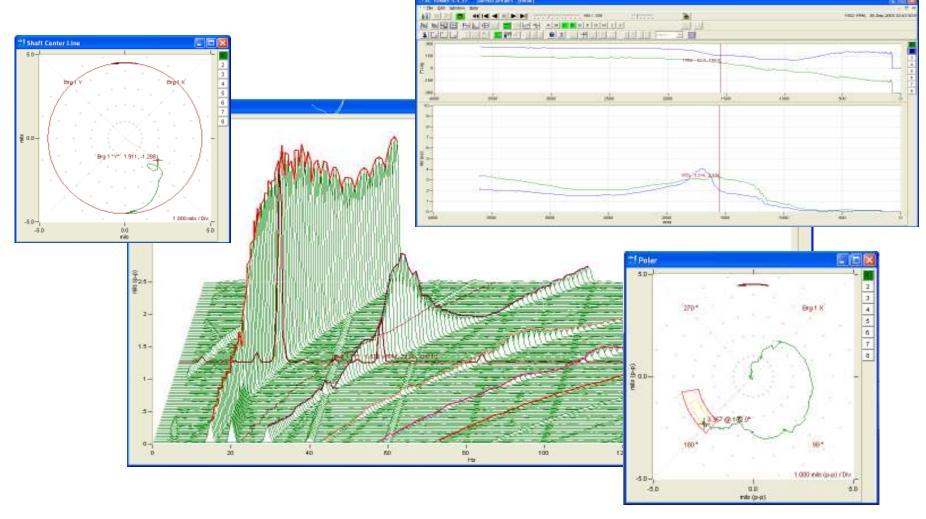


Vibration Seminar, Melville

January 22, 2008





Vibration Seminar, Melville January 22, 2008

- Presenter :
 - Jack Field, Regional Sales Manager, IOtech Inc.
 - Certified Vibration Analyst, Category III
 - Don Link Contech Marketing
 - Anthony Yackovich Contech Marketing



Session Goals

HAVE SOME FUN!!

Learning (and teaching) is far too important to be taken <u>too</u> seriously

If we are all miserable, none of us (your instructor included) will learn a flippin' thing!



Vibration Seminar, Melville January 22, 2008

Machinery Vibration Basics Sensor Considerations Data Acquisition Requirements Data Recording Signal Analysis IOtech Hardware & Software Solutions



What is Vibration?

- The OSCILLATION of an object about an EQUILIBRIUM position
- The RESPONSE of a structure to FORCE



What are the Components of Vibration?

- Amplitude
 - Maximum value of vibration
- Frequency
 - Number of events or cycles per unit time
- Phase
 - Time relationship between vibrations of the same frequency

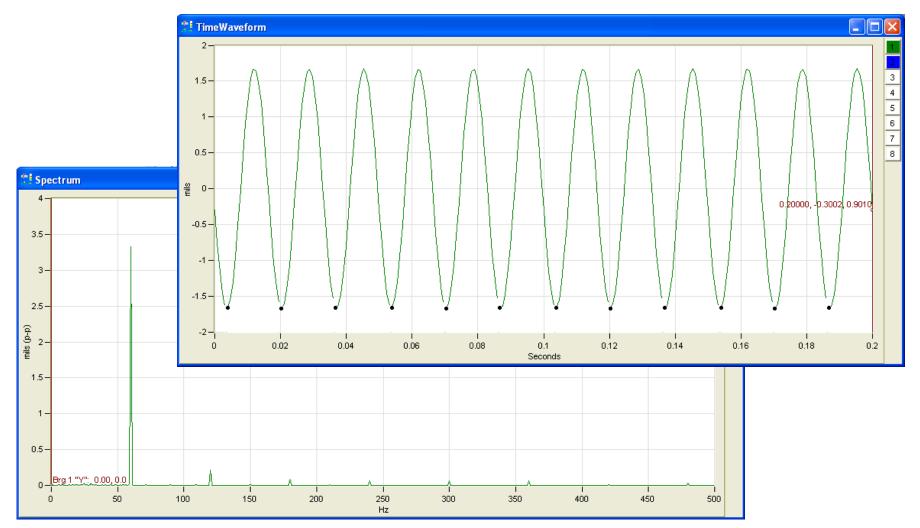


Types of Vibration

- Harmonic
- Periodic
- Impulsive
- Pulsating
- Random

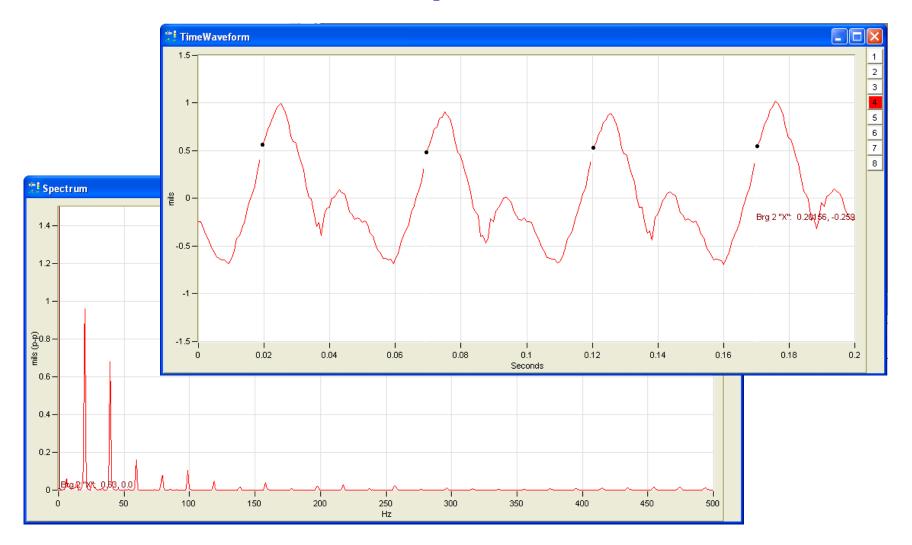


Harmonic Frequencies



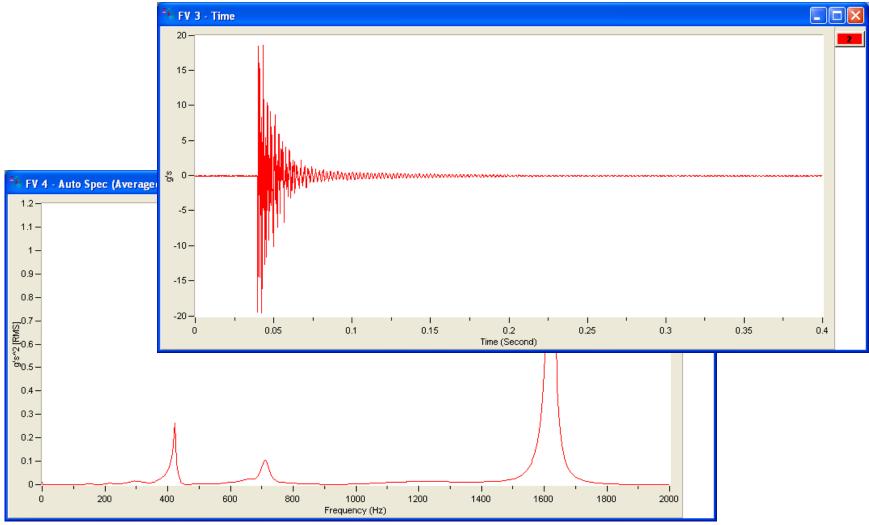


Periodic Frequencies



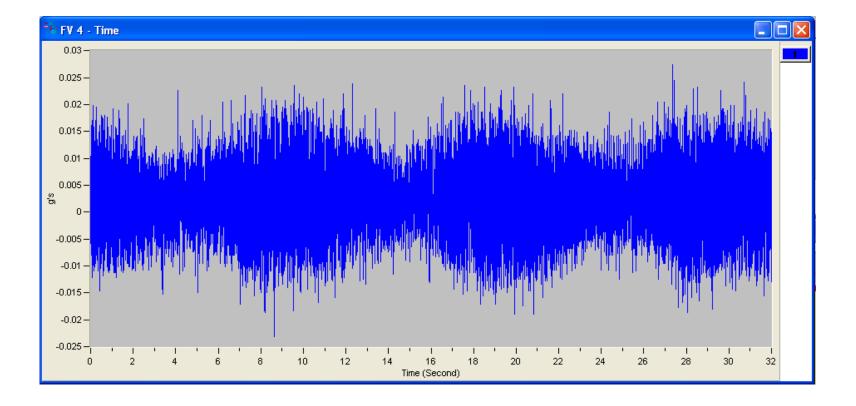


Impulsive / Impact Frequencies



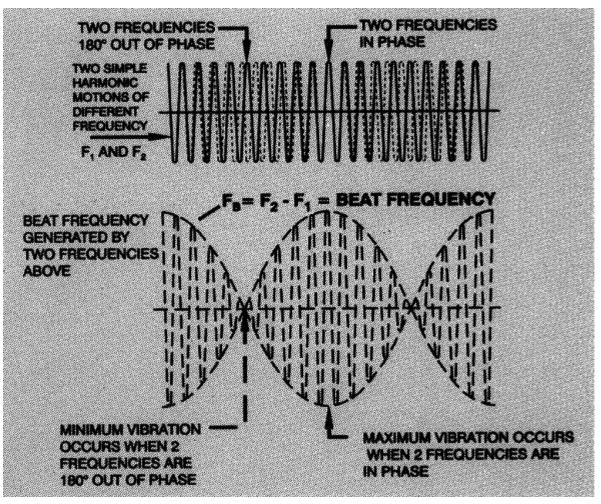


Pulsating / Beat Frequencies





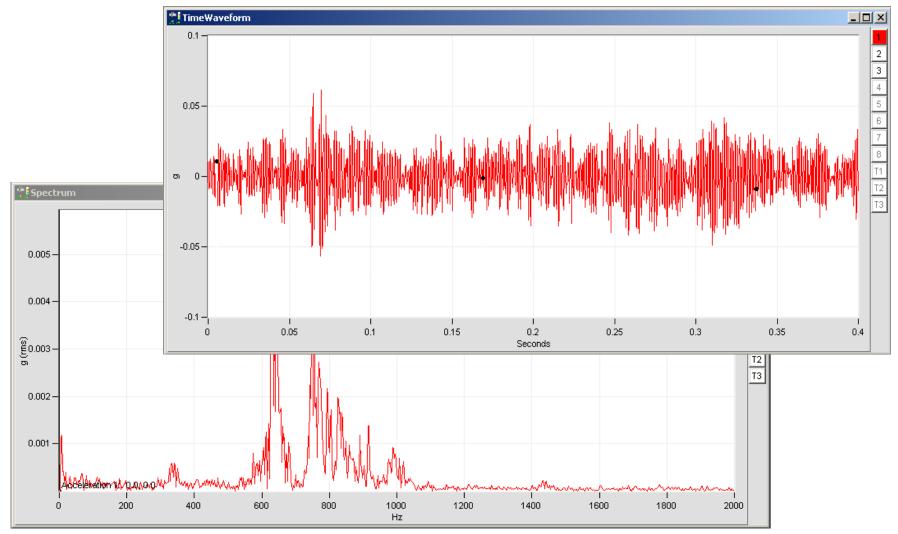
Pulsating / Beat Frequencies



Credit: Technical Associates of Charlotte, Table 1 Vibration Diagnostics Chart



Random Frequencies





Vibration Sources Natural Frequencies / Resonance

- Machine Design Induced Natural Frequencies
 - Machine Structure
 - Mass and Stiffness
 - Damping
- Resonance
 - When a forcing frequency excites a natural frequency
 - In rotating machinery, "Critical Speed"



Vibration Sources Forcing Frequencies

Machine Design

Machine Faults

- Universal Joints
- Asymmetrical Shafts, Cams
- Gear Mesh
- Couplings
- Bearings
- Pumps & Fans
- Reciprocating Machines
- Motors / Generators

- Mass Unbalance
- Misalignment
- Bent Shaft
- Mechanical Looseness
- Casing / Foundation Distortion
- Bearing Faults
- Motor Faults



How is Vibration Measured?

- Primitive, Qualitative Methods / Senses
 - Can you actually SEE movement?
 - Can you *HEAR* something different?
 - What does it FEEL like?
 - Does it *SMELL* funny?
 - TASTE? (not really recommended!)
- Don't ignore what your body tells you!



How is Vibration Measured?

- Better, Quantifiable Methods / Amplitude
 - Movement / Displacement
 - Speed / Velocity
 - Acceleration



Sensors

- Physical Movement / Displacement
 - Proximity Probes
- Velocity / Speed
 - Velocity Transducers
- Acceleration
 - Accelerometers

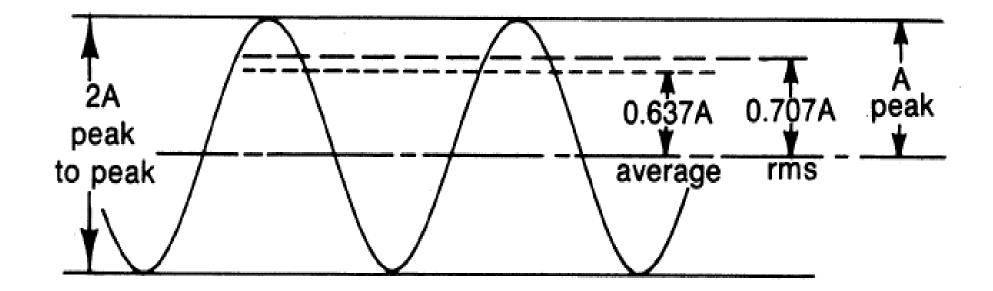


Vibration Units

- 'English' Units
 - Pounds (lb) / Inch (in.) / Second (sec)
 - Displacement in mils, 1 mil = 1/1000th Inch
 - Peak-to-peak measure
 - Velocity in Inches per second (in/sec or ips)
 - Peak or RMS measure
 - Acceleration in g's, 1 g = 386.1 in/sec²
 - Peak or RMS measure



Measures Peak to Peak, Peak & RMS

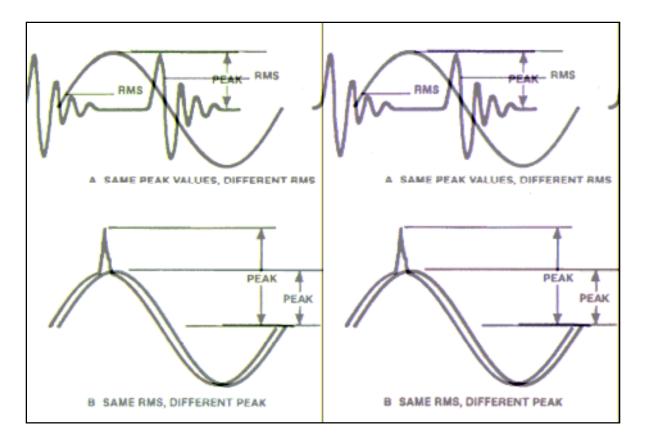


Credit: John S. Mitchell, Machinery Analysis and Monitoring 2nd edition



Measures Peak vs. RMS

Calculated RMS Only Valid for Harmonic Waveforms



Credit: John S. Mitchell, Machinery Analysis and Monitoring 2nd edition

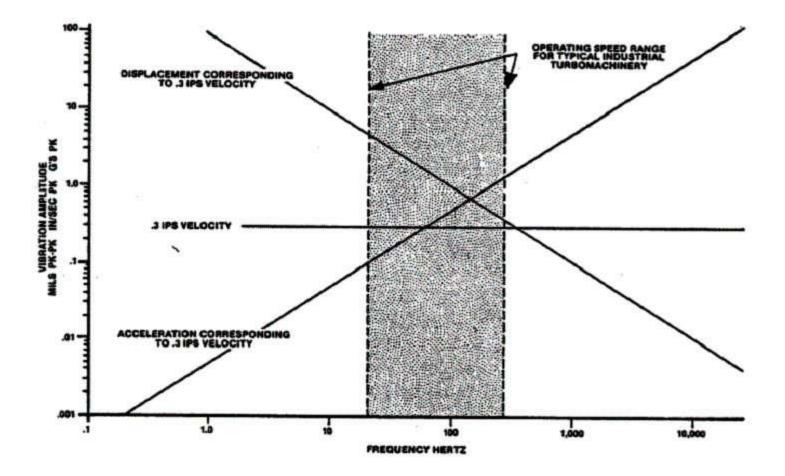


Frequency / Rotational Units

- Vibration Frequencies are expressed as:
 - Cycles per Minute (CPM) or
 - Cycles per Second (HZ)
- Machine or Shaft Speed:
 - Revolutions per Minute (RPM)
- Phase is expressed as:
 - Degrees, 360 degrees per revolution.
 - May also be expressed as Leading or Lagging



Frequency Range Relationships



Credit: John S. Mitchell, Machinery Analysis and Monitoring 2nd edition



Relationship of Amplitude, Velocity & Frequency

Any Quantity can be Calculated If the remaining two Quantities are Known



Oh man... MATH??

- Mathematical Relationships / Displacement to Velocity
 - V = (2 π f) D
 - V = Velocity in Inches per second (ips)

• π (pi) = 3.14159 (or, the button on your calculator)

- f = Frequency in Hz
- D = Displacement in mils <u>peak</u>



Worst... Algebra!

Mathematical Relationships / Velocity to Displacement

•If... V = (2 π f) D

•Then... $D = V / (2 \pi f)$

Velocity to Acceleration

•A = (2 π f) V / 386.1

Acceleration to Velocity

•V = A * 386.1 / (2 π f)



And Finally...

Mathematical Relationships / Acceleration to Displacement

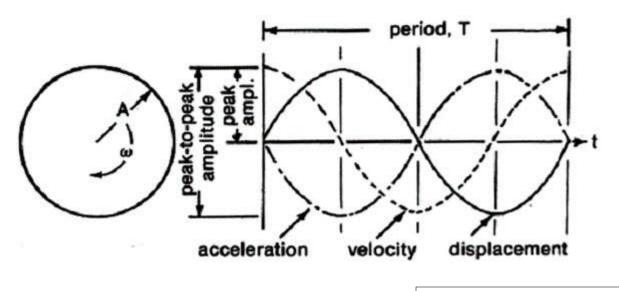
A = D (2 π f)² / 386.1
D= A * 386.1 / (2 π f)²

(we're done now... you can all relax!)



Rotation and Phase Relationships

- Expressed on Degrees, 360 degrees per cycle
- Displacement Leads
- Velocity Lags Displacement by 90°
- Acceleration Lags Velocity by 90 & Displacement by 180°



Credit: John S. Mitchell, machinery Analysis and Monitoring 2nd edition



Machine Vibration Measures

MEASURE	USEFUL FREQ. SPAN	PHYSICAL PARAMETER	APPLICATION
Relative Displacement (proximity probes)	0-1000 Hz	Stress / Motion	Relative Motion in bearings / casings
Absolute Displacement (seismic)	0-10 Hz	Stress / Motion	Machine Condition
Velocity (seismic)	10 – 1000 Hz	Energy / Fatigue	General Machine Condition, medium- high frequency vibrations
Acceleration (seismic)	> 1000 Hz	Force	General Machine Condition, medium- high frequency vibrations



Machine Design Vibration Sources

- Eccentric Shafts / Cams
- Reciprocating Components
- Pumps & Fans
- Gears
- Bearings
- Couplings
- Universal Joints
- Motors & Generators



- Eccentric Shafts / Cams
 - Shaft Speed (1 X) and Multiples (Orders)



- Reciprocating Machines
 - 1/2 and Full Multiples of Shaft Speed



- Pumps & Fans
 - Vane Pass & Blade Pass Frequencies
 - Shaft Speed X Number of Vanes
 - Shaft Speed X Number of Blades
 - Flow Noise / Cavitations



- Gearboxes
 - Gear Mesh Frequencies
 - Shaft Speed X Number of Teeth



Machine Design Vibration Sources

- Bearing Frequencies, Rolling Element Bearings
 - BPFI Ball Pass Freq. Inner Race
 - BPFO -- Ball Pass Freq. Outer Race
 - BSF Ball Spin Frequency
 - FTF -- Fundamental Train Frequency

Max Range Approximation:

Shaft Speed X Number of Elements X 0.6



Machine Design Vibration Sources

- Bearings, Fluid Film / Sleeve
 - Oil Whirl
 - 0.40 0.48 X of Shaft Speed
 - Oil Whip
 - Machinery Operating at >> 2 X Critical Speed
 - Oil Whirl Locks onto 2 X Critical



Machine Design Vibration Sources

- Couplings
 - Shaft Speed X Number of Jaws
 - Sidebands



Machine Design Vibration Sources

- Universal Joints
 - 2 X Shaft Speed



Machine Design Vibration Sources

- Motors & Generators
 - Synchronous Motor Speed (SMS)
 - 2 X Line Frequency / Number of Poles
 - Slip Frequency
 - SMS Actual Speed
 - Variable Speed Drives

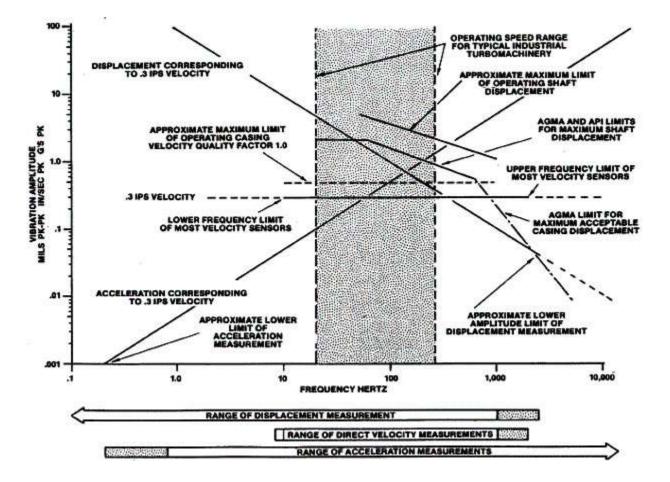


Minimum Acquisition Frequencies

COMPONENT / MACHINE	SPAN
Shaft Vibration	10 X RPM
Gearbox	3 X Gear Mesh
Rolling Element Bearings	10 X Ball Pass Freq. Inner
Pumps	3 x Vane Pass
Motors / Generators	3 X Line Freq X 2
Fans	3 X Blade Pass
Sleeve Bearings	10 X RPM



Applicable Sensors & Limits

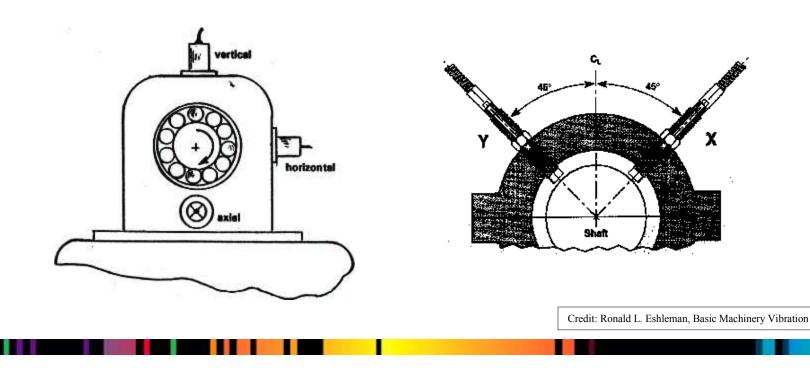


Credit: John S. Mitchell, machinery Analysis and Monitoring 2nd edition



Sensor Mounting Conventions

- Position Referenced from DRIVEN end of Shaft
- Horizontal 90° CLOCKWISE from Vertical
- Direction of Rotation Not Considered
- Axial Transducers In the Load Zone





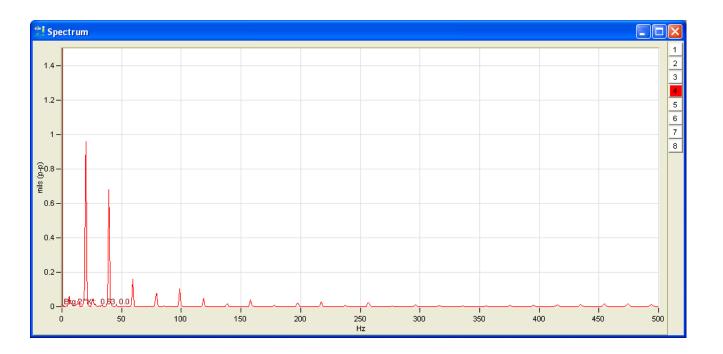
Useable Frequency Spans For Accelerometer Mounting Methods

METHOD	FREQUENCY LIMIT
Hand Held (stinger)	500 Hz
Magnetic Mount	2,000 Hz
Adhesives	2,500 – 4,000 Hz (dependent on compound)
Bees Wax	5,000 Hz (watch surface temp!)
Stud Mount	6,000 – 10,000 Hz



Signal Processing Spectrum Analysis / FFT

- Presents Frequency Components of Time Domain Data
 - Frequency Range Determined by Acquisition Sample Rate
 - Resolution Determined by Acquisition Duration

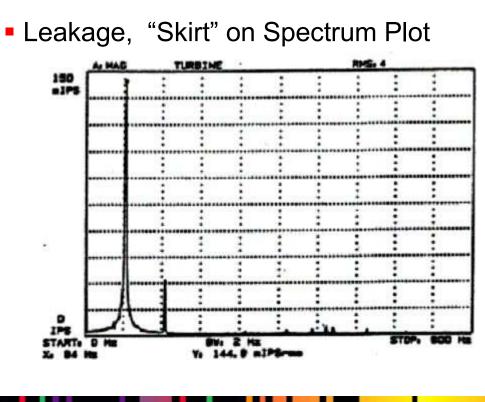


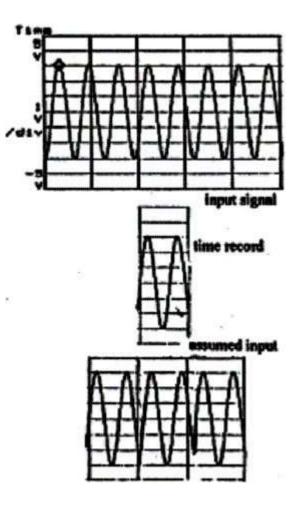


Signal Processing FFT Windowing / Leakage

- Time Data Does Not Begin / End at Zero
- Reconstructed Time Domain Data Not

Contiguous

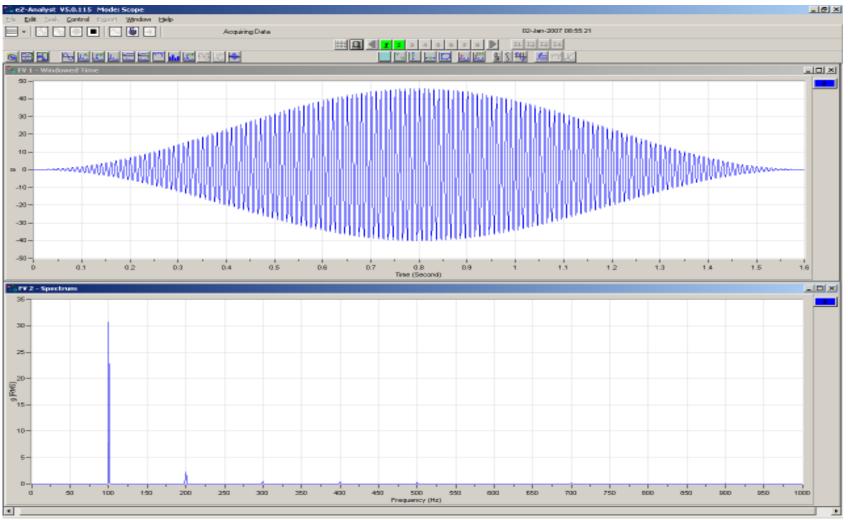




Credit: Ronald L. Eshleman, Basic Machinery Vibration

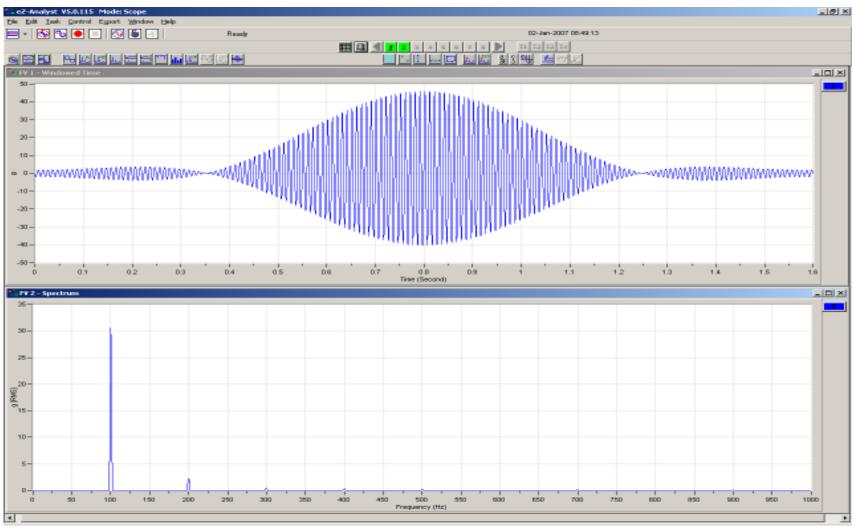


FFT Windows Hanning ('standard' window)



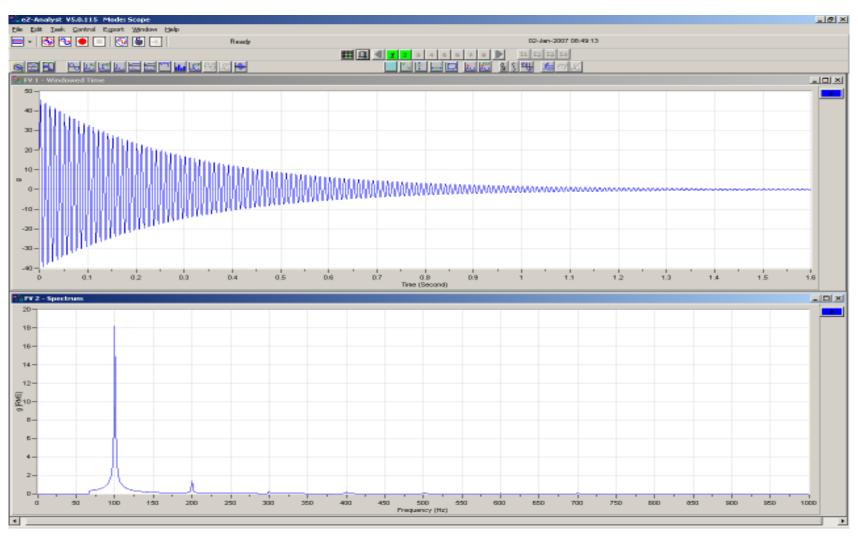


FFT Windows Flat Top, best for amplitude resolution



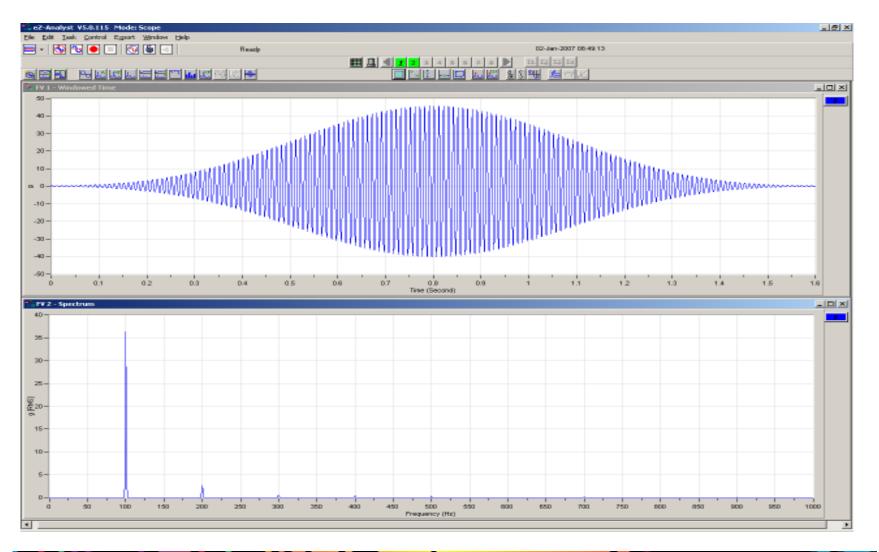


FFT Windows Exponential (programmed decay to zero)





FFT Windows Blackman Harris





FFT Averaging Why Average FFT Data?

- Reduce or eliminate random frequencies
- Capture transient frequencies
- Remove frequencies from adjacent equipment



FFT Averaging Averaging Methods

- Linear (+)
 - True mathematical mean
- Exponential
 - Weighted Average, most recent has highest weight
- Peak Hold
 - Maximum value of each bin maintained
- Linear (-)
 - Special case for Resonance determination
- Time Synch
 - Eliminates frequencies not related to machine speed and phase



ZonicBook/618E Data Acquisition, Recording & Analysis

- Getting Started
 - Machine Condition
 - Instrumentation
 - NEW 600 Series DSA
 - ZonicBook/618E System
 - Vibration Recording and Analysis
 - Impact / Resonance Testing
 - Rotating Machinery Monitoring and Analysis

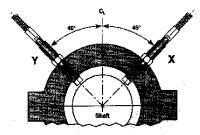




ZonicBook/618E Machine Condition & Instrumentation



- Test Plan based on Machine Condition
- Acceleration > 1 KHz Analysis
- Velocity / Displacement < 1 KHz Analysis
- Microphone
- Tachometer
- Impact Hammer or 2x4









Vibration Seminar Hardware – 600 Series DSA

- 640 Series Features
 - 24 Bit Sigma Delta ADC per channel
 - 4 +/- 10 Volt Inputs, 1 Analog Output
 - Analysis Range to 40,000 Hz
 - IEPE Excitation, per channel selectable
 - Selectable AC or DC Coupling (1.0 Hz)
 - Anti-aliasing Filter, 3 Pole, 360kHz
 - Programmable FIR Filter
 - Spurious Free Dynamic Range of 107 dB
 - Total Harmonic Distortion -100 dB
 - Channels Phase Matched to <0.12°
 - USB 2.0 or Ethernet Versions





Vibration Seminar Hardware – 600 Series DSA

- 650 Series Features
 - 24 Bit Sigma Delta ADC per channel
 - 5 +/- 40 Volt Inputs, 4 IEPE Capable Channels, 1 Tach Channel
 - Analysis Range to 40,000 Hz
 - Selectable AC or DC Coupling (0.1 Hz)
 - Anti-aliasing Filter, 3 Pole, 360kHz
 - Programmable FIR Filter
 - Spurious Free Dynamic Range of 107 dB
 - Total Harmonic Distortion -100 dB
 - Channels Phase Matched to <0.12°
 - USB 2.0 or Ethernet Versions





Vibration Seminar Hardware – ZonicBook System

- 8 Channel Dynamic Signal Analyzer
- 4 Tach Inputs
- Ethernet
- WBK18 Expansion to 56 Channels
- 1 MSample / Sec.
- FSV: +/- 25 mV to +/- 25 V
- ICP / TEDS / Coupling
- EZ-Analyst: Data Recording and Impact Measurement

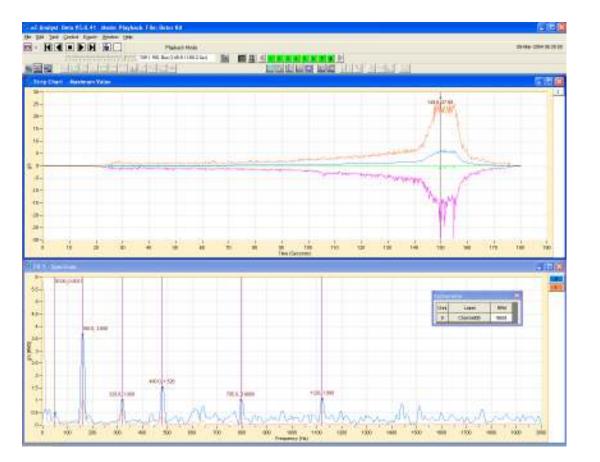
•EZ-TOMAS: Rotating Machinery Monitoring and Transient Analysis





EZ-Analyst Time History Recording

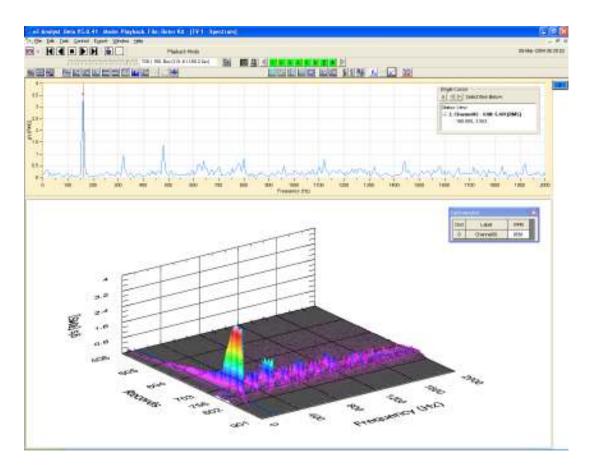
- •Record Continuous Data
- •Stripchart Overview
- •Multiple Displays
- •Multiple Traces / Display
- •Harmonic, Sideband, Peak, Free Form Cursors
- •Time Waveform, Spectrum, PSD





EZ-Analyst Time History Recording

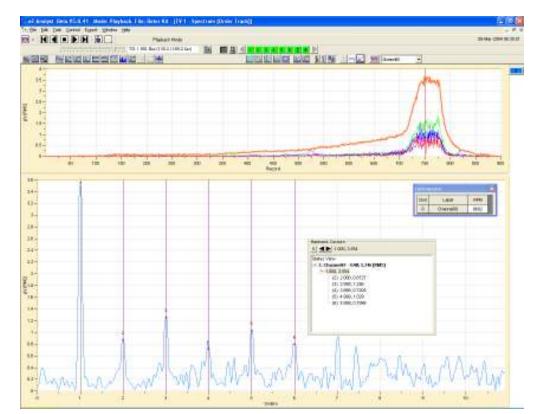
- •Waterfall Displays
 - •Spectral Data
 - •Color Mapping
 - Cursor Annotation
 - Orientation
- •Split Spectrum View
- •Frequency Slice





EZ-Analyst Time History Recording

- •Spectrum
 - Cursor Locations
 - •Order Tracking
 - •RPM Window
 - Annotation
- •Split Order Slice View





EZ-Analyst Configuration Setup

- Analyzer Setup
 - Fmax: up to 50 KHz
 - Lines: up to 25,600
 - 0.1 Hz AC Coupling
 - Triggered Acquisition
 - Averaging
- Input Channels
 - Reference / Response
 - FSV / ICP / Coupling
 - Modal Locations

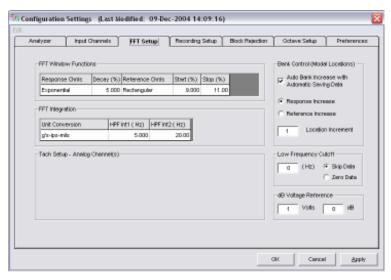


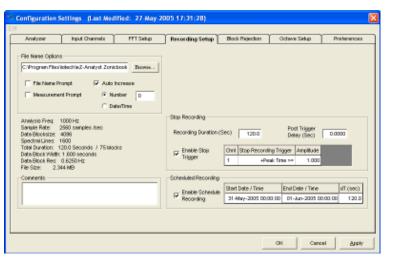
, A	nelyzer -	input	Channels	[PTI Se	tup [Recording:	Setup	Diock	Rejection] od	tave Setu	ΡĨ	Preference
										· · · ·			
No.	Active	Label	Ref / Resp	FS	KP	Coupling	EU Mode	niv / EU	EU Orfset	Unito	Locefon	Coord	Input Type
1	5	Hannar Ch 1	Reference	-0.5 to 0.5	V P	AC	EU	7.DDD	0.0000.D	br	- 1	X +	Force
2	5	Accel Ch 2	Response	-5.0 to 5.0	v P	AC	EU	100.D	0.0000.D	g	2	X +	Acceleration
3	2	Accel Ch 3	Пекротон	-5.0 to 5.0	v 🖻	AC	EU	100.D	0.0000.D	g	3	X +	Acceleration
4		Channel 4	Response	-25.0 to 25.	av 🗖	DC	EU	100.D	0.0000.0	gʻz	4	X+	Acceleration
5		Channel 5	Response	-25.0 to 25.	av 🗖	DC	EU	100.D	0.0000.D	gʻz	5	X+	Acceleration
Б		Channel 6	Response	-25.0 to 25.	av 🗖	DC	EU	100.D	0.0000.D	gʻz	6	X +	Acceleration
7		Channel 7	Response	-25.0 to 25.	av 🗖	DC	EU	100.D	0.0000.D	gʻz	7	X+	Acceleration
в		Channel 8	Reference	-1.0 to 1.0	v 🗖	AC	EU	1.500	0.0000.D	N	a	X +	Parce
No.	Active	Label	Ref / Re	op Coupling	Tech Mode	Pulse / Re	w Trig	Level T	vig Slope	RPM Multiple	fer Eilg	e Delect	Delay Tine
Tt		Chennel 9	Respon	se AC	Votage	1	0.	0000	POS	1.00	D	elayed	600 nS
T2		Channel 10	Respon	se AC	Votage	1	0.	0000	POS	1.00	D	elayed	600 nS
T3		Channel 11	Respon	se AC	Votage	1	0.	0000	POS	1.00	D	elayed	600 nS
T4		Channel 12	Respon	se AC	Votage	1	0.	0000	POS	1.00	D	elayed	600 nS
_													



EZ-Analyst Configuration Setup

- FFT Setup
 - Hanning, Flat Top, Exponential, Rectangular
 - Increment Modal Location
 - HPF Ski Slope effect
- Recording Setup
 - File Name, Increment
 - Duration: up to 100,000 sec
 - Stop Triggers
 - Scheduled Recording



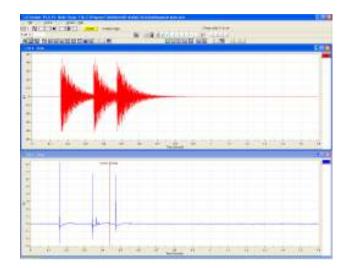


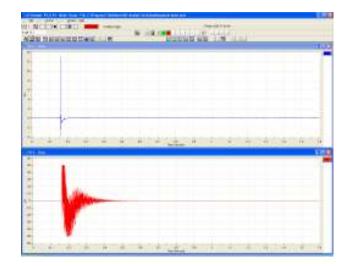


EZ-Analyst Configuration Setup

- Block Rejection
 - Double Hammer
 - Overload
 - Manual

Analyzer	Input Channels	FFT Setup	Recording Setup	Block Rejection	Octave Setup	Preferen
Reject	ion Options for Average t	lensurements				
	Double Harmiter	X Axis Lini	to (% of Blocksize)	Y Axis Linits (%-o	tFS)	
	(Reterence Channels)	000.8	12.00	-5.000	5.000	
F	Overload (All Channels)					
	7 Maruai					
F						
Ā						
F						
4						

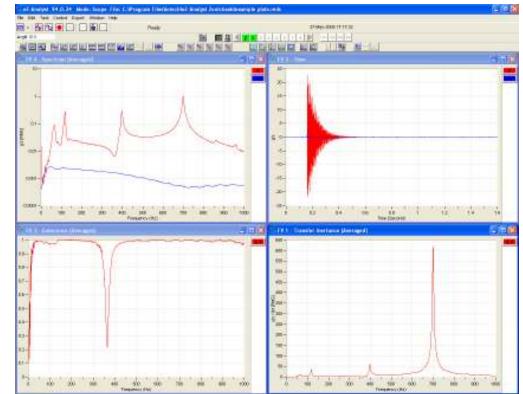






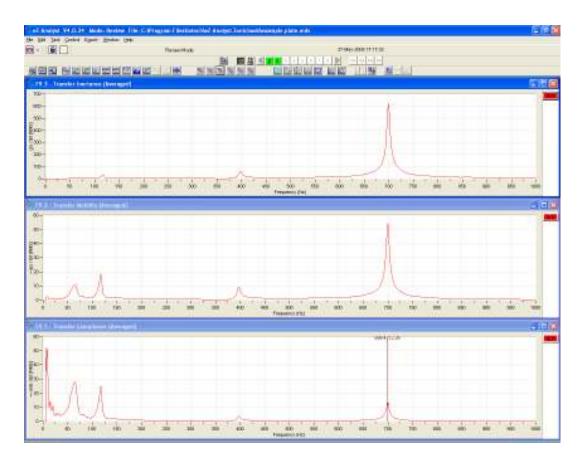
- •Data Stored in MDS File
- •Data Analysis:
 - •Time, Spectrum
 - •Coherence, FRF, and Transfer Function
- •Export to XL; Overlay from XL

•Export to Modal Analysis Software





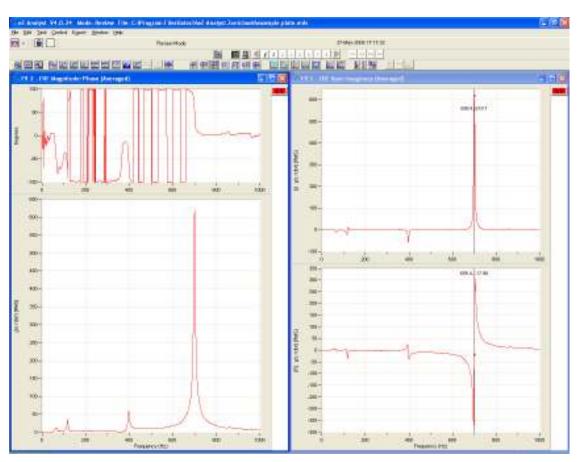
- •Transfer Function
 - •Inertance, Mobility, Compliance
 - •A-V-D / Force
- •Displacement:
 - Accentuates Low Freq
 - •Attenuates High Freq.





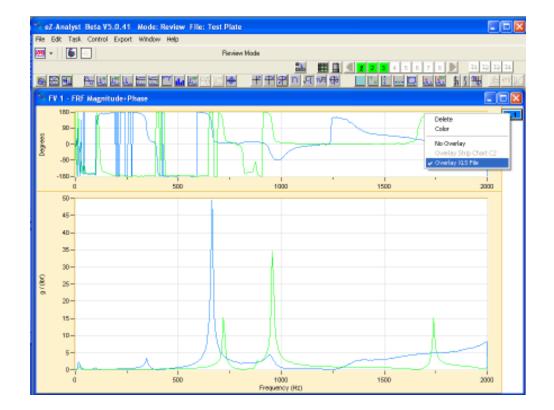
•FRF Magnitude / Phase

- •180 Phase Shift
- •FRF Real / Imaginary
 - •Mode Shape
 - •A / D use Imaginary
 - •V use Real





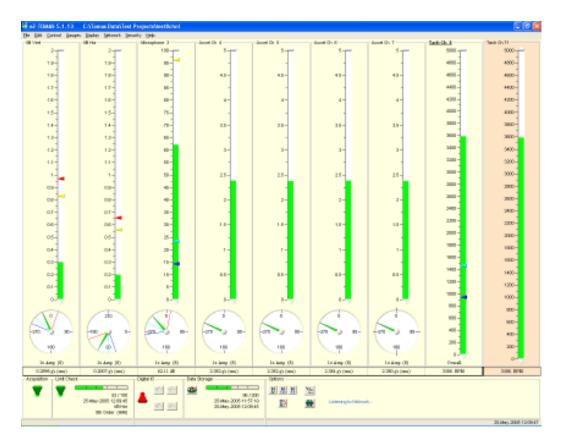
- •Overlay Using XL
 - •Compare Design Changes
 - •Compare vs. Criteria





EZ-TOMAS Monitoring Gauge Window

- Current Values & Status
- Vertical Amplitude
- •Circular Phase
- •Limit Checking / Log Events
- •FIFO Storage
- •High Water Marks
- •Relay Outputs





EZ-TOMAS Configuration Setup

•Acqusition

Fmax: up to 20 KHz
Lines: up to 25,600
Hanning / Flat Top FFT
Scale Pref: RMS, PK, P-P

Input Channels

- •D: DC Cplg, +/- 25V
- •A: ICP, AC Cplg, +/- 5V
- •Gap & Runout Ref.
- •Orbit / Tach Pairs

Acquisition	Input Channels	Storage			
iaruhvare ZonicBook 616E	Acquisition Analysis Frequency (Hz): Spectral Lines: 800 • Diverse Data Acaptetion Number of 4 Averages: FFT Velndow: Hanning •	High Pass AC Coupling Filter © 0.1 Hz C 1.0 Hz Integration Preferences A > V > D Units gro-sign-smite v None Single Double 1 0000 5.0000 15.000			
Acquisition Lind Checking BighaliO BReference EU Value for 0.48 a pages2	Valui Speet Parge: 75.–91.44. RPM Acquisition Time: 1.6000 Seconds Time Recolution: 0.000761 Seconds Frequency Recolution: 0.02390 Hz Resolutitie Frequency: 1.8750 Hz	Scele Protecences			

_	Arm	ui silien		J	ken	t.Chernett.:		Ľ	0	0.400		_
Ha.	Type -	Harre	Omage 14	Cauge Max	Unio	Integration	101/101	Dituri	FIEV	129	Employ	P
4	Displacement	Bigli	· 8	8 8 3000	mile	Hane	200.00	6.6	28.00 to 28.00	E	A.C	-
3	Distant	Dig To		8.3000	-	10/m	200	0.0	-28.09% 28.09		AC	
1	Distiscent	0411	· 6	8,3000	mitr	Hone	200.00	- 6.6	-25.010 25.00		AC	
1 4 9 7 8	Displacement	Big 3 %	7 8	8.3000	min	Have	200.00	6.6	2030 6 2030	•	AC	
з	Danismox	199.3 7	- s	8.3000	-	70/m	200	5.5	-28.0916-28.09		AC	
1	Dationet	0112	r 8	8.3000	mity	Hone	200.00	6.6	-3.10 to 25.10		AC	
2	Displacement	ing 4 W	- a	8.3000	min	Have	200.00	6.6	28.00 to 28.00		AC	
	1scromber	162 RD		4000.0	1018		1000	5.5	-28.0916-28.09		AC	
•	line	Réder	Palae. King 20	10641 (c.8-1	an Ter	0r 34/46	ikuir		_			
8	Faceh Berlin	3	,	- L - E	5	Ύ						



EZ-TOMAS Configuration Setup

•FIFO Storage

•Up to 200,000 Records / Channel

•RPM Range

•Change in RPM, Time, Vibration

•Alarm Condition

•User Snapshot

🐱 Setup Configuration				
Edit				
Acquisition	Input Channels	Y	Storage	e)
History File 15000 FIFO Records Required Disk Space: 1312.9 I Available Disk Space: 163488.	MB	Backup Project prior to	FIFO.	
RPM Range	RPM Change	-Overall Change		
Finabled Maximum 4000.0	Enabled	Channel	Delta EU	Enabled
		Brg 1Y	0.35000	
Minimum 10.0	5.0 RPM	Brg 1X	0.35000	
User Snapshot	Time Change	Brg 2 "Y"	0.35000	
15 Seconds of Continuous	Enabled	Brg 2 "X"	0.35000	
Data Storage	Chasica Seconds	Brg 3 "Y"	0.35000	
Note: Data Storage is triggered by	15.0 C Minutes	Brg 3 "X"	0.35000	
- Change in RPM, Time, Overall; OR	C Hours	Brg 4 "Y"	0.35000	
- User Snapshot; OR - Alarm Event (while RPM within specified range)	C Days	Tach Ref 8	200.00	
L Data Acquisition Must Be OFF to modify some Configuration Se	ettings.	<u>o</u> k	<u>C</u> ance	el <u>A</u> pply



EZ-TOMAS Configuration Setup

- •Spectral Bands
 - •OAll, Vdc, 1xA & 1xP
 - •6 User Defined
 - •Overall, Peak, Phase
 - •Fault Toolkit

•Spectral Limits

- •2 High / 2 Low
- Delay
- •Text Message

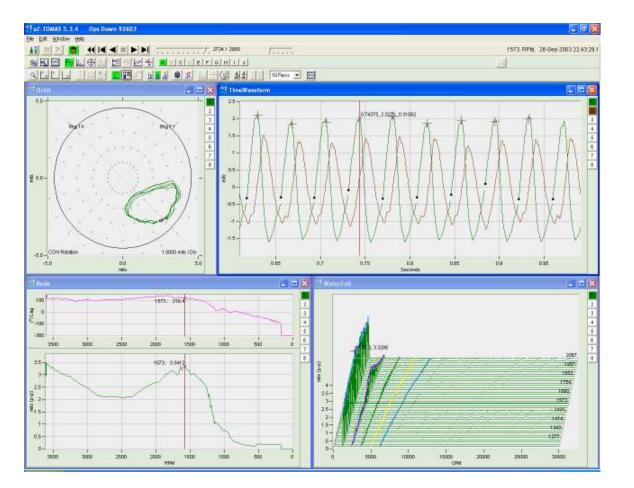
	amai		Handle: KTv1,0Hg T						
DH	Note	Dist a	Spectral Band	PHROME	PreqLD	PVK/H	CALC	Ang LD	Anp
4	ing tV		Overall	HE	00	400.00	Devel	00	8.00
3	Big 12		BC/04) V	HE	00	00	Depart	-20080	203
1	Big 2111	0	tx.AmpBubs	Onlens	1.0000	1,0000	Peak	00	0.000
4	hg2'0'	D	To Piece	Draines	1 0000	1 0000	Pres	00	360
3	Rg2"7"		258	Dribni	20000	10000	1968	00	100
1	Boo're'	1	0.4	Ordens	0.0000	0.0000	Peak	00	1.000
2	Rep 1797	0	dali -	Draines	4.0000	4.0000	Ped	00	1 000
	167/2018	н	0.8	Dribni	10000	10000	1968	00	108
		1	Ós A	Ordens	6.0000	6,0000	Peak	00	1000
		1	Tali	Draines	10000	10000	Period	00	1 000
	Band Toulet	Rente	aforte 📃	ikdere –	Genera	- Y	Parija (Par	1	lete
Speech;					Dening Fe		(Draine)	5	
		HO.	rading benefits	11	the Pass C	UNI DITO	2.010	_	
	-	Part	h Diamakar	4.0855	Cod Parts In	ner (OPF)s	5.9421		
C.B		Del 1	i fisiir 2in	ONEND	Section:	in (FP)	8.4140		
10.00		001	ыслар	00	and Spin Pr	N(RP)	2,9487		

	1000 4 10									
Alemi.opPie	ROM Exec							1000	here a give	
Necercla: 100		Links to any PRIVADA	HE.					Rite	et la ser d	iem Cvert
Figur Shapshot on Alarm		Lingha ka Tipanailina Wataosi								
The second second		aryes						14 M	ros the	chel Beni Diblini ficil Miccoge
									Server:	NUM DALS
aph-Link Values										
Rogalitonumb								2.00	Hana	
Excel/Report Limits	- Jack Ref.	Letin						Page	No.	New Contraction
			0.	0.	0.	0	1.1		lens ette	
	-		-					ilute t		ning@idmi-use
hput Chemelo	-Units Inc	of Oramal 1								
CR MARK	D	Spectramental	LOLO	LO	1.1	8044 D0	ING UNC	NL.	A216	0841.400.001
		Overal	29000	0.0129	0.7864	0.9(14	1.1	1	R	2105500401@shed.com
1 0111	#i									while kinds on
1 0/211/ 2 0/211	0	OC Gee V	00	0.0	0.0	0.0	1.1	2	R.	
		OE Cep V 1s Anglitude	27229	20500	0.00	0.5390	10	2	R	410000.000
2 0111	0									41000000
2 0111 3 01211	0	to Anglibole	27299	20500	0.4080	0.5390	1.1	0	П	
2 0ra18 3 0ra2*/* 4 0ra2*/*	0 0	to Anglitude to Phase	2.7299 297.9	2000 2050	0.4000 2007	0.5000	10	0 4	П	
2 0111 3 012211 4 012211 5 012311	0 0 0 0	15 Anglitele 15 Phese 2c4	27299 297.9 00	20580 2850 00	5.4080 292.7 00	05090 0023 00	10 10 10	0 4	П	
2 0111 3 01211 4 01211 5 012311 5 012311 5 012311	0 0 0 0 0 0	To Anglibule To Pineos 204. 304.	27299 2979 00 00	20500 2850 00 00	54000 2027 00 00	05390 0023 00 00	10 10 10	0 4	П	
2 0911 3 09214 4 09210 5 09314 8 09310 7 093414	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	13 Anglitude 13 Phase 204 304 404	2129 2979 00 00	2000 2050 00 00 00	54000 3927 00 00 00	05390 002:1 00 00 00	10	0 4	П	a mgono nom



EZ-TOMAS Rotating Machinery Analysis

Orbit, Time Waveform
w/ or w/o Filtered
N Revolutions
Bode
w/ or w/o Runout
OAll, 1x, nX
Waterfall
Order Tracks
RPM Annotation

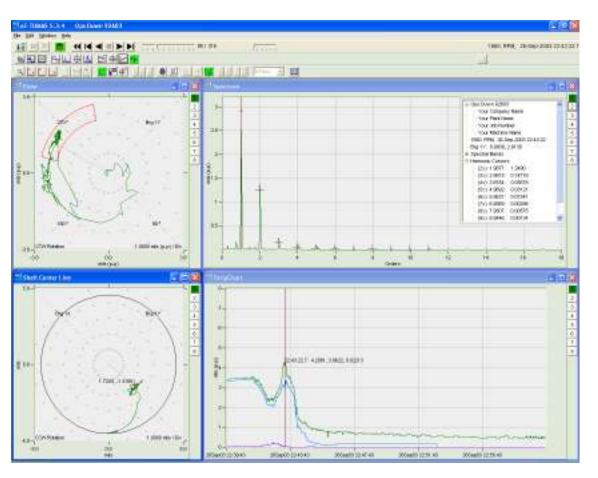




EZ-TOMAS Rotating Machinery Analysis

•Polar

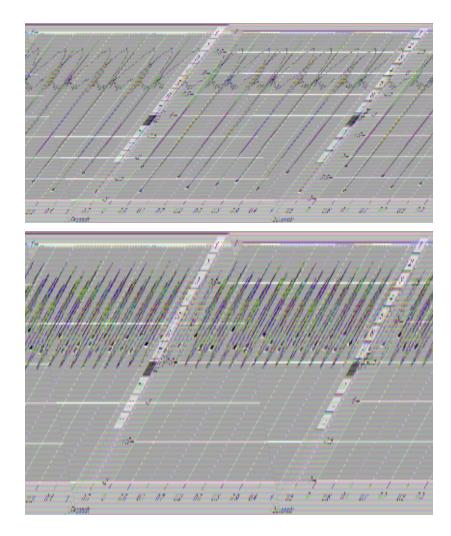
- •Runout, Limits
- Annotation
- •Spectrum
 - •Harmonic, Sideband Peak Cursors
- •Shaft Center Line
- •Trend
 - •OAll, 1x, nX
 - •Cursor to History Location





EZ-TOMAS Rotating Machinery Analysis

- •Automatic Tach
 - •Analog Inputs
 - •Dynamically adjust trigger levels
 - •Trigger Direction





EZ-TOMAS Learning Limits

Statistical Report

Steady State Condition

•Min, Avg, Max, Dev

 Calculate Limits based on Normal Operation

 Before / After Shutdown comparisons

le –							
Chril	Name	Units	Description	Minimum	Average	Maximum	Deviation
1	Brg 1Y	nik (me)	Overall	3.1119	3.4396	3,7128	0.09676
1	Brg 1Y	Valta	DC Gap V	-8.0771	-8.0000	-7.9300	0.06150
1	Brg 1Y	nik (me)	1x Amplitude	2.9420	3.1234	3.2681	0.07957
1	Brg 1Y	Degener	1xPhase	292.55	257.76	264.40	3.3972
1	Brg 1Y	nit (me)	2xA	0.01730	0.07570	0.22603	0.04568
1	Brg 1Y	nit (me)	3xA	0.25903	0.33503	0.42625	0.05835
1	Brg 1Y	nit (me)	4A	0.01038	0.04155	0.06890	0.01055
1	Brg 1Y	nik (me)	54	0.06156	0.07785	0.09773	0.00363
1	Brg 1Y	nit (me)	6xA	0.05857	0.06922	0.07501	0.00301
1	Brg 1Y	nik (me)	7xA	0.02417	0.03139	0.04463	0.00478

7-

5-

5-

4 -

n...

Overall

