🔛 🗎
. Task list	K Time(i	Set state to	o initialized																- 🗆 🗵
ž .	[m/s <sup>2</sup> ]	Set state to	o working						Time(Acc	elerometer	) - Input							Cu	irsor Values
Configuration	2Т.	Set state to	o done	_			-	Wor	cing : Inpu	it : Input : F	FT Analyzer							=   <sup>×</sup>	= Undefined
	1.6-	Save Task I	Layout												_			×	= 112.5m s
	12-	AULUSAVE		_														_	
Display	900	Taskivote	1	•														Sta	atus
	400																		
	400m-																		
	0-																		
	-400m																	_	
	-800m -																	_	
	-1.2																	_	
	-1.6		-	_														_	
	-2		-	_									8		_			_	
	0	2	0m	40m	60m	1 8	0m	100m	12	Om [s]	140m	160m	18	Om	200m	220m	240m		•
	Autospectrum(Accelerometer) - Input																		
	[dB/1.00 r	n/s²]		<u> </u>				Aut	ospectrum	(Acceleron	neter) - Input							C1	ursor Values
								Wor	king : Inpu	it : Input : P	FT Analyzer						_	— Y	' = Undefined
	.10																	×	( = 0.000 Hz
	20																		
	-20																	St	tatus
	-30-																		
	-40-						2				-						-	_	
	-50 -												-				_	_	
	-60-																	_	
	-70-																	_	
	-80							-											
	i 'o	100	200	30	10 4	00 50	0	600 7	00	800 [Hz]	900	1k	1.1k	1.2k	1.3k	1.4k	1.5k	1.6k	<b>P</b>
Save the task law																_			
Start			1 - Microsoft	w	Brüel & Ki	ær - PULSE											5500		
	- <b>(</b>																14000		

46. Try switching between the windows by clicking on the task buttons.

47. The 'Measurement Bar' toolbar has been disabled for the 'Display' task. Click the 'Display' task to activate this window. The 'Measurement Bar' toolbar contains the 'Activate Template' button and also the buttons that are used to start and stop the measurements. Reactivate this toolbar by selecting 'View' → 'Toolbars' → 'Measurement Bar'. Then select 'Task' → 'Save Task Layout' to ensure that the toolbar is displayed each time the 'Display' window is opened.



48. It is now possible to start taking measurements. Click the 'Start' button on the 'Measurement Bar' toolbar.

The measurement process will not start until the trigger conditions have been met. Therefore, tap the beam to start the measurement process.



49. The display will take a couple of seconds to display the response. The time and Autospectrum response should then be displayed in their respective windows. The graphs may need to be scaled, if so right click on the graph and select properties. Under the Y Axis tab click Autoscale. Alternately the use of the shortcut keys F10, Ctrl+F10 or Alt+F10 for the different autoscaling options.



50. It is possible to save the template by selecting 'File'  $\rightarrow$  'Save' from the menu. Similarly, in the future this template can be opened using 'File'  $\rightarrow$  'Open'.

# **Frequency Response Functions**

## **Equipment Set-Up**

The following equipment is required for this demonstration.

- 1x Pulse Front-end.
- 1x Pulse Front-end power supply.
- 1x PC with Pulse Labshop installed.
- 1x Ethernet crossover
- 1x Pulse Dongle.
- 2x B&K 2635 Charge Amplifier.
- 1x B&K 4393 Accelerometer.
- 1x B&K 8202 Hammer

It is possible to substitute another type of Charge Amplifier and/or accelerometer if these are not available.

## **Template Set-Up**

- 1. Follow the steps 1-11 in "Time Signal and Spectrum Analysis" to set up two signals:
  - 8202 Hammer and 2635 Pre Amp in channel 1.
  - 4393 Accelerometer and 2635 Preamp in channel 2.



- 2. Activate the Template
- 3. Set up two signal groups in the Measurement Organiser and insert the signals as shown in steps 14 18 in "Time Signal and Spectrum Analysis"
- 4. Insert the FFT into Setup in the Measurement Organiser tree and then insert both groups into this, see steps 19 & 20 of the previous section.
- 5. Activate the Template

The measurement organiser should now look like this.



6. Right click on the hammer signal in the measurement organiser and select properties. Choose the Channel tab and change the Gain Adjust to −1. This allows for the negative signal from the hammer.

🛱 Hammer								
Signal Channel Transducer								
Frame:     IDAe Frame Type 3560C (frame 1)       Module:     6/1 ch. Input/Dutput Module Type 3032 (slot 2)       Channet:     Input:       Input:     Vise Transducer Data       Sensitivity:     10m V/ms <sup>2</sup> Gain Adjust:     -1								
Input Direct Max Peak Input 7.071 V -707.1 m/s <sup>2</sup> Filters: High-pass: 7 Hz	Pol. Voltage C Channel Delay 0 s Coupling C Eloating C Ground							

7. To set up the trigger right click Setup and left click on properties. Choose the trigger tab if it isn't automatically chosen. Click the new trigger button and insert a name, in this case hammer has been used. Change the trigger type to signal.

	Accelerometer	
🛗 Setup		
Measurement Control Env Multi-buffer 1 Multi-buffer	vironment Settings   Time/Date Sy r 2   Multi-buffer 3   Multi-buffe Trigger	vnc er 4
Trigger Name:		
Hammer	New	
Manual 2 Manual 3 Hammer	<u>R</u> emove	
	<u>Graphical Setu</u>	
Trigger <u>T</u> ype: Signal	Divider: <u>D</u> elay: Delay <u>U</u> ni 1 0 s	։ ▼
Generator Manual External	Slope: Positive	
Time Tacho 💌	Level: 10 % = 70.7 m/s	^2
707.111 m/s^2	<u>H</u> ysteresis: 5 % = 35.4	
Max. Input Level	Hold- <u>O</u> ff: 0.1 s	

8. Chose the type of signal to trigger from, in this case the hammer.

🖥 Setup		_1	
Measurement Control En Multi-buffer 1 Multi-buffe	vironment Se r 2   Multi	ettings   Time/Date Syn i-buffer 3   Multi-buffer	nc   4
	Trigger		
Trigger Name:			
Hammer		New	
Manual 2 Manual 3	-	<u>R</u> emove	
Hammer	E	<ul> <li><u>G</u>raphical Setup</li> </ul>	
Trigger <u>T</u> ype: Signal	Djvider:	Delay: Delay Unit:	•
<u>S</u> ignal:		Slope:	
Hammer	•	Positive 💌	
Hammer Accelerometer	evel:	10 % = 70.7 m/s^	2
707.111 m/s^2	<u>H</u> ysteresis:	5 % = 35.4	
Max. Input Level	Hold- <u>O</u> ff:	0.1 s	

9. Click on graphical setup. Click on start and tap the beam with the hammer as if you were performing a measurement.



- 10. The impact of the hammer should be seen clearly. Set the Level and the Hysteresis lines to an appropriate amount (usually 10 20% for the Level, and 5% for the Hysteresis). This can always be changed later if the hammer is triggering too early or not at all. Also set the delay to -0.5s. Refer to sections 28 29 of "Setting up the Template in Labshop" for more information.
- 11. Click ok and close the Setup box.
- 12. Right click FFT Analyser and select properties. The analysis that will be used here will only look at frequencies up to 1.6 kHz. Set the frequency span to 1.6 kHz and also select 1600 lines so that the measurement resolution will be 1 Hz.



- 13. For this example three measurements will be taken and the results all will be averaged, to do this insert 3 for the number of averages. Change the averaging mode to linear.
- 14. Click the trigger tab. Set the Start Trigger to Hammer, Record Trigger to Hammer and Average Trigger to New Record.

🛗 FFT Analyzer	_ 🗆 🗙
Set-up Trigger Time Start Trigger: [Hammer	Spectra   Slices   Slice Setup
Record <u>I</u> rigger: Hammer	Avgrage Trigger:           New Record
	Undo Last Average

15. Click on the Spectra tab and chose the hammer group under cross spectrum. Click the measured button. This allows the frequency response function to be measured and displayed. The window should look like the picture below.

🛱 FFT Analyzer	_ 🗆 ×
Set-up         Trigger         Time         Spectra         Slices         Slice Setup           Not Measured	1
Multi-buffer 1 Multi-buffer 3 Multi-buffer 2 Multi-buffer 4	
Autospectrum	
Cross-spectrum	
1) 2)	
1) Hammer Group	
2) Accerometer	

16. Under Setup and FFT Analyser in the measurement organiser tree, right click the Hammer Group and chose properties. Change the Time Weighting Window to Transient, the shift time to 480ms and the length to 50ms. The shift time describes the time until the window starts, the length sets how long the window will be.

🛗 Hammer Group	
Signal Channel Transducer	
Acoustic Weighting:	Integration
Time Weighting Window: Transient	
Shift: 480m s	L <u>e</u> ngth: 50m s
Leading: 0 s	Trailing: 0 s
Frequency Weighting	
jw - Weighting None 💌	
Acoustic Weighting None	•

17. Now open the properties of the Accelerometer Group. Change the time Weighting Window to Exponential, the Shift to 480ms and Tau to 100ms. Tau describes the rate at which the exponential curve decays (the smaller it is the faster it decays).

100 C C C C C C C C C C C C C C C C C C	- í
🛱 Accerometer Group	╝
Signal Channel Transducer	
Acoustic Weighting:	
None None	
Time Weighting	
Window: Exponential	
Shift: 480m s Iau: 100m s	
Tapers	
Leading: 0 s	
Frequency Weighting	
jw - Weighting None 💌	
Acoustic Weighting None	

- 18. Activate the template and move to the function organiser.
- 19. Right click function group and select insert. This will add a function called Autospectrum (Hammer). Right click it and go to properties.

20. Change function to Frequency Response H1. Set the Signal as Accelerometer and the Reference Signal as Hammer.

🖥 Frequency Response H1(A	ccelerometer,Ham 💶 🗅
Function	
Protection:	Follow Measurement Mark
Not Protected	Input 💌
- Eunction	Туре
Frequency Response H1	🔹 Standard 💌
<u>S</u> ignal	<u>R</u> eference Signal
Accelerometer 💌	Hammer 💌
Source Template	Measurement
Working	
Analyzer	Buffer
FFT Analyzer	- Input
	,

21. Similarly add a new function and change the function to Coherence.

ik/Function Organiser
E-E Function Organiser
Frequency Response H1(Hammer,Acceleromete
Coherence(Hammer,Accelerometer) - Input

- 22. Right click on both functions and chose Show As, Classic Display.
- 23. Follow steps 38 46 in "Time Signal and Spectrum Analysis" to create two tasks in the task bar, one to show the configuration and the other to show the two displays that have just been created.

24. The display layout should look like this.



- 25. In the view tool bar select toolbars and measurement bar. This will provide you with buttons to start and stop the measurement. Make sure to save this in the display layout.
- 26. Now the time weighting functions need to be set. Move to the Configuration window. Under the Function Organiser create 4 new function groups:
- Time (Accelerometer)
- Time (Hammer)
- Time Weighting (Accelerometer)
- Time Weighting (Hammer)
- 27. Add the 4 groups, right click on each and select properties.

Time(Accelerometer) - In	put 💶 🔁
Function	
Protection:	Follow Measurement Mark
Not Protected	Input 💌
- Eunction	Туре
Time	▼ Standard ▼
<u>S</u> ignal	
Accelerometer	
Source Template	<u>M</u> easurement
Working 💌	Input 💌
<u>A</u> nalyzer	<u>B</u> uffer
FFT Analyzer 💌	Input 🔹

- 28. Select the appropriate function and signal for each.
- 29. For the two Time Weighted functions select the time weight tab and chose Use Signal Weighting.
- 30. Close the box and activate the template.
- 31. Create classic displays for the first two Time Functions.



32. Create a new task in the task bar called Time Weighting and arrange similarly to the display task already created, showing the displays of Time (Accelerometer) and Time (Hammer).



- 33. Activate the template.
- 34. Click the run button and tap the beam with the hammer. Click the Stop button. The time signals should show up like this. The graphs may need to be scaled, if so right click on the graph and select properties. Under the Y Axis tab click Autoscale. Alternately the use of the shortcut keys F10, Ctrl+F10 or Alt+F10 with different Autoscale options.

	🖻 🖻 🖉 🖸	? 🕅 🏛					₽₽	R. #	# A.	🛛 🏠 I	🗉 🔡 🔽	41 1	12 13	4	0 👿	<b>11</b>	1	⊱ ↓ 1	• I 🗸
ist 📘	🦶 Time Weightin	(Acceleromete	er) - Input																
<b>-</b>	[m/s²]							Т	ime(Accel	erometer) ·	Input								
ation	80 T I	1		1			ĩ	Worki	ng:Input:	Input : FF1	Analyzer	1		1		1	1		
	60			_															
	40													الباني	1.1.1				il di
ay 1	40										li li la			hh		its ht	l da da	hilduli	i di katala
<b>•</b>	20-									UN '988	040111	1949	WW	1911	1983	0,4040	u in dili	P M M M 1	1.1
e tina	0									1.11	di Kila	المالية ا	il dil '	i I' I Ii		f P.J.Yi	i KA M	. Mili	Шh.
	-20									- 11 - 11		inii uu	i bi bi bi						n d d d
	-40			-			-			1111	1.11.4166	11.1411.	1111	li ti li ti.	ant ta t	1.11	u da		h li ti ku
	-60			_						1.1	41.11	11 1	1.1	5.101			<u> </u>	_	
	-80																		
	0 40r	80m 120	lm 160m	200m 24	0m 280m	320m 3	60m 40	0m 440r	n 480m	520m	560m (	600m 64	0m 680	)m 720	n 760	m 800m	840m	880m 5	920m 96
H	Timo Woightin	(Hammor) In	put							[9]									
- Iĉ	[m/s²]	(numiner) in	puc						Time(Ha	mmer) - Inp	ut								
								Worki	ng : Input	Input : FF	l Analyzer								
	200																		
	150																		
	100			-															
							-										_	_	-
	50																		
	50								_										
	50																		
	50 0 									1						-			-
	50 0 -50 -100																		
	50 -50 -100 -150																		

35. Right click on each graph and select properties. Under the function tab select Time Weighting (Accelerometer) for the first graph and Time Weighting (Hammer) for the second. The two properties boxes should look like this.

🖥 Time Weighting(Accele 💶 🗖 🗡	📙 Time Weighting(Hamm 💶 🗖 🗙
Cursor Options1 Options2 Color Function X-axis Y-axis Z-axis	Cursor Options1 Options2 Color Function X-axis Y-axis Z-axis
Function Group	Function Group
Function Group	Function Group
<u>F</u> unction	Eunction
Coherence(Hammer, Accelerometer) Erequency, Besponse, H1(Hammer, 4	Coherence(Hammer,Accelerometer)
Time Weighting(Accelerometer) - In	Time Weighting(Accelerometer) - In
Time (Accelerometer) - Input	Time Weighting[Hammer] - Input Time(Accelerometer) - Input
Time(Hammer) - Input	Time(Hammer) - Input
	Coordinate
Real Part	Real Part 🗾
Spectral Unit	Spectral Unit
Acoustic Weighting iw Weighting	Acoustic Weighting weighting
<b>Y Y</b>	<b>Y Y</b>
<u>G</u> raph Type	<u>G</u> raph Type
Curve	Curve

36. This will allow the time weighting function to be viewed over the time signal it will be weighting, allowing the weighting function to be adjusted to fit correctly. Notice that the zero value for each are not lined up. To change this click on the Y Axis tab and change the minimum value to −1. Use the graphs to tune the Shift and Length values of the transient window and the Shift and Tau values for the exponential window. The transient window should cover the length of the force impulse. The exponential window should start just before the accelerometer signal and decay to zero before the end of the time record to avoid overlap error.



A measurement can now be taken.

37. Click on the Display tab and activate the template. Click on the start button.

38. Take three successive measurements; making sure the beam has stopped vibrating before the next measurement is taken and that the hammer strikes the same spot each time. The proceeding of the measurement is displayed on the right side of the curve where the number of averages increases.



The FRF and Coherence displays should look something like this.



39. The coherence is a measure of how similar each of the averages are and it can be used as a check to see whether the measurement is good or bad. At each of the resonances the coherence should be 1 as this is where the signal is the strongest. However at the anti-resonances it is expected that the coherence will drop as the signal is now not as strong and is being significantly influenced by noise in the system. 40. Now for example it may be important to zoom in on the resonance at 275 Hz and look at it with a greater resolution. To do this right click on the FFT Analyser in the Measurement Organiser and select properties. Change the analysis mode to Zoom and change the centre frequency to 275 Hz. Change the number of lines to 800 and change the span to 200 Hz. This has increased to resolution to 4 lines per Hz.



- 41. Notice how good the coherence has become; there isn't a drop now at the antiresonance at 215 Hz.
- 42. Sometimes after pressing the 'Start' button, it stops automatically after few seconds, in this case press the 'Proceed' button to carrying on measuring. To avoid this the trigger can be reactivated in the 'Setup' as shown before

# Setting up a new transducer

Setting up a new transducer under Pulse can be a useful task. While many B&K products are already in the Transducer database, many non-B&K products are not. The transducer database does not also readily support combining instruments, such as a 2635 Charge Amplifier and an accelerometer, which is still in use in many laboratories. By using adding these new combinations to the transducer database, it is easy to use any combination of transducers with Pulse.

In this example an entry will be made for a 4394 Accelerometer connected to Pulse via a 2635 Charge Amplifier.

1. The first step in adding a new equipment setup to the Pulse Transducer database is to select 'Configuration' → 'Transducer Database'.



2. This will open the 'Database Administrator' window. Select 'Edit/Add' to add a new transducer setup.

Database Administrator	×
Transducer	Store Clear Close
Nom Sensitivity: Type: CCLD: Nom Sensitivity: Name: CCLD: Name: Nom Sensitivity: CCLD: Name: N	Transducer Type Edit / Add Read Transducer
Pol. Volkage: L Description: This is a comment field	Find Read History Correction Curve Curve:
A sur fit of Collection	
Sensitivity: Capacitance: Time:	800m -
This is a comment field	400m -
Cocal Caloration Sensitivity: Capacitance: Time:	0 400m 800m This is a comment field
This is a comment field	

3. This will open the 'Edit / Add Transducer Type'. Select 'Accelerometer' from the 'Family' drop-down list.

Edit / Add Transd Transducer	ucer Type	×
Family:	Microphone 💌	
Туре:	Accelerometer Auxiliary	
Nom.Sensitivity:	Coupler Force	
Sensitivity Unit:	Hydrophone	
CCLD powered	Photocell	
Pol. Voltage		
Description:		
OK	Remove Cance	ы

4. Type a name into the 'Type' edit box. In this case '4393+2635'.

Edit / Add Transdu	cer Type 🛛 🗙
- Transducer	
Family:	Accelerometer
Туре:	4393+2635 💌
Nom.Sensitivity:	
Sensitivity Unit:	
CCLD powered	
Weight:	9
Description:	
ОК	Remove Cancel

5. Enter a 'Nom. Sensitivity' and 'Sensitivity Unit' for this combination. When a 2635 is used, the sensitivity can be set using the dials on the front of the unit. In this case select a 'Nom. Sensitivity' of 10 and a 'Sensitivity' of 'mV/ms^-2'. The weight of the accelerometer can be found on the calibration sheet provided with all accelerometers. In this case a 4393 Accelerometer weighs 2.4g. A description can be added if desired.

l	Edit / Add Transd	ucer Type 🔀
.[	Family:	Accelerometer 💌
	Туре:	4393+2635
l	Nom.Sensitivity:	10
	Sensitivity Unit:	mV/ms^-2
	CCLD powered	
	Weight	2.4 9
1	Description:	
	ОК	Remove Cancel

Note: The sensitivity setting on the 2635 Charge Amplifier should be as shown in the picture below. The 'Transducer Sensitivity' is taken from the accelerometers calibration data sheet, given in  $pC/m/s^2$ . In case of the Hammer the sensitivity is given in pC/N and this value has to be reported without any changing. The red LED indicates the decimal point and is adjusted with the 'Transducer Sensitivity' switch. The Charge Amplifier sensitivity or the sensitivity as seen by the analyser that the charge amplifier is connected to is changed by altering the 'mV/Unit Out' dial. A default value of 10 mV/Unit is already set in the pulse for the accelerometers and hammer used. In case that the overload LED is activated, this values has to be lowered and consequently the set up value has to be changed as shown in point. 5 above. Generally a high value of the output is desirable to maximize the Signal/Noise ratio. The high and low pass filters are set using the lower two dials. The output can also be integrated with respect to time to provide a velocity or displacement signal, though it should be noted that some error can be introduced by integrating the signal as any noise in the signal is also integrated and can cause the signal to drift from a zero mean level. Set the High Pass Frequency filter to  $m/s^2$  and value of 2 Hz



#### For the Hammer Type 8202

Batt. Transducer Sens. pC/m/s <sup>2</sup>	Calibration C Impact Hamm Serial No	hart for her Type 2.3/9 s Force T 2.2.5 6 ibration put of her	ransducer T 9.2 narti nort of appr	Vierum Denmark
	For Rar (N	rce nge I)	Duration Range (ms)	Approx. Frequency Range (-10 dB) (Hz)

For the Accelerometer Type 4393



6. Click 'Ok' to apply the changes. Note that Remove can be used to remove a transducer from the Transducer Database. Also click the 'Close' button in the top right hand corner of the 'Database Administrator' window. The transducer is now setup and ready to use in a template.

# Exporting measurements

Once measurements are taken, post-processing or storing of the information outside of the Pulse Labshop file is often needed. Pulse allows measurement data to be saved in various locations and with different file formats. How and what method should be used is obviously dependant on the final use. Two examples of note which may determine how you export the data are: modal analysis where another software system will be used for processing of the measurement data such as MEScope. In this instance it is advantageous to use the bulk save and file format given by Pulse in the configuration window. The other notable time is when you would like to output data in the same units as displayed on the graphical output. Individual measurements can be saved like this through right clicking the graph and "save as".

However the most common post-processing of data occurs with the use of matlab. Exporting data in a manner able to be easily accessed in matlab will be explained in the following section.

## Adding a measurement Mark

If multiple batches of measurements are to be taken with the same setup, then they can all be saved in the same Pulse Labshop project file. The save measurements can later be reviewed or exported separately by the use of measurement marks.

1. To save a current measurement, go to the Measurement Organiser and right click the "input" measurement and save.



2. Now you can add a measurement mark to the saved measurement by right clicking and selecting "Add/Remove Measurement Mark" from the menu. In this case we will add "Mark 1".



- 3. The saved measurements can now be made available for viewing or export by allowing the Function Organiser to follow the measurement mark. (By default the Function Organiser follows the current measurement in progress, being "Input").
- 4. Right click the "Function Group" and select Properties.



5. Select "Mark 1" from the drop down menu

🛱 Function Group		
Function		
Protection:		Follow Measurement Mark
Not Protected	-	Mark 1
- Eunction		None
		Input Current
Signal		Mark 1
	-	Mark 2 Mark 3
1000		
Source		Messurement
Working	<b>_</b>	
Analuzar		Puffer
[FFT Analyzer		Input

6. You will now notice that the Function Organiser follows measurement mark "Mark 1"

Function Organiser
🖃 📳 Function Organiser
E Function Group
Autosperfrum(acc) - Mark 1     Ime(acc) - Mark 1     Ime(acc) - Mark 1     Ime(acc) - Mark 1     Ime(acc) - Mark 1

## Export to Matlab (fast way for small data)

A simple way of exporting data is to right click on a curve already plotted, Save Active Curve. This command will save in a .txt file



once saved the file can be easily edited, cutting the information up and down the file so that it can be used straight away in Matlab. The file will have 4 columns with the following data:

Order number X axis value Y value (real part) Y value (complex part)

File Ed	it Format Help		
1	6_00000000000+000	8.57261e-004	0_0000e+000
2	5_0000000000000000000000000000000000000	9.480310-004	2.52591e-004
3	1.000000000000+000	1.14791e-003	3.83554e-004
4	1.5000000000e+000	1.35919e-003	3.72136e-004
5	2.0000000000e+000	1.47807e-003	2.39441e-004
6	2.5000000000e+000	1.44728e-003	1.18171e-004
7	3.0000000000e+000	1.36889e-003	1.08240e-004
8	3.5000000000e+000	1.34107e-003	1.68972e-004
9	4.0000000000e+000	1.38092e-003	2.36026e-004
10	4.5000000000e+000	1.47069e-003	2.60454e-004
11	5.0000000000e+000	1.56250e-003	2.18468e-004
12	5.5000000000e+000	1.60790e-003	1.30365e-004
13	6.000000000e+000	1.59244e-003	4.89615e-005
14	6.500000000e+000	1.55523e-003	1.20085e-005
15	7.000000000e+000	1.54193e-003	2.44582e-006
16	7.5000000000e+000	1.55570e-003	-2.46561e-005
17	8.000000000e+000	1.55603e-003	-8.63048e-005
18	8.500000000e+000	1.51692e-003	-1.52203e-004
19	9.000000000e+000	1.45199e-003	-1.92262e-004
20	9.5000000000e+000	1.38689e-003	-2.03020e-004
21	1.0000000000e+001	1.33380e-003	-1.96764e-004
22	1.050000000e+001	1.29646e-003	-1.82460e-004
23	1.1000000000e+001	1.27765e-003	-1.74448e-004
24	1.1500000000e+001	1.26120e-003	-1.89272e-004

## Export to matlab (recommended method)

Exporting data to matlab can be done in various ways. A method for exporting when the data is to be processed on a computer which you are not running the Pulse Labshop software from is discussed in this section. This is the recommended method to use for exporting to matlab as it works irrespective of the software installed on the computer used for further analysis. See the next section for a slightly different and easier method when using matlab on the same computer as the Pulse Labshop software is running.

1. Open the component organiser, as shown or with the shortcut key Ctrl+9



2. Now select the bridge to matlab option from the component organiser

3.



4. Upon selecting the bridge to matlab option a window should open as shown. The measured signals arranged into function groups are shown on the left hand side. Any combination of measured signals may be exported by selecting the check boxes, however here we will export all the signals being the autospectrum(acc) and time(acc).



5. After the desired signals for export are selected a folder to which they will be exported to needs to be given, in this case a folder called "test" was added to the C:\ directory to which we will export our measured signals, also the radio button "do nothing" is selected.

Bridge to MATLAB	
Functions          Image: Constraint of the second	Export  PIDESE ASCII File destination path  C:Vitest  Backwo existing files  When files are generated  Do nithing  Import data into MATLAB  Import data into MATLAB  Do not overwrite MATLAB variables

- 6. Once these selections have been made, click the export button.
- 7. Now it can be seen that our folder C:\test, contains two new files, one a text file containing our measured data, and the other a matlab m-file. There is only ever one m-file with the name "BKFiles.m", but depending on the combination of signals being exported the number and name of the text files may change, but this will not be a problem as the same steps can be followed in either case.

🔁 test				
File Edit View Favorites Too	ls Help			
🖙 Back 🔹 🤿 👻 🔯 Search	🔁 Folders	🎯 🕾 🥸	$\times$	5
Address 🛄 test				
test	BKFiles.m	Function Group.txt		
Select an item to view its description. See also: <u>My Documents</u> <u>My Network Places</u> <u>My Computer</u>	_			

- 8. Now transfer the folder C:\test to the computer you wish to undertake the matlab post-processing in and open matlab
- 9. Once matlab is open, make the copied test folder as the matlab working directory



10. As we are assuming that the signals will be analysed on a different computer to the one which has the Pulse software installed, one more step needs to be followed. Open a new m-file in the current working directory, in this case C:\test.



11. Copy the contents of Appendix B, into the created m-file called and save as "GetPulseAsciiFile". This file serves in-place of the GetPulseAsciiFile.dll file which is only available when the Pulse Labshop software is installed.



12. In the matlab command window type "BKFiles", the workspace will now contain three different files. The measurement data is located in the structural array file type

AMATLAB					_ 🗆
File Edit View Web Wir	ndow Help				
🗅 😂   X 🖻 🛍 🗉	a 🖂 🚺 🗌	? Current	t Directory: C:itest		<b>_</b>
Workspace			X 5	Command Window	5
😂 🛃 📑 📑 Sta	ok: Base 💌			>> BKFiles	
Name	Size	Bytes	Class	<i>"</i>	
🚼 BKFilenames	2x1	184	cell array		
BKIndex			double array		
E Group1	1×1	1033058	struct array		
Coroupi	111	1000000	Scruce dridy		
Workspace C	urrent Directory				
Command History			X 5		
				1	

13. Now if you are familiar with structural array file types in matlab you will be able to interrogate and find all the measured data information within this file. However if you are not familiar with structural arrays and wish to obtain the measurement data in a more familiar format containing only numerical values, copy and paste the matlab script in Appendix A, into the matlab command window and press enter.

14. Three new files will appear in the matlab workspace, being name\$, data\$ and x\_axis\$ with the \$ ranging from 1 through to the number of measurement signals that were exported, in this case 2. The file named name\$ is the name of the measurement signal in Pulse, data\$ contains the measured data values and x\_axis\$ contains the x-axis range of the corresponding data\$.

A M	TLAP					
File F	Fdit View Web Win	dow Help				
		) (a   🚺		Directory: C: test		
Works	pace			× 5		
<b>2</b>	🖬 🛛 🛐 🛛 🗊 Stad	c Base 💌				
Name	:	Size	Bytes	Class		
B	KFilenames	2x1	184	cell array		
B	KIndex	1x1	8	double array		
- <b>E</b> G	roupl	1x1	1033058	struct array		
E a		1x5	1031414	struct array		
Eb		1x1	263066	struct array		
<b>∎</b> d	atal	1x16384	131072	double array		
<u>⊞</u> d	ata2	1x16384	131072	double array		
abo n	amel	1x27	54	char array		
abo n	ame2	1x17	34	char array		
	_axisl	16384x1	131072	double array		
<b>I</b> ⊞×	_axis2	16384x1	131072	double array		
				•		
	Workspace Cu	rrent Directory				

15.

#### Exporting to matlab on the same computer as Pulse is running

- 1. Follow steps 1-3 from the following section
- 2. Select the "import data into matlab" radio button and the file folder to be exported to, being in this instance C:\test and click export

Bridge to MATLAB	
Functions ☐ I All PULSE Function Groups ☐ I Function Group ☐ Autospectrum(acc) - Input ☐ Time(acc) - Input	Export  PUESE ASUI File destination path  C:\test  Backup existing files  When files are generated  Oo nothing  (minort data into MATLAB)  minort data into MATLAB  minort data into MATLAB and run this m-file  Do not overwrite MATLAB variables

3. The matlab command window will now be open, although it looks like nothing has happened the data will now be in the matlab workspace. Type the command "desktop" into the maltab command window to view the matlab working environment in the default configuration, displaying command window and workspace etc.



4. Now follow steps 12 and 13 from the previous section.

# Time Capture Analysis

If further signal processing of measured signals is needed outside of the Pulse Labshop environment, then the raw time record data will usually need to be captured and exported. Outlined within this section is how to set-up the "Time Capture Analyzer".

1. Right click "setup" in the Measurement Organiser and insert the "Time Capture" module.



2. Now right click the "Time Capture Analyzer" and insert the signal groups you would like to measure.



3. Right click "Time Capture Analyzer" and select properties. The time capture set-up menu will now be visible. From this menu; the frequency span, track length and trigger conditions can be selected. We will select the max frequency span for this analyzer, 25.6kHz and a record length of 1 s. (If the combination of frequency span and track length is too large for the RAM size on the computer that is being used, the time record can be written directly to the hard drive. This method is not currently explained in this document)

🛗 Time Capture Analyzer	
Set-Up	
Frequency Use Wave Span Span: 25.6k Hz	Max. Track Length:
Trigger <u>S</u> tart: Free Run	<b>I</b>
Stop: Stop At End	

4. Now move to the Function Organiser and right click the "Function Group" and click Insert.

Ctrl+R
Ctrl+R
Ctrl+R
Ctrl+R
•
+
-

5. Right click and select the properties of the inserted signal, and change the Analyzer to "Time Capture Analyzer" and the function to "Compressed Time" in the available menu. (At the moment only the compressed time is in the function organiser, the compressed time displays less data points and should be the function used when viewing the time captured data, however the expanded time sub-function will need to be inserted so that the full time capture data is available for exporting)

🛱 Compressed Time(acce	elerometer casing) - In 💶 🔲 🗙
Function Expand	
Protection:	Follow Measurement Mark
Not Protected	▼ Input ▼
- Eunction	Туре
Compressed Time	▼ Standard ▼
Signal	
accelerometer casing	<b>▼</b>
Source	
Lemplate	Measurement
Working	💌 airoff500rpm 💽
Analuzer	<u>B</u> uffer
Time Capture Analyzer	▼_nput ▼

6. Right click the inserted compressed time function and now insert a "Sub Function"

Function Organiser		
E-		
E Function Group		
Compressed Time(accel	erometer casing) - Innut	
	Expand All	
	Collapse	
	Edit Label Ctrl+R	
	Insert 🕨	Sub Function
	Delete	Slice
	Properties	Interpolation
	Сору	
	Paste	
	Play	
	Save 🕨	
	Show as	-
-		-

7. Once again right click the inserted compressed time function and select properties, the properties menu will now have another tab labelled "Expand" select this tab and de-select 2<sup>n</sup>-width radio button, and set the "Width" to the same time amount as entered in step 3.

🖥 Compressed Time(accelerometer casing) - In 📃 🔲 🗙
Function Expand
Time Selection
Align with Delta Cursor
Start: 0 s Width: 1 s
☐ <u>R</u> elative X-axis
☐ <u>M</u> ulti-buffer

8. The time captured data is now able to be displayed or exported as has been done with other Functions previously. (Don't forget to press "F2" to update the project file).

# Why is the time record 2.56 times longer than the selected frequency span?

When exporting time capture data you will notice that the record length is 2.56 times the frequency span that was selected for the analyzer. For instance if a frequency span of 25.6kHz, 1 second track length is selected, then the length of time record might be expected to be 25600 samples in length however it will be noticed that it is indeed 65536 samples long, i.e. 1 second of data sampled at 65.536kHz. The time signal is actually sampled at 2.56 times the frequency span selected, in order to allow for the anti-aliasing filter signal distortion and comply with the sampling theorem. Therefore the selected frequency span indicates the useful frequency range of the data, and if exported for later processing it needs to be kept in mind the sampling frequency is 2.56 times that of the frequency span.

# Where to find more information

• Pulse demonstration videos, <u>http://www.bksv.com/Products/PULSEAnalyzerPlatform/PULSEDem</u> <u>onstrationVideos.aspx</u> (a nice feature shown in one video is the ability to have live measurements displayed in excel.)

# Appendix A:

```
for i = 1:length(BKFilenames)/2;
a = struct2array(eval(char(BKFilenames(i*2))));
if length(a)<2;</pre>
    n = a.('Name');
    eval(['name' num2str(i) '=n;']);
    b = a.('DatasetSection');
    c1 = b.('Data')(1:end);
    c2 = b.('X_axis')(1:end);
    eval(['data' num2str(i) '=c1;']);
    eval(['x_axis' num2str(i) '=c2;']);
else
    for j = 1:length(a);
        n = a(j) \cdot ('Name');
        eval(['name' num2str(j) '=n;']);
        b = a(j).('DatasetSection');
        c1 = b.('Data')(1:end);
        c2 = b.('X_axis')(1:end);
        eval(['data' num2str(j) '=c1;']);
        eval(['x_axis' num2str(j) '=c2;']);
    end
end
end
```

# Appendix B: GetPulseAsciiFile.m

```
function kk = GetPulseAsciiFile(BKFilenames1)% function input is the
file name
for i = length(BKFilenames1):-1:1 % loop through and remove any
leading file directories from the file name
if BKFilenames1(i) == '\'
break
end
BKFilenames(i) = BKFilenames1(i);
end
BKFilenames = nonzeros(BKFilenames)';
fid = fopen(BKFilenames, 'rt');% open file
line = fgetl(fid);% get first line of file
d3 = sscanf(line, '%s');% print lines of file to d3 variable
while isempty(d3) % loop through until a line with text is found
      line = fgetl(fid);
      d3 = sscanf(line, '%s');
end
z3 = 0;
while line ~= -1;% loop through until final line of file ie. line=-1
    clear d3;
    d3 = sscanf(line, '%s');% print non empty elements to d3
variable
    c = str2double(d3(end-1:end)); % grab header line number from
first line of header section in file
    d1 = d3;
    for j = 2:length(d1);
        field(j-1) = d1(j-1);
        if field(j-1) == '-';
            field(j-1) ='_';
        end
        if d1(j) == ':';
            break
        end
    end
    value = d1(j+1:end);
    Attributes.(eval('field')) = value;
    ii = 0;
    for i = 1:c-1
        line = fgetl(fid);
        clear d3;
        d3 = sscanf(line, '%s');% print non empty elements to d3
variable
        if ~isempty(d3)
        for j = 2: length(d3);
            field(j-1) = d3(j-1);
            if field(j-1) == '-';
               field(j-1) ='_';
            end
            if d3(j) == ':';
            break
            end
        end
        value = d3(j+1:end);
        if length(field) == 10;
            if field == 'X_Axissize';
                s1 = str2double(value);
            end
```

```
Appendix B: GetPulseAsciiFile.m
Page 56 of 57
```

```
end
        if length(field) == 5;
            if field == 'Title';
                y3.Name = value;
            end
        end
       Attributes.(eval('field')) = value;
       clear field;
       clear value;
        end
    end
    data = [];
    z = 0;
    while isempty(data) || (nxtindex==1)
        z = z + 1;
        line = fgetl(fid);
        f1 = sscanf(line, '%f');
        f = sscanf(line, '%s');% print non empty elements to f
variable;
        if isempty(f1)
            if ~isempty(f)
                for j = 2:length(f);
                     field(j-1) = f(j-1);
                     if field(j-1) == '-';
                        field(j-1) ='_';
                     end
                     if f(j) == ':';
                        break
                     end
                end
            value = f(j+1:end);
            DatasetSection.(eval('field')) = value;
            clear field;
            clear value;
            end
        end
        [data, ncols, errmsg, nxtindex] = sscanf(line, '%f');
    end
    data = [data; fscanf(fid, '%f')];
    line = fgetl(fid);
    z1 = 0;
    TagScale1 = [];
    if line(1:9) == 'Tagsbegin';
         for i = 1:length(line);
            field(i) = line(i);
            if line(i) == ':';
            break
            end
         end
        while isempty(TagScale1)
            z1 = z1+1;
            f = cellstr(line);
            line = fgetl(fid);
            if length(line)>14;
                 if line(1:14) == 'TagScalesBegin';
                     TagScale1 = line;
                end
            end
        end
    end
    z^2 = 0;
```

```
k = [];
    while isempty(k)
        z^2 = z^2 + 1;
        f = cellstr(line);
        m(z2,:) = f;
        line = fgetl(fid);
        if line(1:12) == 'TagScalesEnd';
                k = line;
        end
    end
    m(z2+1,:) = cellstr(k);
    SpecialSection = m;
    line = fgetl(fid);
    eval('data = reshape(data, ncols, length(data)/ncols)'';', '');
    DatasetSection.Data = data;
    while isempty(line)
        line = fgetl(fid);
    end
    z3 = z3+1;
    y3.Attributes = Attributes;
    y3.DatasetSection = DatasetSection;
    y3.SpecialSection = SpecialSection;
    eval(['Function', num2str(z3), '=y3;']);
end
for i = 1:z3;
    kk.(['Function' num2str(i)]) = eval(['Function' num2str(i)]);
end
fclose(fid);
end
```