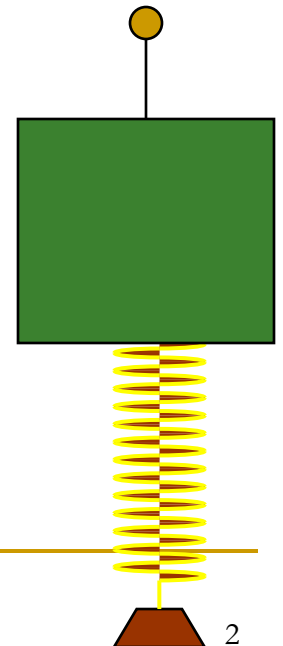
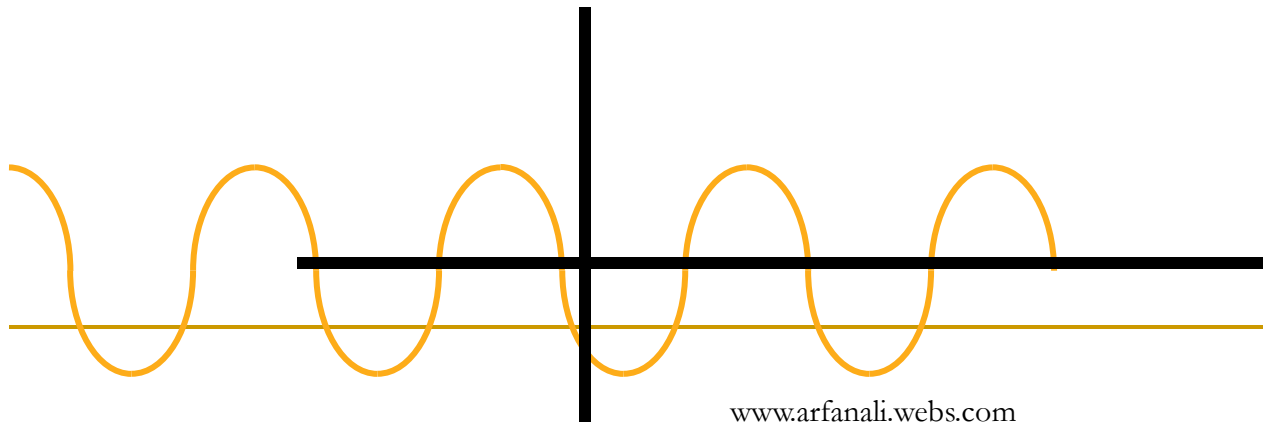


Bentley Nevada 3500 System Architecture and Rack Configuration

Presented by:
Arfan Ali

Introduction to Vibration

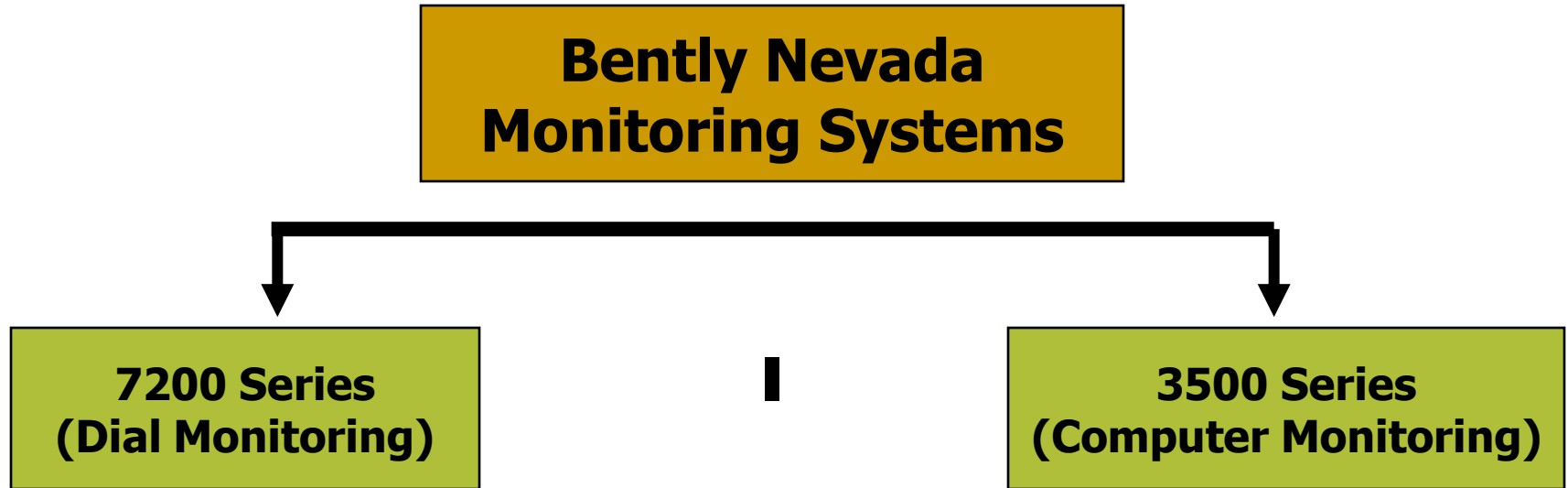
- The Oscillatory (back and forth) motion of a machine from its normal position of rest.
- Any motion that repeats itself after a specific interval of time .
- **Vibration Example :**



Importance of Vibration Monitoring System

- Essential for
 - Protection against machinery faults
 - Predict and diagnose crucial machinery Problems
 - Imbalance
 - Misalignment
 - Shaft crack
 - Bearing Failures and etc.
- Parameters to measure
 - Thrust
 - Vibration
 - Speed
 - Temperature

Monitoring Systems



we have two types of vibration monitoring system the Bently nevada 7200 series vibration monitoring system. It is a dial monitoring analog system installed at our plant on Air Compressor partially and on Most of the TPs etc.

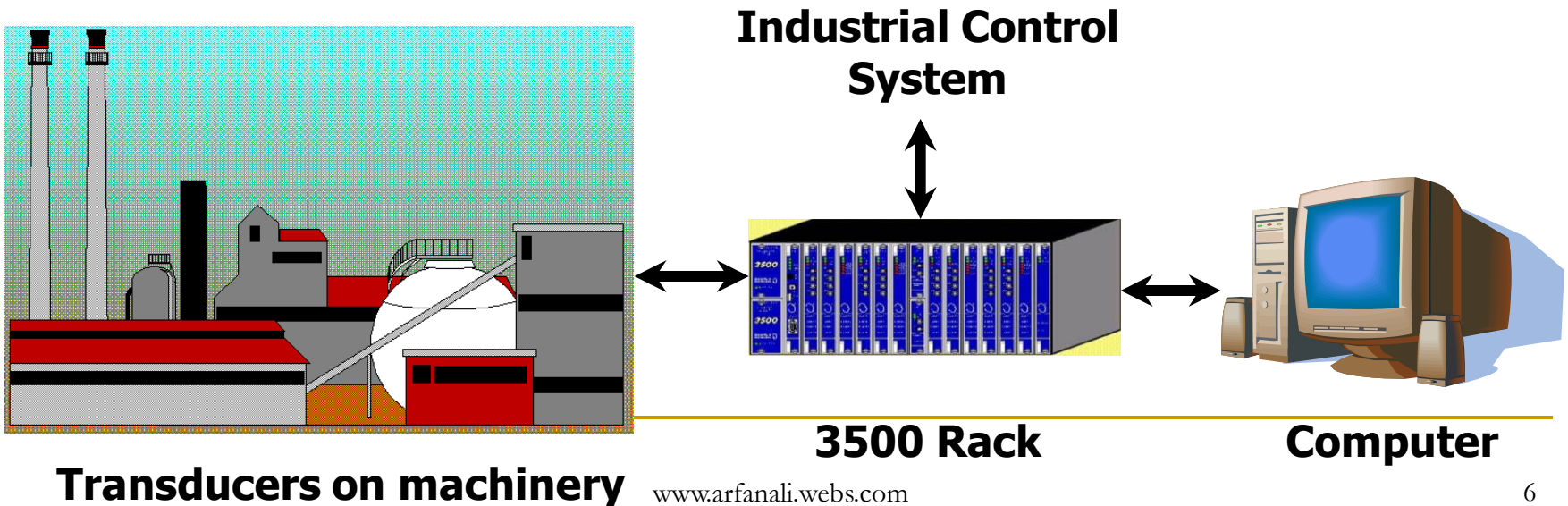
The second one is bently nevada 3500 series vibration monitoring system it is computer based digitized system installed at Syn compressor, Ammonia commpressor, CO2 compressor and on Air compressor partially. The scope of presentation my presentation is limited to 3500 system only.

Features of 3500 Monitoring System

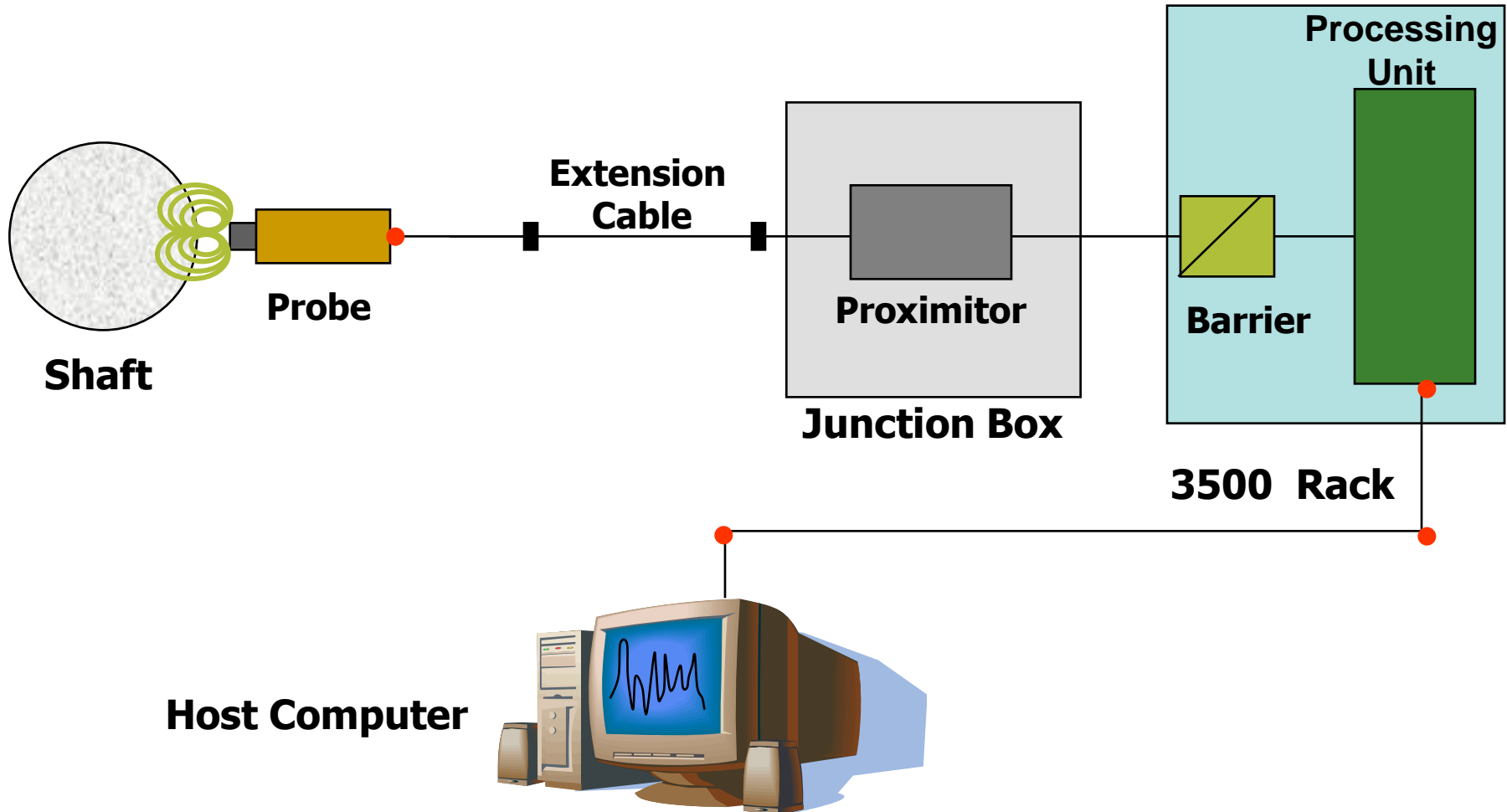
- State of art vibration monitoring system
- Processor based system
- Modular & Flexible Architecture
- Tight integration with DCS using Industry Standards Interfaces
- Hot Insertion or Removal of Modules
- Provides Enhanced Operator Information
 - Windows based operator display
 - Data can be displayed at multiple locations
- Improved Reliability due to
 - Redundant power supply and distribution network
 - Triple Modular Redundant Relay Modules

3500 Monitoring System Components and Layout

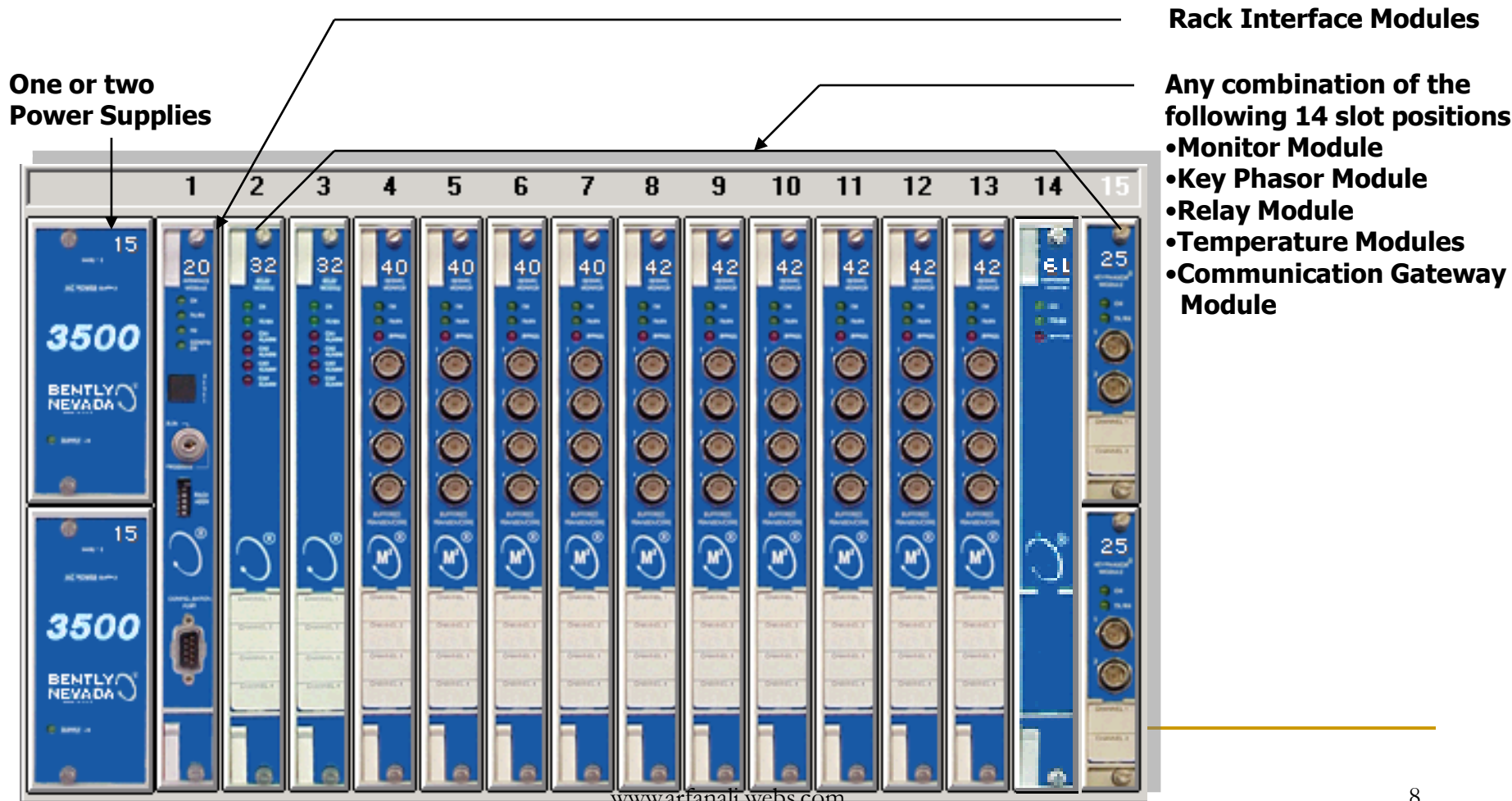
- Transducers
- 3500 Rack
- 3500 Software
- Computers



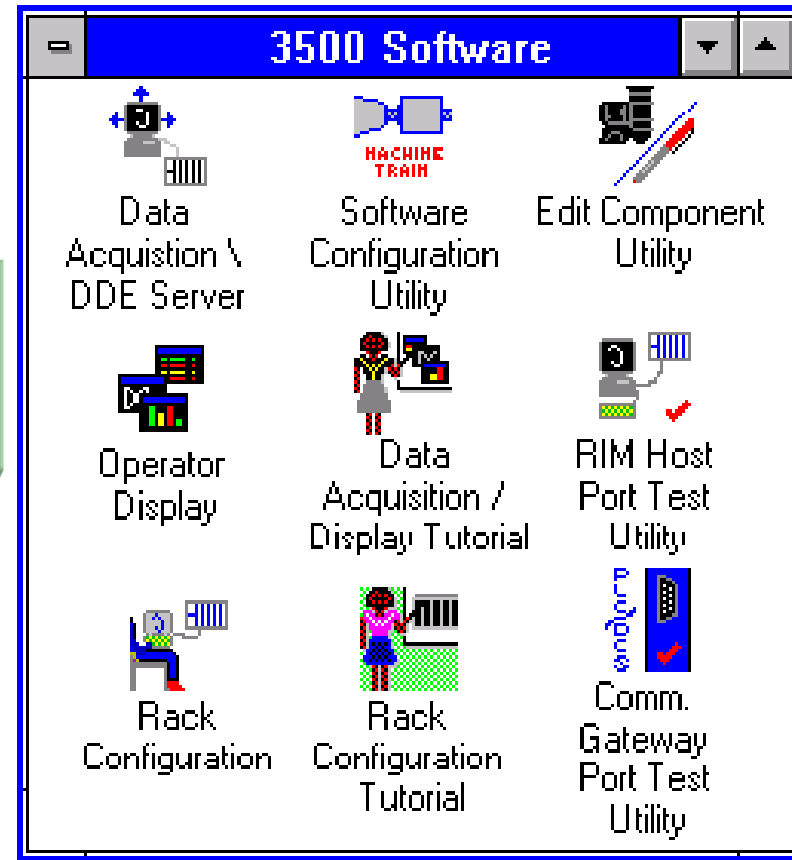
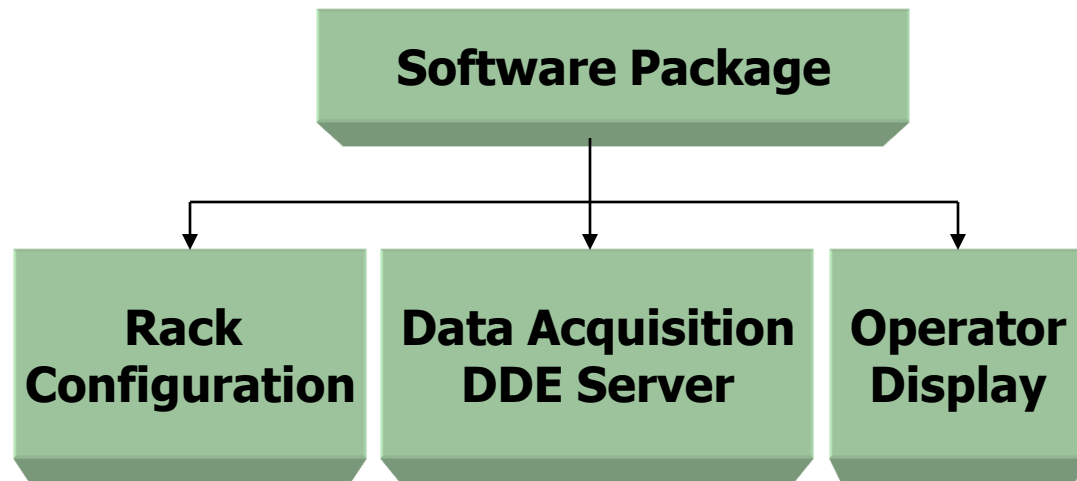
Vibration Monitoring System Overview



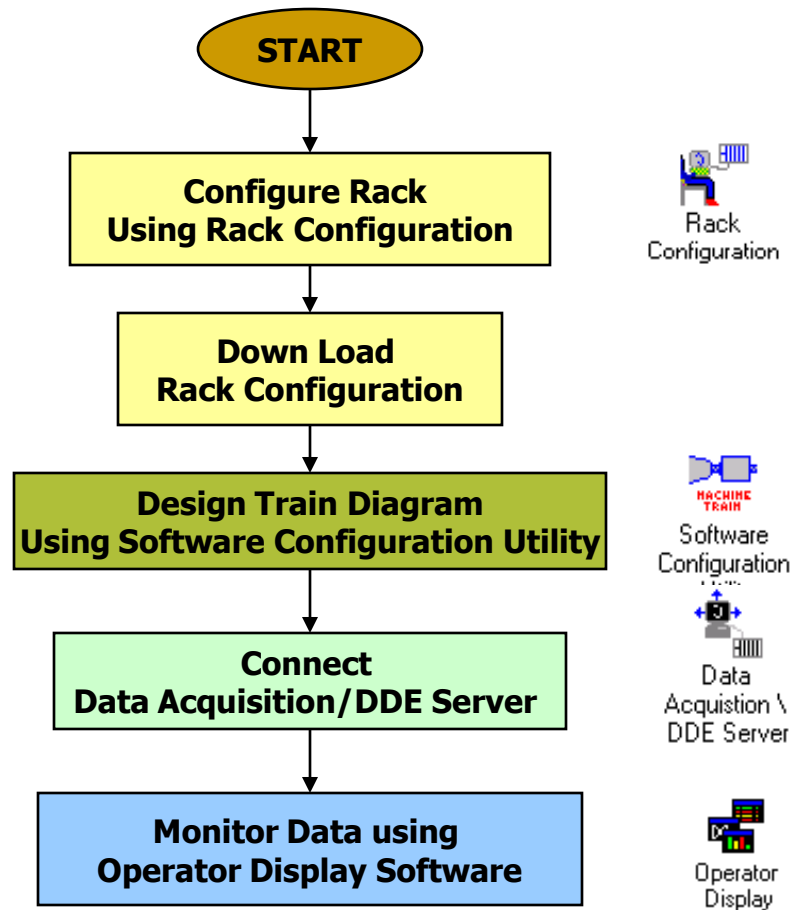
3500 System Monitor



3500 Software Packages



3500 Software Sequence



Common Pitfalls

- Not Ok
- By Pass
- Internal Faults

Question & Answers

3500/15 AC & DC Power Supplies

- Half Height Modules
- Always Installed in the left most slot
- Upper Module.. Primary Supply
- Lower Module.. Backup Supply
- Removing & insertion of one Supply at one time will not disrupt operation.



3500/20 Rack Interface Module (RIM)

- Must be located in the 1st Slot
- Interface card between the rack & monitoring computer
- Works as a communication server



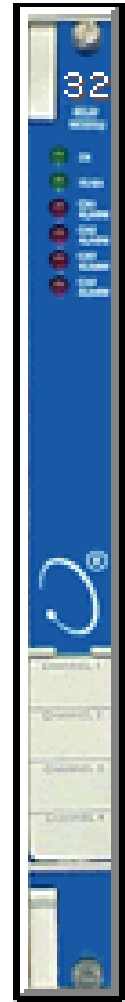
3500/42 Proximator/Seismic Monitor

- Four Channel Monitor
- Accepts input from proximity and seismic transducers
- Monitor acceleration, velocity and absolute shaft measurement as well



3500/32 The 4 Channel Relay Module

- Full Height Module
- Provides Four Relay outputs
- Provide Alarm on Alert & tripping on Danger situations
- Programmable for AND/OR voting of trip Relays



3500/40 Proximator Monitor

- Four Channel Monitor
- Accepts input from proximity transducers
- Monitors Radial Vibration and Thrust Position
 - Vibration 0- 500 μ m or 0- 20 mil Max.
 - Thrust 40-0-40mil Max.
- Hold Alarm set points (Alert & Danger)
- Compare monitored values with Alarm set points
- Provide Input signal to Relay module, when the monitored value exceed from the set point



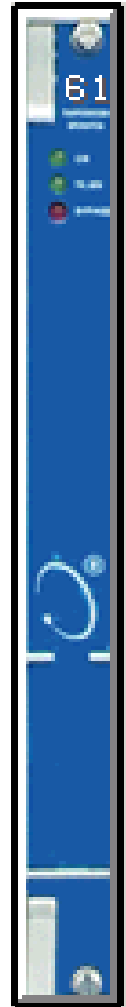
3500/25 Key Phasor Modules

- Half Height module with 2-channels
- Measure RPM of the observed shaft
- View either Notch or Projection on the Shaft
- Association of key Phasor signal with peak to peak vibration is used to determine Vibration spectrum
- Range 1 to 99,999 RPM
- Maximum 4 key Phasor signals are possible in 3500 System
- Front View
 1. **OK** and **TX/RX**
 2. Buffered O/P



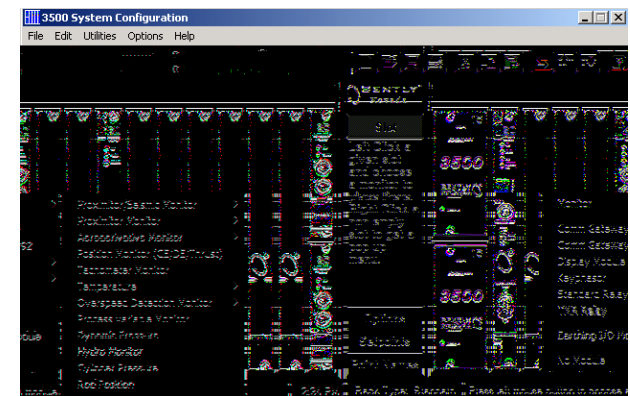
3500/61 Temperature Monitoring

- Full Height module
- Six channel Monitor
- Accepts both Thermocouple & RTD type inputs
- Provide 4 to 20 mA recorder outputs
- Not in use at FFC-MM



Rack Configuration Software

- Configuration radial Vibration Channel
- Configuration Axial vibration channel
- Configuration of Keyphasor
- Configuration of Relay module



Configuration of Radial Vibration Channel

- Transducer field installation
- Range
- Set points
- Key phasor
- Alert latching / non latching



Configuration of Axial vibration channel

- Transducer field installation
- Towards / away
- Zero position
- Range
- Set points
- Key phasor
- Alert latching / non latching
- Time delay
- 1X, 2X and not 1X



Configuration of Key phasor

- Association
- Range
- Notch



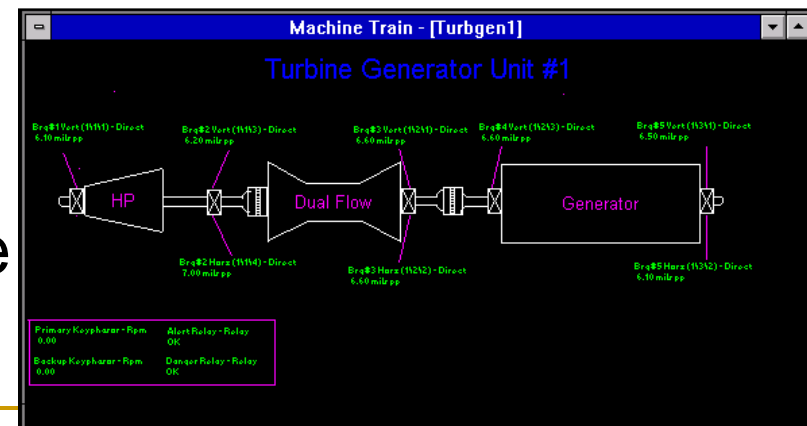
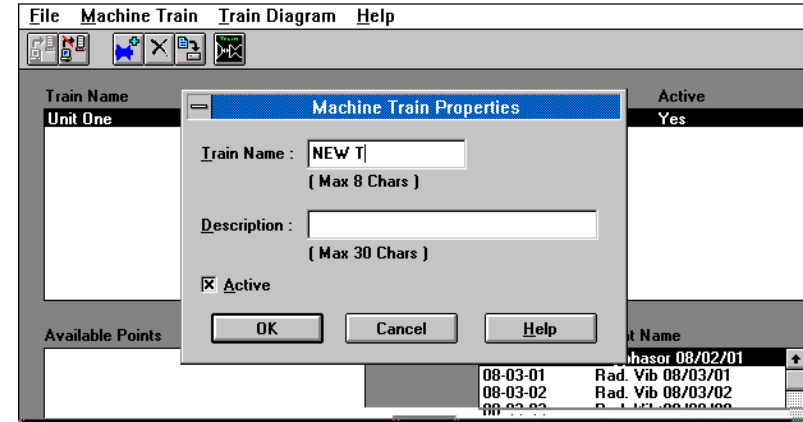
Configuration of Relay Card

- Identify the XTs and VTs required for alarms and danger
- Type of voting



Software Configuration Utility

- Used to create Machine Train Displays
- Specify Historic trend parameters
 - ❑ Enabling/Disabling
 - ❑ Time B/W two consecutive points
 - ❑ Memory Size
- Generate Report on Machine Train Displays



Data Acquisition/DDE Server

- Collects machinery monitoring Data, Alarm, and System Events data
- Provides data to Operator Display Software
- Stores historical and real-time trend data

Operator Display Software

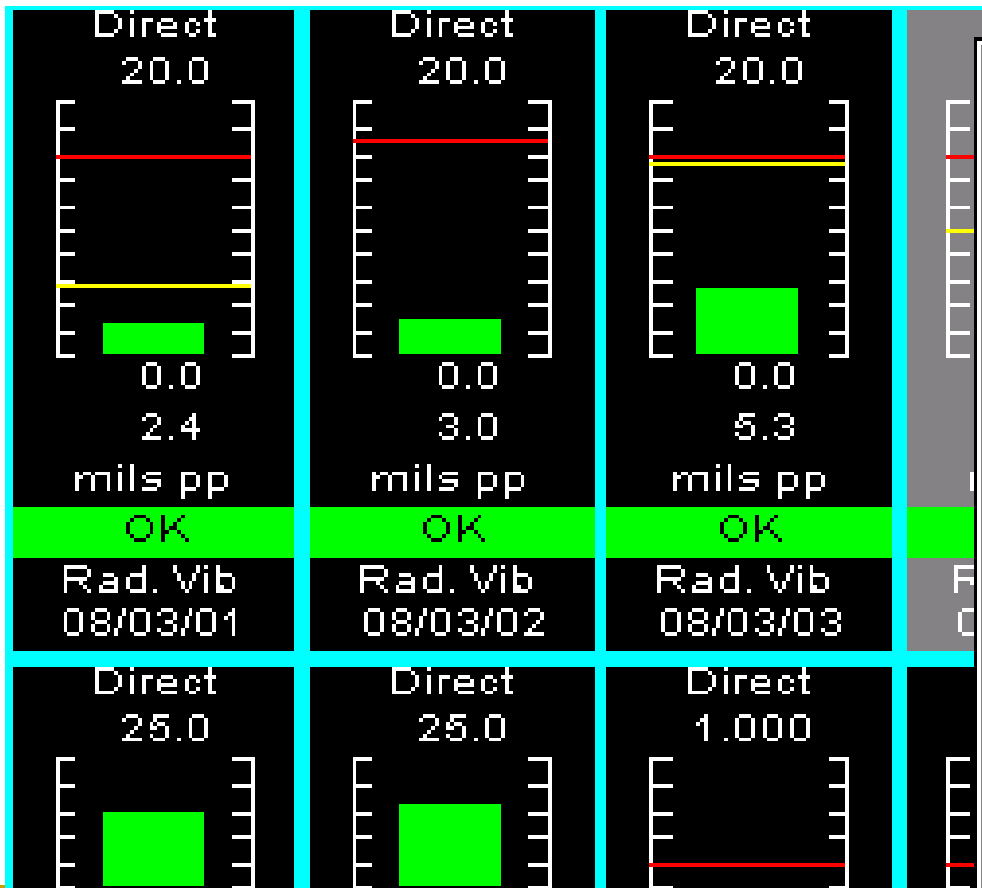
- Displays machine monitoring data using
 - ❑ Current values
 - ❑ Bargraphs
 - ❑ Trends (Historical/Real)
 - ❑ Machine Train Diagrams
- Used to view
 - ❑ System Event List
 - ❑ Alarm Event List

Current Values

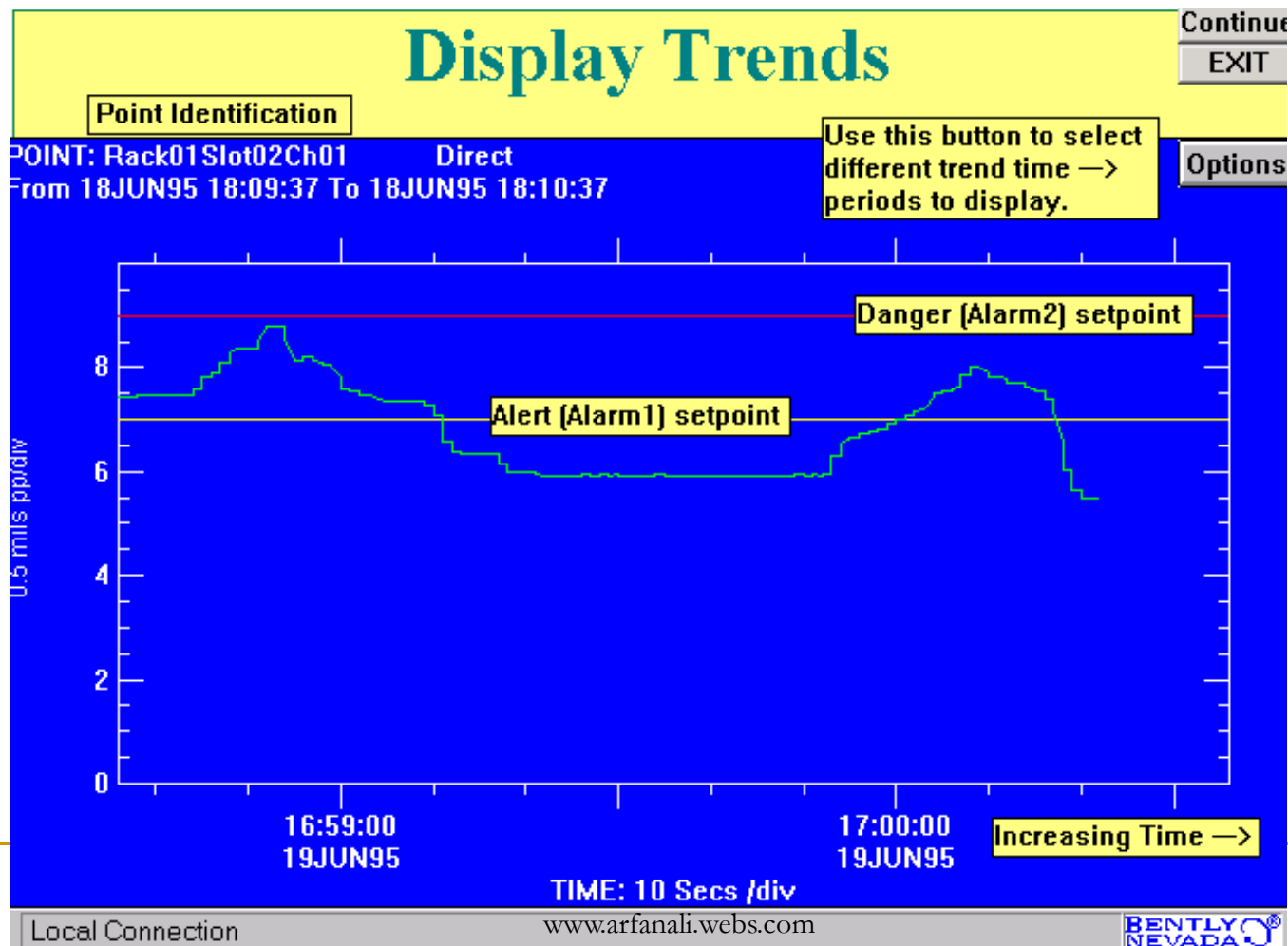
Point Name: Rad. Vib 08/03/04
Point Location: R8S3C4

TYPE	VALUE	STATUS
<input checked="" type="checkbox"/> Direct	5.9 mils pp	OK
<input type="checkbox"/> Gap	-9.4 volts	OK
<input type="checkbox"/> 1X Amp	6.7 mils pp	OK
<input type="checkbox"/> 1X Phase	239 degrees	OK
<input type="checkbox"/> 2X Amp	0.14 mils pp	OK
<input type="checkbox"/> 2X Phase	NA	Invalid
<input type="checkbox"/> Not 1X Amp	0.22 mils pp	OK
Point Status	OK	Update Bargraph
Kph Status	OK	Adjust Setpoints
Speed	148 rpm	Set Ch Switch
Trip Multiply Status	Inactive	Help
Inhibit Status	Inactive	Close

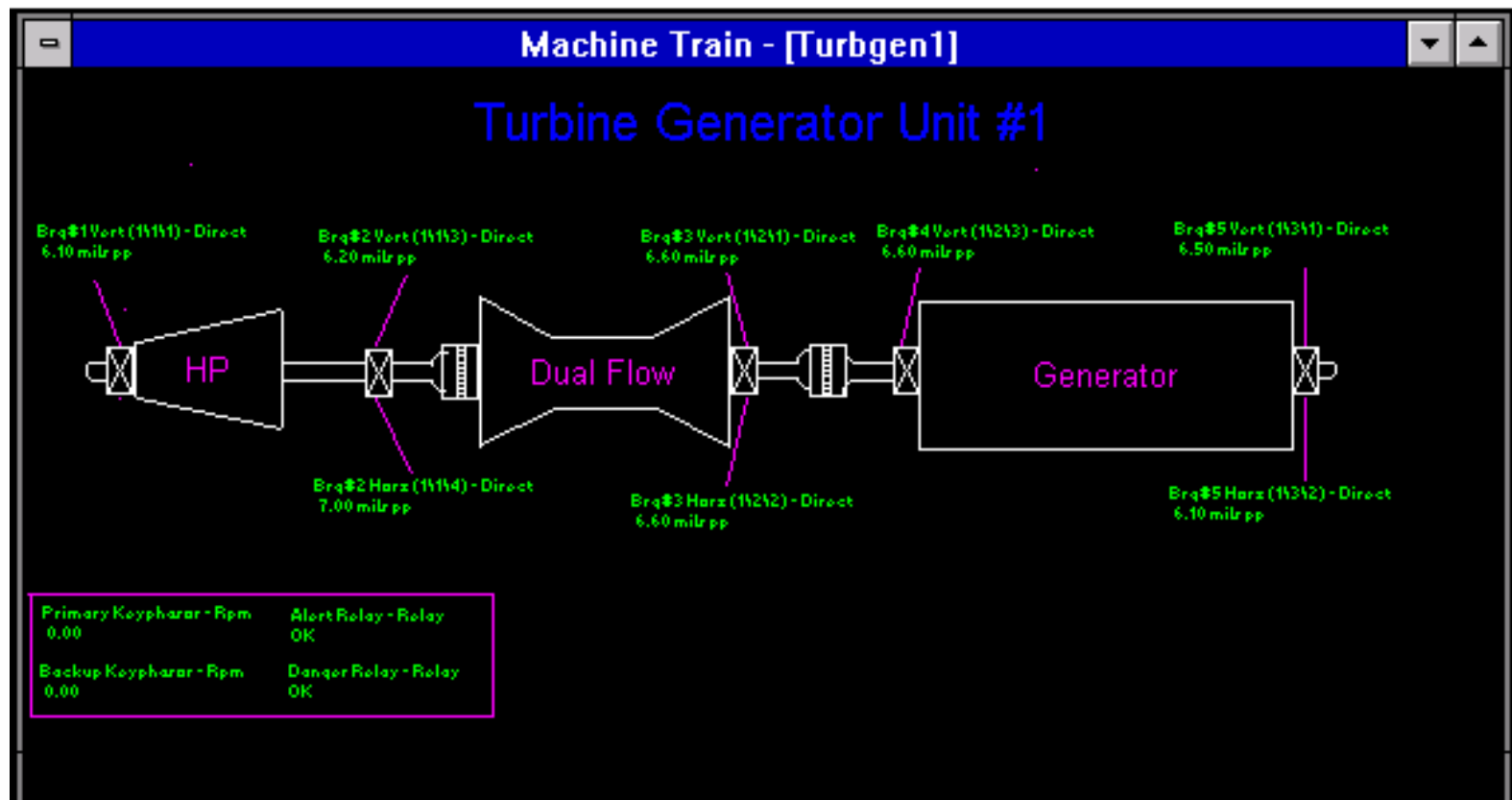
Bargraphs



Trends





Machine Train Diagram



System Event List

3500 Operator Display - [System Event List - Rack1] Continue

File Train Diagram Bargraph Events Options Window Help EXIT

OK  Test Trn 

Sequence Number	Event Information	Event Number	Class	Date dd/mm/yy	Event Time	Event Specific	Event Slot
0000001872	Config Token Released	00051	2	19/06/95	17:06:20		
0000001871	disable ch 2 ch byp sw	00002	0	19/06/95	17:06:20		
0000001870	disable ch 2 spc inh sw	00003	0	19/06/95	17:06:19		
0000001869	disable ch 2 a2 byp sw	00001	0	19/06/95	17:06:19		
0000001868	disable ch 2 a1 byp sw	00000	0	19/06/95	17:06:18		
0000001867	Config Token Acquired	00050	2	19/06/95	17:06:17	Front	2
0000001866	Config Token Released				17:06:05	Front	2
0000001865	disable ch 2 ch byp sw				17:06:05		
0000001864	disable ch 2 spc inh sw				17:06:04		
0000001863	disable ch 2 a2 byp sw				17:06:03		
0000001862	enable ch 2 a1 byp sw				17:06:03		
0000001861	Config Token Acquired	00050	2	19/06/95	17:06:02	Front	2
0000001860	HW Rack Reset Inactive	00077	2	19/06/95	17:05:26		2
0000001859	HW Rack Reset Active	00076	2	19/06/95	17:05:26		2
0000001858	Config Token Released	00051	2	19/06/95	16:51:19	Front	2
0000001857	Device Configured	00300	2	19/06/95	16:51:14		2
0000001856	Module Entered Cfg Mode	00302	2	19/06/95	16:50:50		2
0000001855	Config Token Acquired	00050	2	19/06/95	16:49:13	Front	2
0000001854	Config Token Released	00051	2	19/06/95	16:48:45	Front	2

Each Event has a date and time tag.

Complete explanations for events are included in the 3500 Monitoring System Manuals.

Local Connection

Save All

BENTLY NEVADA

Local Connection

<--Scroll through events by 'dragging' the indicator with the mouse pointer.



Alarm Event List

3500 Operator Display - Server : LOCAL - [Alarm Event List - Rack1]

File Train Diagram Bargraph Events Options Window Help

OK System Test

Sequence Number	Point Address	Point Name	Date dd/mm/yyyy	Time hh:mm:ss.msec	Alarm Type
0000006318	01/04/01	VT-1	07/01/2004	16:24:56.41	Left
0000006317	01/04/03	XT-3	07/01/2004	16:24:27.64	Left
0000006316	01/04/03	XT-3	07/01/2004	16:24:26.60	Ente
0000006315	01/04/03	XT-3	07/01/2004	16:24:12.04	Left
0000006314	01/04/03	XT-3	07/01/2004	16:24:11.00	Ente
0000006313	01/04/03	XT-3	07/01/2004	16:24:08.55	Left
0000006312	01/04/03	XT-3	07/01/2004	16:24:07.19	Ente
0000006311	01/04/01	VT-1	07/01/2004	16:24:07.19	Ente
0000006310	01/04/01	VT-1	07/01/2004	15:41:41.99	Left
0000006309	01/07/04	Rad. Vib 01/07/04	07/01/2004	15:41:18.32	Ente
0000006308	01/07/03	Rad. Vib 01/07/03	07/01/2004	15:41:18.32	Ente
0000006307	01/07/02	VT-209 STAND BY	07/01/2004	15:41:18.32	Ente
0000006306	01/07/01	VT-208 STAND BY	07/01/2004	15:41:18.32	Ente
0000006305	01/06/04	VT-202 STAND BY	07/01/2004	15:41:18.19	Ente
0000006304	01/06/03	VT-201 STAND BY	07/01/2004	15:41:18.19	Ente

Local Connection

Ack Refresh

BENTLY

Configuration of Radial Vibration

Four Channel Proximator/Seismic Monitor

Slot: Rack Type: Configuration ID:

Slot Input/Output Module Type
☒ Discrete Internal I/O ☐ TMR I/O (Discrete)
☐ Discrete External I/O ☐ TMR I/O (Bussed)

Channel Pair 1 and 2
Channel Pair Type

Keyphasor Association
☐ No Keyphasor

Primary	Backup
Upper <input checked="" type="radio"/> Channel 1 <input type="radio"/> Channel 2	Upper <input checked="" type="radio"/> Channel 1 <input type="radio"/> Channel 2
Lower <input type="radio"/> Channel 1 <input type="radio"/> Channel 2	Lower <input type="radio"/> Channel 1 <input type="radio"/> Channel 2

Channel 1
☒ Active

Channel 2
☒ Active

Channel Pair 3 and 4
Channel Pair Type

Keyphasor Association
☐ No Keyphasor

Primary	Backup
Upper <input checked="" type="radio"/> Channel 1 <input type="radio"/> Channel 2	Upper <input checked="" type="radio"/> Channel 1 <input type="radio"/> Channel 2
Lower <input type="radio"/> Channel 1 <input type="radio"/> Channel 2	Lower <input type="radio"/> Channel 1 <input type="radio"/> Channel 2

Channel 3
☒ Active

Channel 4
☒ Active

Navigation buttons: <===, =, <===

Configuration of Radial Vibration Channel (contd)

Radial Vibration -

Channel: (Active) Slot: Rack Type:

Enable

	Full-scale Range	Clamp Value
Direct	<input type="text" value="0-10 mil pp"/>	<input type="text" value="0.00"/>
Gap	<input type="text" value="-24 Vdc"/>	<input type="text" value="0.0"/>
<input type="checkbox"/> 1X Ampl	<input type="text" value="0-10 mil pp"/>	<input type="text" value="0.00"/>
1X Phase Lag		<input type="text" value="0"/>
<input type="checkbox"/> 2X Ampl	<input type="text" value="0-10 mil pp"/>	<input type="text" value="0.00"/>
2X Phase Lag		<input type="text" value="0"/>
<input type="checkbox"/> Not 1X Ampl	<input type="text" value="0-10 mil pp"/>	<input type="text" value="0.00"/>
<input type="checkbox"/> Smax Ampl	<input type="text" value="0-10 mil"/>	<input type="text" value="0.00"/>

Recorder Output ☐ Two mA Clamp

Delay ☐ 100 ms
Alert Danger
1 - 60 s 1.0 - 60.0 s

Transducer Direction
☒ Toward Probe
☐ Away From Probe

Zero Position Volts
(Gap)

Trip Multiply 1.00 to 3.00 (steps of 0.25)

Direct Frequency Response cpm

Transducer Selection

Type

Transducer Jumper Status (on I/O Module):

Alarm Mode

Alert
☒ Latching
☐ Nonlatching

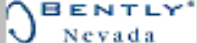
Danger
☒ Latching
☐ Nonlatching

Transducer Orientation

Degrees
☒ Left
☐ Right

Barriers

☒ None ☐ Internal
☐ MTL 796(-) Zener Ext.
☐ Galvanic Isolator



Configuration of Radial Vibration Channel (contd)

Setpoint Configuration: Radial Vibration -

Alert / Alarm 1

Direct	Gap	1X Ampl	2X Ampl	Not 1X	Smax
mil pp	Vdc	mil pp	mil pp	mil pp	mil
3.00	-15.6	6.50	6.50	3.00	3.00
10	-24	10	10	10	10
0	0	0	0	0	0
Enabled	Enabled	Enabled	Enabled	Enabled	Enabled

1X Phase deg

0 45 90 135 180 225 270 315

0 108

☐ Enabled

2X Phase deg

0 45 90 135 180 225 270 315

0 108

☐ Enabled

Danger / Alarm 2

Direct	1X Ampl
mil pp	mil pp
6.00	7.87
10	10
0	0
Enabled	Enabled

Monitor Slot 2 Channel 1 Copy... OK Cancel Print Help

BENTLY Nevada

Configuration of Axial Vibration Channel

Thrust Position -

Channel: (Active) Slot: Rack Type:

Enable

Full-scale Range: Direct Clamp Value:

Gap:

Recorder Output: ☐ Two mA Clamp

Zero Position (Direct) -6.33 to -13.99 Volts

Transducer Type

I/O Module Attached - Jumper Position:

OK Mode

☐ Latching ☒ Nonlatching

Delay

Alert: 1 - 60 s Danger: 1.0 - 60.0 s ☐ 100 ms

Alarm Mode

Alert

☒ Latching ☐ Nonlatching

Danger


☒ Latching ☐ Nonlatching

Barriers

☒ None ☐ Internal ☐ MTL 796(-) Zener Ext. ☐ Galvanic Isolator

Normal Thrust Direction

☒ Toward Probe ☐ Away From Probe



Configuration of Axial Vibration Channel (contd)

Setpoint Configuration: Thrust Position

Alert / Alarm 1

Direct
mil

7.5

25

-25

-7.5

☒ Enabled

Gap
Vdc

-15.6

-24

0

-8.4

☒ Enabled

Danger / Alarm 2

Direct
mil

15.0

25

-25

-15.0

☒ Enabled

Monitor Slot 2 Channel1 Copy... OK Cancel Print Help

BENTLY Nevada

KeyPhasor Module Configuration

Keyphasor	
ConfigID: <input type="text"/>	Slot: 2
Keyphasor Position: Upper	I/O Module: <input checked="" type="radio"/> Internal <input type="radio"/> External
<div>Channel 1 <input checked="" type="checkbox"/> Active</div> <div><div>Signal Polarity <input checked="" type="radio"/> Notch <input type="radio"/> Projection</div><div>Type <input checked="" type="radio"/> Proximator <input type="radio"/> Magnetic</div></div> <div>Hysteresis: <input type="text" value="2.0"/> 0.2 to 2.5 Volts</div> <div><div>Threshold Type <input checked="" type="radio"/> Auto <input type="radio"/> Manual</div><div>Value: <input type="text"/> -20.0 to 0.0 Volts <input type="button" value="Adjust..."/></div></div> <div>Events Per Rev: <input type="text" value="1"/> 1 - 255</div> <div><div>Orientation Degrees: <input type="text" value="0"/> </div><div><input type="radio"/> Left <input type="radio"/> Right</div></div> <div>Upper RPM Limit: <input type="text" value="99999"/> </div> <div>RPM Clamp Value: <input type="text" value="0"/> </div>	<div>Channel 2 <input checked="" type="checkbox"/> Active</div> <div><div>Signal Polarity <input checked="" type="radio"/> Notch <input type="radio"/> Projection</div><div>Type <input checked="" type="radio"/> Proximator <input type="radio"/> Magnetic</div></div> <div>Hysteresis: <input type="text" value="2.0"/> 0.2 to 2.5 Volts</div> <div><div>Threshold Type <input checked="" type="radio"/> Auto <input type="radio"/> Manual</div><div>Value: <input type="text"/> -20.0 to 0.0 Volts <input type="button" value="Adjust..."/></div></div> <div>Events Per Rev: <input type="text" value="1"/> 1 - 255</div> <div><div>Orientation Degrees: <input type="text" value="0"/> </div><div><input type="radio"/> Left <input type="radio"/> Right</div></div> <div>Upper RPM Limit: <input type="text" value="99999"/> </div> <div>RPM Clamp Value: <input type="text" value="0"/> </div>



Relay Configuration

3500 System Configuration

File Conv Utilities Help

Relay Association

Available Monitors: Rack Type: Standard Config ID: N/A Relay Slot: 7

2	3	4	5	6	7	8	9	10	11	12	13	14	15
25 KPH 00E 0V1 1 2	44 KPH 00E 0V1 1 2	42 KPH 00E 0V1 1 2	40 KPH 00E 0V1 1 2	38 KPH 00E 0V1 1 2	36 KPH 00E 0V1 1 2	34 KPH 00E 0V1 1 2							

Available Monitor Channels/Alarms:

- S05C##A1 (Slot 5 Any Active Alert)
- S05C##A2 (Slot 5 Any Active Danger)
- S05C01A1 (Slot 5 Channel 1 Alert)
- S05C01A2 (Slot 5 Channel 1 Danger)
- S05C02A1 (Slot 5 Channel 2 Alert)
- S05C02A2 (Slot 5 Channel 2 Danger)**
- S05C03A1 (Slot 5 Channel 3 Alert)
- S05C03A2 (Slot 5 Channel 3 Danger)
- S05C04A1 (Slot 5 Channel 4 Alert)
- S05C04A2 (Slot 5 Channel 4 Danger)

And (*) Or (+) Enter <---
() CLR

☒ Active

Simplex Relay Channel Association

☐ Channel 1 ☒ Channel 3
☐ Channel 2 ☐ Channel 4

Alarm Drive Logic:
S04C01A1 * S05C02A2

Relay NE\NDE Switch Status: N/A

OK Cancel Help

Not OK

- Channel not ok status results from any of the following conditions:
 - ❑ Probe is open
 - ❑ Connection looseness

- Note: If time defeat is ON
 - ❑ 30 sec are required to move from not OK state OK state
 - ❑ When any channel go into Not okay state it will go into bypass state

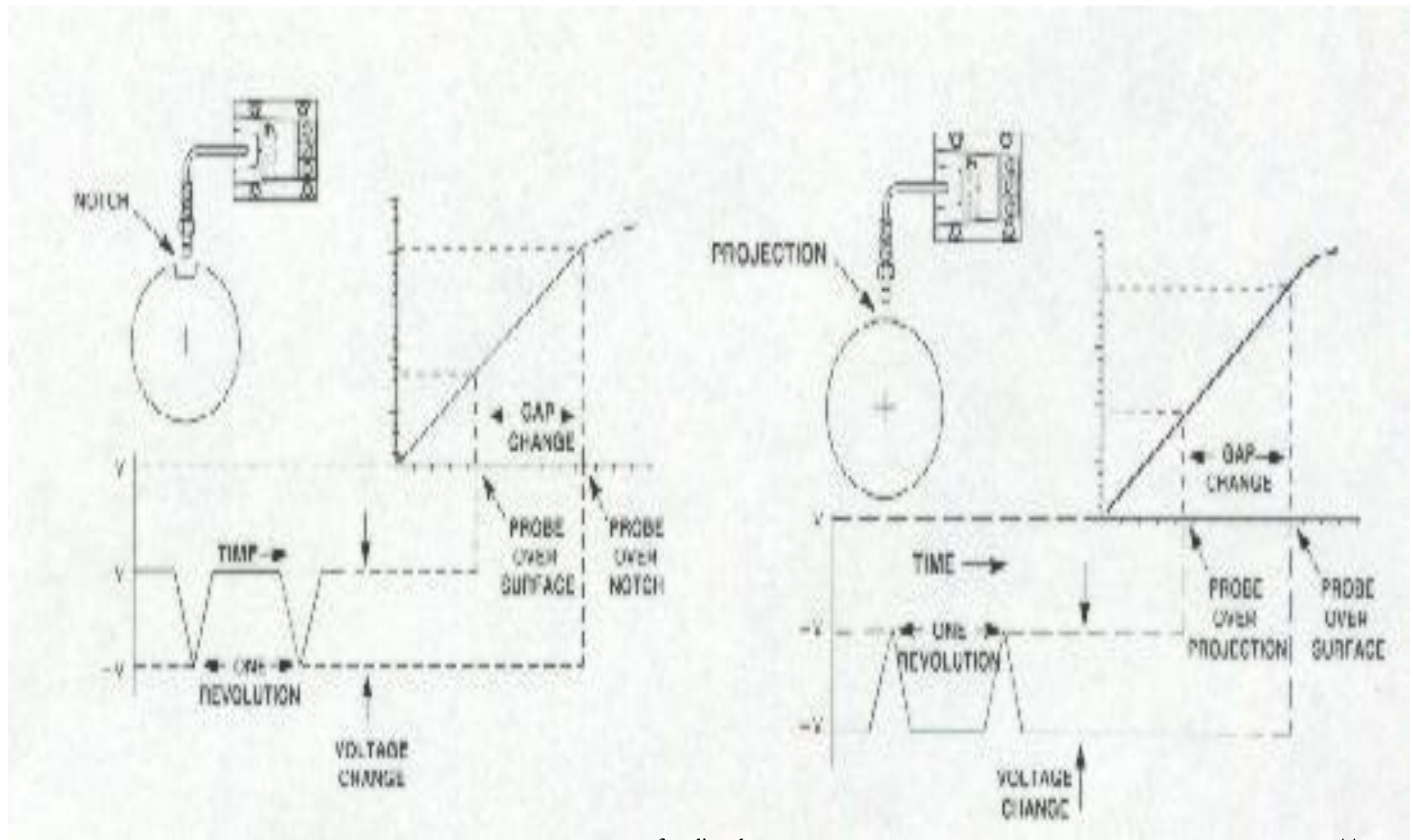
By Pass

- A software switch is bypassing any channel alarming function
- A transducer is not okay and the channel is configured for “Timed ok Channel Defeat”
- The Keyphasor associated with the channel has gone invalid
- The monitor has detected a serious internal fault

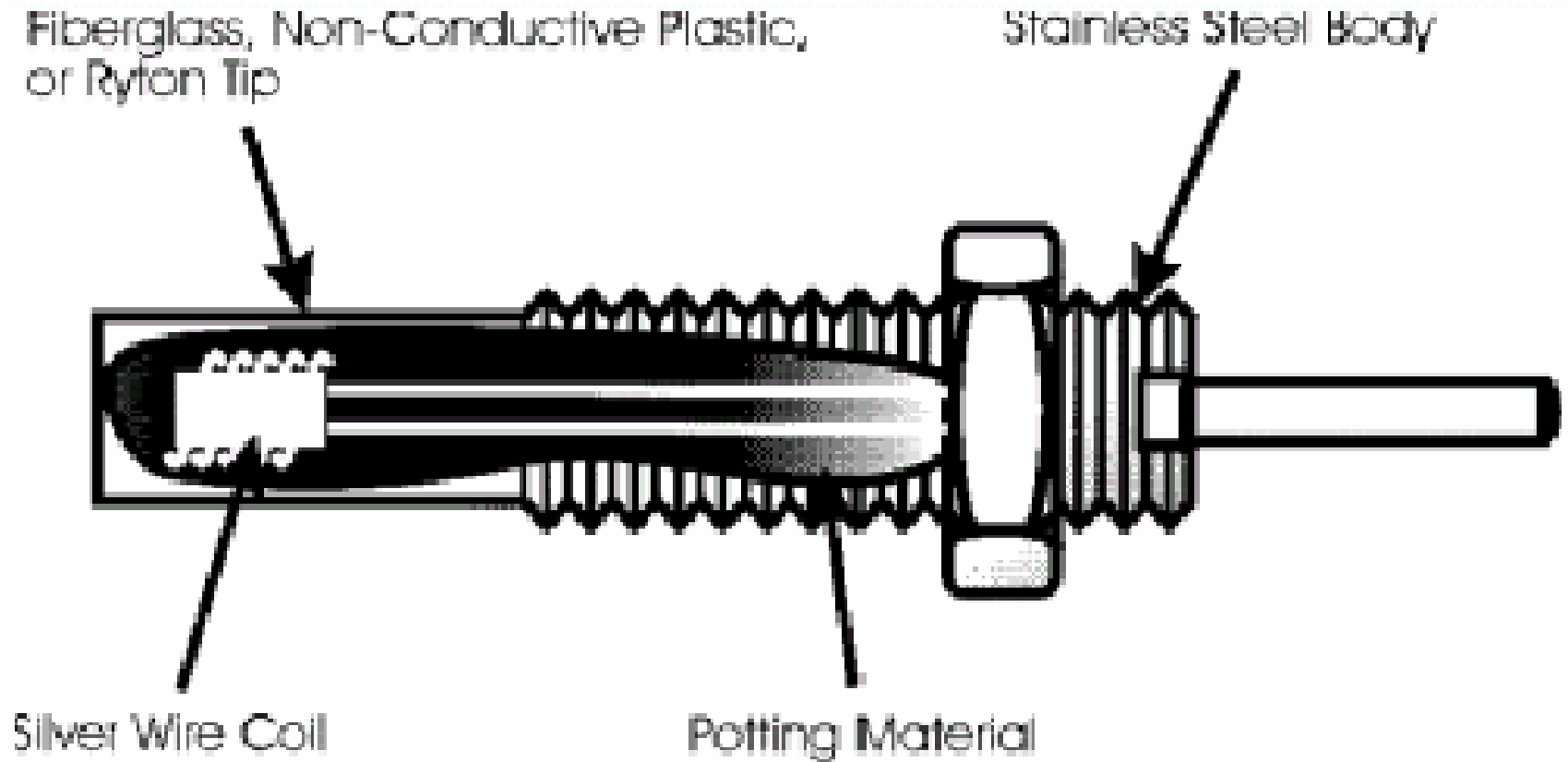
Internal Fault

- Internal faults are rectified by checking the code (event number) from the system event list and checking the corresponding value in the system manual.

Key Phasor



Shape of proximity probe



Negative Supply of Proximitors

- I am glad you benefited from my article. To answer your question is that the first reliable transistors that were commonly available for use were NPN, which required a negative supply .

Mark Snyder, Bently Nevada