Sentry G3 Machinery Protection Monitor

The Sentry G3 Machinery Protection Monitor is a high performance signal conditioning unit; providing a universal platform for the interfacing of various sensor types in compliance with the API 670 standard. Each of the four channels can be independently programmed to provide continuous monitoring and protection facilities across a broad spectrum of measurement regimes (including vibration, expansion, temperature, speed, etc). Utilising the latest DSP technology, once a channel is set up and running, the resulting alarm relay and analogue output facilities are independent from the remaining module functionality, resulting in a scalable high integrity configuration.

The module is provided with an intuitive colour LCD display and drive facility to provide immediate viewing and access to the machine parameters. Several modes of display are available including bar graph, FFT and an alarm historian.

The module provides the necessary power source for the selected transducer, providing for 2 (ICP type) or 3 – wire accelerometer variants, ± 24V proximity probe systems, LVDTs and a range of speed & temperature sensors.

Each transducer signal is buffered and available via the front panel analogue connection arrangement and a USB interface is provided for programming of the unit and storage of channel history and settings.

The unit is designed for mounting in a custom 19 inch rack assembly which also contains a dual redundant power supply option. The G3 system offers excellent channel density with up to 24 measurement channels in a 3U format.

Each channel can provide independent analogue outputs of current and voltage for DCS connection in addition to an alarm relay. Further alarm relay expansion is possible through connection to digital outputs at the rear of the module.
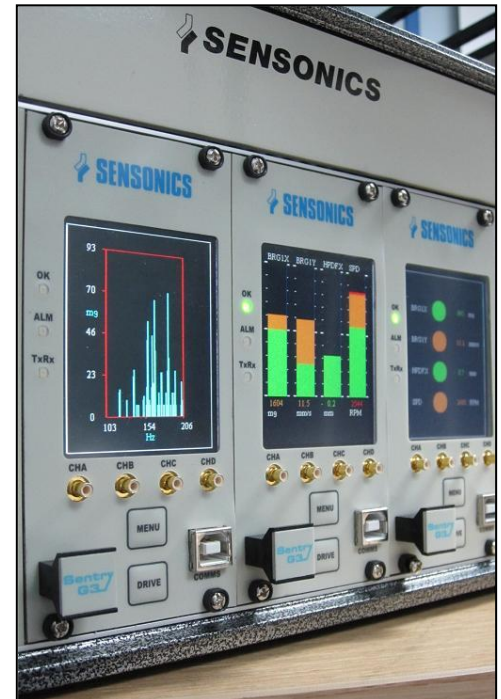
Machine Measurement Modes

- Absolute and Relative Vibration
- Displacement and Thrust Position
- Speed, Phase and Reverse Rotation
- Differential and Casing Expansion
- Rod Drop
- Temperature

Turbine Specialist Measurement Modes

- Shaft Eccentricity
- Differential Ramp Expansion
- Rotor / Stator Air Gap

Flexible Configuration

- LPF, HPF, Tracking and Notch Filters
- Programmable Warning and Danger Alarms with Relay Logic
- Cross-Channel Voting
- Harmonic and Phase Analysis
- Programmable Transducer Supply
- Scaleable Module Hardware with plug in DSP card, up to four channels
- Dual Redundant Power Supply
- Gateway Communications Module
- USB Programmable
- Defeat, Park and Calibration modes

DS 1221

Absolute Vibration

Selectable Measurement Modes

AM1   Overall Level, Band limited (LPF & HPF)
AM2   Overall Level, Fixed HPF & Tracking LPF
AM3   Overall Level, Fixed HPF & Tracking Notch
AM4   Fund and Harm Magnitude & Phase

Configurable Warning and Danger, negative and positive going alarms per channel.

Measurement Units

Select from Acceleration (m/s^2 or g), Velocity (mm/s or ips) and Displacement (um or mil).

Select from average, rms, pk, pk to pk, pk / rms or dB referenced to $20Log_{10}(1.0V)$.

Filter Characteristics
Low Pass

Programmable 3dB, 100Hz to 10kHz
Roll off >24dB / Octave
Setting resolution 1%
Tracking ratio of 0.1 to 10 of incoming Tacho
Tacho division (multi tooth wheel) 1 to 60

High Pass

Programmable 3dB, 0.1Hz to 100Hz
Roll off >24dB / Octave
Setting resolution 1%

Notch Filter

Programmable, 100Hz to 10kHz
Constant Q, 35dB rejection
Setting resolution 1%
Tracking ratio of 0.1 to 10 of incoming Tacho
Tacho division (multi tooth wheel) 1 to 60

Measurement Range, Accuracy and Resolution
For AM1 & AM2 measurements
Maximum range setting
Acceleration   0 – 100.0g, ±0.2% typ, ±1.0% max
Velocity   0 – 100mm/s, ±0.2% typ, ±1.0% max
Displacement   0 – 1000um, ±0.2% typ, ±1.0% max
Resolution of displayed readings better than 1%

For AM3 measurements
Maximum range setting
Acceleration   0 – 100.0g, ±1.0% typ, ±3.0% max
Velocity   0 – 100mm/s, ±1.0% typ, ±3.0% max
Displacement   0 – 1000um, ±1.0% typ, ±3.0% max
Resolution of displayed readings better than be 1% min

For AM4 measurements
Maximum range setting
Acceleration   0 – 100.0g, ±2.0% typ, ±5.0% max
Velocity   0 – 100mm/s, ±2.0% typ, ±5.0% max
Displacement   0 – 1000um, ±2.0% typ, ±5.0% max
Phase   0 - 360º, ±1.0º typ, ±5.0º max
Resolution of displayed readings better than 1%

Noise Floor

Acceleration   0.001g rms typ
Velocity   0.02mm/s rms typ
Displacement   0.05um pk typ

Transducer Configurations

Accelerometer
Sensitivity Range   10.00mV/g to 10.00V/g
Standard ICP option   +24V or -24V
3/4 – wire option   +24V, -24V or +12V

Velocity Transducer
Active or Passive option
Sensitivity Range   1mV/mm/s to 50mV/mm/s
Standard ICP option   +24V
3/4 – wire option   +24V or +12V

Transducer Integrity
Active device range   -19.0V to +19.0V
Passive device   O/C and S/C detection

Relative Vibration
Selectable Measurement Modes

AM1   Overall Level, Band limited (LPF)
AM2   Overall Level, Tracking LPF
AM3   Overall Level, Tracking Notch
AM4   Fund and Harm Magnitude & Phase
AM5   Overall Level, dual mode eccentricity

Configurable Warning and Danger positive going alarms per channel.

Measurement Units

Displacement (um or mil), pk or pk to pk,

Filter Characteristics
Low Pass

Programmable 3dB, 100Hz to 10kHz
Roll off 24dB / Octave
Setting resolution 1%
Tracking ratio of 0.1 to 10 of incoming Tacho
Tacho division (multi tooth wheel) 1 to 60
Gap Filter Fixed 3dB at 0.5Hz, 16 sample average

High Pass

Fixed 3dB at 0.8Hz, AM1 to AM4
Fixed 3dB at 0.015Hz, AM5
Roll off >24dB / Octave

Notch Filter

Programmable, 100Hz to 10kHz
Constant Q, 35dB rejection
Setting resolution, 1%
Tracking ratio of 0.1 to 10 of incoming Tacho
Tacho division (multi tooth wheel) 1 to 60

Measurement Range, Accuracy and Resolution
For AM1 & AM2 measurements

Displacement   0–1000um max, ±0.2% typ, ±1.0% max
Resolution of displayed readings better than 1%

For AM3 measurements

Displacement   0–1000um max, ±1.0% typ, ±3.0% max
Resolution of displayed readings better than 1%

For AM4 measurements

Displacement   0–1000um max, ±2.0% typ, ±5.0% max
Phase   0 - 360º, ±1.0º typ, ±5.0º max
Resolution of displayed readings better than 1%

For AM5 measurements

Displacement   0–1000um max, ±2.0% typ, ±5.0% max
Resolution of displayed readings better than 1%
Low Speed mode measurement – true pk-pk
High Speed mode measurement – rms calculated pk-pk
LSM to HSM transition   0 – 50,000 rpm

Noise Floor

Displacement   0.05um pk typ

Transducer Configuration

Eddy Current / Proximity Probe
Sensitivity Range   1.00mV/um to 10.00mV/um
Fixed Options   3.94mV/um & 7.84mV/um
4 – wire system   -24V @ 40mA max
Integrity window   -19.0V to -1.0V
Gap measurement   -20.0V to -0.1V

Thrust / Differential Expansion
Measurement Modes

AM1   Relative Expansion, Y = mX+c
Y is the desired calibrated measurement
X is the proximity probe measured value
m is a scaling factor resulting from calibration
c is an offset factor resulting from calibration

AM2   Complementary Expansion, switches between 2-channels either side of a collar arrangement to enhance measurement range, each channel calibrated Y=mX+c.

AM3   Dual Ramp Expansion, utilises 2-channels on a ramp collar arrangement (Chan A – Chan B) / 2, each channel calibrated Y=mX+c.

Dual level, configurable negative and positive going alarms per channel.

Measurement Units

Displacement mm, um, mil or inch

Filter Characteristics

Low Pass

Measurement Filter 400Hz, 128 sample average
Gap Filter Fixed 3dB at 0.5Hz, 16 sample average

Measurement Range, Accuracy and Resolution

Displacement   0–100mm max, ±0.2% typ, ±1.0% max
Resolution of displayed readings better than 1%

Transducer Configuration

Eddy Current / Proximity Probe
Sensitivity Range   0.8mV/um to 10.00mV/um
Fixed Options   3.94mV/um & 7.84mV/um
4 – wire system   -24V @ 40mA max
Integrity window   -19.0V to -1.0V
Gap measurement   -20.0V to -0.1V

Speed
Measurement Parameters

Frequency Range   0.02Hz to 20kHz
Accuracy   < ±0.1% of reading
Resolution   <±0.1% of full scale
Dynamic range   100mV pk-pk – 20V pk-pk
Measurement Range   0 – 50,000 rpm
                         0 – 1000 Hz

Input Settings

Teeth Setting Range   1 – 256
Threshold mode   Manual Level
Threshold detection   Transistion
Manual detection setting +19.0V to -19.0V

Overspeed Mode

The Overspeed mode when set shall capture maximum machine speed event following a shutdown.   This positive going alarm can be allocated to an appropriate relay.

Overspeed Mode   Auto / Manual
Overspeed Trigger   0 – 50,000rpm

Zerospeed Alarm

The zerospeed alarm is raised when the shaft rotation drops below a set speed. This negative going alarm can be allocated to an appropriate relay.

Zerospeed detection period   1 – 60 seconds

Over Acceleration Alarm

The acceleration alarm is raised if the rate of change of speed exceeds the set percentage. This positive going alarm can be allocated to an appropriate relay.

Acceleration Setting   1 – 1000%
Acceleration Start   100 – 50000 rpm

Transducer Configuration

Eddy Current / Proximity Probe option
Sensitivity   3.94mV/um & 7.84mV/um
4 – wire system   -24V @ 50mA max
Integrity window   -19.0V to -1.0V
Gap measurement   -20.0V to -0.1V
Gap Filter Fixed 3dB at 0.5Hz, 16 sample average

Other Probe options
Passive Magnetic Probe   2-wire 10kOhm
Active Magnetic Probe   2-wire +12V 10kOhm
Active Magnetic Probe   3-wire +12V 10kOhm

Phase Reference (1/rev)
Measurement Mode

When a DSP channel is configured in this mode a phase reference is generated for use by other channels configured in the absolute or relative vibration modes. Up to two channels per module can be configured as a phase reference. The phase reference is selectable from any other module channel connected to the rack system.

Measurement Parameters

Frequency Range	0.02Hz to 20kHz
Accuracy	< ±0.1% of reading
Resolution	<±0.1% of full scale
Dynamic range	100mV pk-pk – 20V pk-pk
Measurement Range	0 – 50,000 rpm
	0 – 1000 Hz
Buffered Output	TTL

Input Settings

Threshold mode	Manual
Threshold detection	Transistion
Manual detection setting	+19.0V to -19.0V

Transducer Configuration

Eddy Current / Proximity Probe option

Sensitivity	3.94mV/um or 7.84mV/um
4 – wire system	-24V @ 40mA max
Integrity window	-19.0V to -1.0V
Gap measurement	-20.0V to -0.1V

Gap Filter Fixed 3dB at 0.5Hz, 16 sample average

Other Probe options	
Passive Magnetic Probe	2-wire 10kOhm
Active Magnetic Probe	2-wire +12V 10kOhm
Active Magnetic Probe	3-wire +12V 10kOhm

Casing Expansion / Valve Position (LVDT)
Measurement Mode

Expansion or Position, $Y = mX + c$
Y is the desired calibrated measurement
X is the LVDT measured value
m is a scaling factor resulting from calibration
c is an offset factor resulting from calibration

Dual level, configurable negative and positive going alarms per channel.

Measurement Units

Displacement mm, um, mil, inch or % of stroke

Measurement Range, Accuracy and Resolution

Displacement   0–1000mm max, ±0.2% typ, ±1.0% max
Resolution of displayed readings better than 1%

Transducer Drive

AC LVDT
Amplitude Voltage	3.5Vrms typ
Frequency	3kHz ± 5%

Integrity Alarms

Invalid measurement alarm is raised if reading falls outside of calibrated stroke range. Transducer integrity alarm raised on loss of valid signal from secondary winding.

Temperature
Measurement Mode

Two channels of temperature measurement are available for each DSP channel. The DSP channel is fixed to a particular sensor type.

Measurement Units

Temperature ºC or ºF

Measurement Range, Accuracy and Resolution

RTD	-20 ºC –150 ºC, ±0.5% typ, ±1.0% max
	Sensitivity 10mV / ºC
K-type	-20 ºC – 1000 ºC, ±0.5% typ, ±1.0% max
	Sensitivity 41uV / ºC
	Junction compensated

Resolution of displayed readings better than 1%

Integrity Alarm

Transducer integrity alarm raised on loss of valid signal from transducer.

Reverse Rotation
Measurement Mode

When two DSP channels are configured in this mode a phase reference is generated by each channel for detection in the module of reverse rotation against a multi-toothed target. Consult Sensonics for details regarding the precise positioning requirement of the probes.

Measurement Parameters

Frequency Range	0.02Hz to 20kHz
Accuracy	< ±0.1% of reading
Resolution	<±0.1% of full scale
Dynamic range	100mV pk-pk – 20V pk-pk
Buffered Output	TTL

Input Settings

Threshold mode	Manual
Threshold detection	Transition
Manual detection setting	+19.0V to -19.0V

Transducer Configuration

Eddy Current / Proximity Probe option
Sensitivity	3.94mV/um or 7.84mV/um
4 – wire system	-24V @ 40mA max
Integrity window	-19.0V to -1.0V
Gap measurement	-20.0V to -0.1V

Gap Filter Fixed 3dB at 0.5Hz, 16 sample average

Other Probe options	
Passive Magnetic Probe	2-wire 10kOhm
Active Magnetic Probe	2-wire +12V 10kOhm
Active Magnetic Probe	3-wire +12V 10kOhm

Threshold mode	Auto / Manual
Threshold detection	Pulse / Gap
Manual detection setting	+19.0V to -19.0V

Forward and Reverse Alarm

Two alarms are available to provide the status of the rotating shaft. Each alarm can be allocated to an appropriate relay.

Zerospeed Alarm

The zerospeed alarm is raised when the shaft rotation drops below a set speed. This negative going alarm can be allocated to an appropriate relay.

Zerospeed detection period   1 – 60 seconds

Rod Drop
Measurement Mode

The Rod Drop measurement mode monitors the position of a piston rod synchronised to a once per revolution phase reference (configured in a separate channel). Alarm functions are available for relative change in rod position from calibration point and for rod vibration. These positive going alarms can be allocated to an appropriate relay.

Measurement Units

Displacement, mm, um, mil or inch

Measurement Range, Accuracy and Resolution

Displacement   0–4mm max, ±0.2% typ, ±1.0% max
Vibration   0–1000um max, ±0.2% typ, ±1.0% max

Resolution of displayed readings shall be < 1%

Average Rod Drop calculated when no sync pulse available.

Transducer Configuration

Eddy Current / Proximity Probe
Fixed Options   3.94mV/um & 7.84mV/um
4 – wire system   -24V @ 40mA max
Integrity window   -19.0V to -1.0V

Rotor to Stator Air Gap
Measurement Mode

The Rotor to Stator Air Gap mode monitors the stator wall gap to the rotor poles synchronised to a once per revolution phase reference (configured in a separate channel). Suitable for hydro turbine generator applications the system utilises readings from suitable capacitive displacement probes fixed at positions around the stator.

Dual level, configurable negative and positive going alarms per channel.

Measurement Units

Gap, mm or inch

Measurement Range, Accuracy and Resolution

Gap   2–32mm, ±1.0% typ, ±2.0% max
Resolution of displayed readings shall be < 1%

Gap measurement provided for average, maximum and minimum with pole number for max and min.

No. of Poles or samples per revolution, 2 to 128.

Transducer Configuration

Capacitive Proximity Probe
Sensitivity   333mV/mm
4 – wire system   +24V @ 150mA max
Integrity window   0.1V to 9.9V

Common Alarm Features
Parameter Alarms

Two parameter alarms (A1 and A2) are available per channel, programmable within the set measurement range. Hysteresis, Latching mode and Delay are configurable.

Hysteresis   1 to 10%, resolution 1%
Delay   1 to 60s, resolution 0.1s
Mode   Latching or Fleeting

For displacement measurements (e.g. thrust, differential expansion, air gap, etc.) each parameter alarm can be configured for both positive and negative going values for window alarming.

For speed measurements each parameter alarm can be configured for either positive or negative going.

Integrity Alarms

The A3 and A4 alarms are allocated to transducer integrity and channel / gap integrity respectively. Hysteresis, Latching mode and delay are configurable.

Hysteresis   1 to 10%, resolution 1%
Delay   1 to 60s, resolution 0.1s
Mode   Latching or Fleeting

Relay Alarms

A single relay is available per channel; this can be allocated to an alarm or group of alarms as required and configured for energised or de-energised to alarm.

For further relay expansion eight channels of Alarm I/O are available at the rear terminals for allocation to available alarm parameters.

Summary Alarms

A single open collector line at the rear terminals is allocated to a 'First up' Alarm for identification of the primary channel alarm in the system rack.

Channel Defeat

Individual channels can be defeated to disable all alarm functionality and also configured to defeat parameter alarms in the event of an integrity alarm. During defeat all other channel interfaces operate as normal.

Alarm Historian

All alarm events are stored and time stamped for later access through the front panel display and drive facility. Capacity to store 100 events.

Alarm Reset

All latched alarm events or individual channel latched alarms can be reset through the front panel display and drive facility.

Park Enable

The Park function permits the analogue outputs to be forced to a preset value in the event of a transducer alarm (user software control only)

Analogue Outputs
Current and Voltage Outputs

Two analogue outputs are available per channel, configurable for either 4 – 20mA or 0 – 10V.

Accuracy	±0.5% of range
Amplitude Linearity	± 1% of range

The analogue output is set across the measurement range as standard.

Buffered Outputs

For each channel the raw transducer signal is buffered to both the front panel and rear terminals.

Frequency Range	DC to 10kHz
Accuracy	± 1%

For speed and timing measurement modes a TTL signal only is available at the rear terminals.

Common Rack Features

Trip Level Multiply or Divide; Module detection of this common rack facility will multiply or divide alarm levels when configured for vibration or speed channels respectively.

Calibration; Module detection of this common rack facility will force the analogue outputs to a preset value. Alarms can be defeated in this mode if required.

Reset; Module detection of this common rack facility will reset all active latched alarms.

Set Up Disable; detection of this common rack facility will disable changes via the front panel user interface and disable the USB interface.

Tacho 1 & 2: speed and phase marker channels can output tacho signal to backplane for use with other measurement channels

Front Panel Facilities

Colour LCD display	Size 43mm x 57mm
	Resolution 240 x 320 pixels
	Backlight Timeout Function
Display Modes	4 Channel Bargraph
	4 Channel Traffic Light
	All Channel Alarm Historian
	Single Channel Alarm
Historian	Single Channel Trend
5000pts	Single Channel FFT 1024pts
LED Indicators	OK Active Green
	ALM Active Red
	TxRx Active Green
Communications	USB Type B Interface
	Windows XP compatible
Navigation	Menu Button
	Drive Button
Buffered Outputs	SMB Jack 75 Ohm

Communications

USB interface for front panel user set up

RS-485 Modbus slave at rear terminals

Power Supply

Module Supply Voltage	+18V to +28V
Module Power Consumption	15W typ 20W max
Rack Supply Voltage	90 - 264Vac 50/60 Hz
Rack Power Consumption (with 6 modules)	90W typ 120W max

Mechanical

Module Dimensions	3U x 12HP x 220mm
Module Mass	0.9kg

Temperature

Operating	-30 ºC to +65 ºC
Storage	-30 ºC to +85 ºC

CE Marking

EN55011 Heavy Industrial Standard conducted & radiated emissions

EN61000-3-2:1995
EN61000-3-3:1995

EN55014 Heavy Industrial Standard Immunity

EN61000-4-2:1995,
EN61000-4-3:1996,
EN61000-4-4:1995,
EN61000-4-5:1995,
EN61000-4-6:1996,
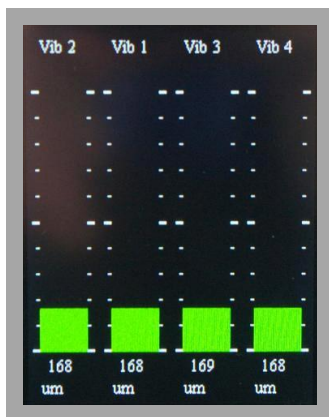EN61000-4-8:1993,
EN61000-4-11:1994
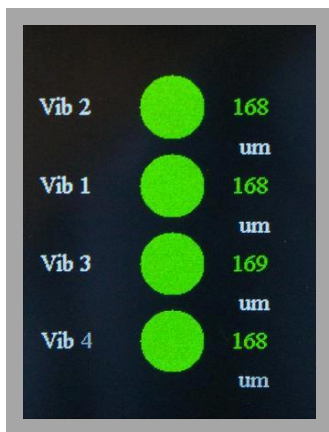
Low Voltage Directive
EN60950:1992+A1+A2+A3+A4

Software Facilities

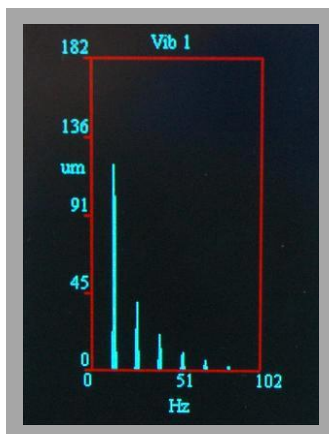**Front panel** permits display of channels in various modes.

Bar Graph with colour coded alarm status



Traffic Light with colour coded alarm status

FFT for dynamic channels

The Sentry G3 **User interface** provides complete set up and control of all module channels. Uploading measurement algorithms to the DSP card, configuring for sensor input type, measurement mode, alarm alarm levels and analogue outputs.

Overall user panel provides intuitive status of the module measured values and alarm status.
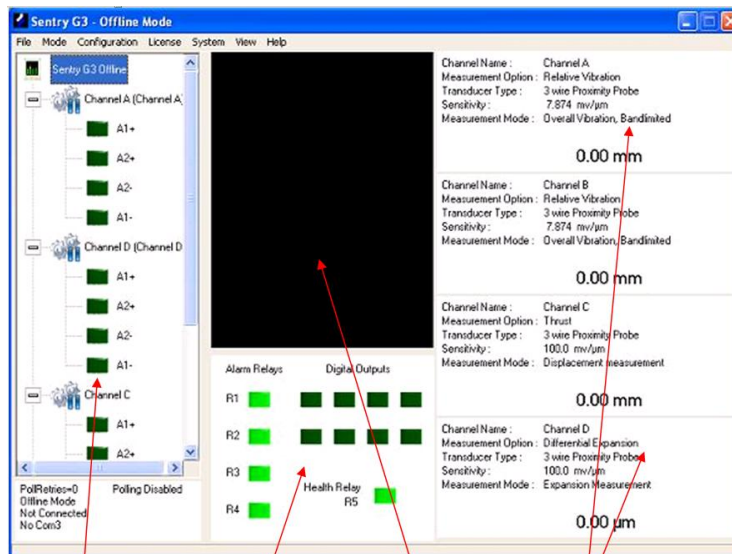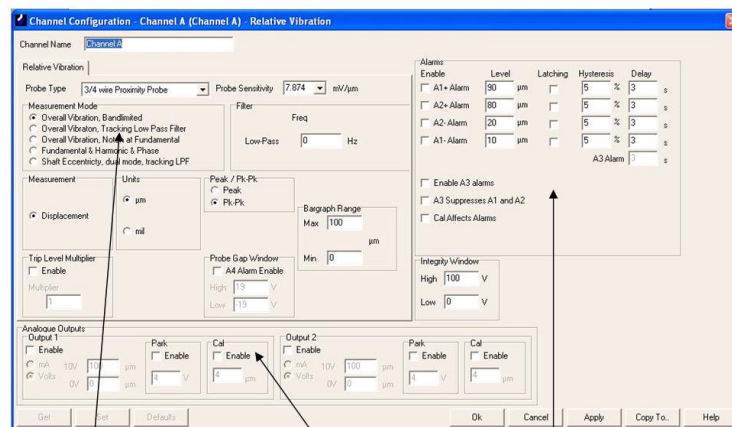

Module Status Window   *Alarm Relay Status and Configuration*   *Module Display Facility*   *Channel Summary Windows*

The channel measurement panel is the same format for all measurement algorithms, providing a common interface for the detailed configuration of the channel parameters.

Measurement mode configuration   *Analogue Outputs Control*   *Alarm Panel Configuration*

If you require assistance with any questions please contact your local Sensonics representative

SENSONICS