

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.

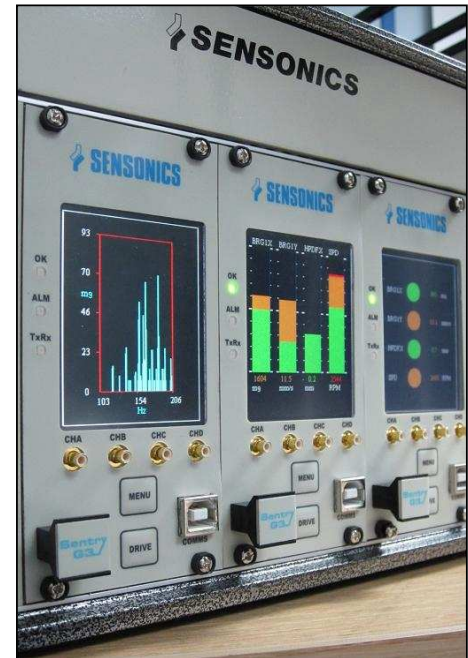
The module is provided with an intuitive colour LCD display and drive facility to provide immediate viewing and access to the machine parameters. Several modes of display are available including an alarm historian and parameter trending per channel.

The module provides the necessary power source for the selected transducer, providing for 2 (ICP type) or 3 – wire accelerometer variants, \pm 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
- Mark - Space Differential Expansion
- Differential Ramp Expansion
- Rotor / Stator Air Gap

Flexible Configuration

- LPF, HPF, Tracking and Notch Filters
- Programmable Warning and Danger Alarms
- 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

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/s² 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 20Log₁₀(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% or 1Hz

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 shall be < 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 shall be < 1%

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 - 360°, ±1.0° typ, ±5.0° max
 Resolution of displayed readings shall be < 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

High Pass

Fixed 3dB at 0.09Hz, 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 shall be < 1%

For AM3 measurements

Displacement 0–1000um max, ±1.0% typ, ±3.0% max
 Resolution of displayed readings shall be < 1%

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For AM4 measurements

Displacement 0–1000um max, $\pm 2.0\%$ typ, $\pm 5.0\%$ max
Phase 0 - 360°, $\pm 1.0^\circ$ typ, $\pm 5.0^\circ$ max
Resolution of displayed readings shall be < 1%

For AM5 measurements

Displacement 0–1000um max, $\pm 2.0\%$ typ, $\pm 5.0\%$ max
Resolution of displayed readings shall be < 1%
Low Speed mode measurement - pk-pk
High Speed mode measurement - rms
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 @ 50mA 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, utilises 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

Gap Filter Fixed 3dB at 0.09Hz
Roll off 20dB / decade

Measurement Range, Accuracy and Resolution

Displacement 0–100mm max, $\pm 0.2\%$ typ, $\pm 1.0\%$ max
Resolution of displayed readings shall be < 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 @ 50mA 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	< $\pm 0.1\%$ of reading
Resolution	< $\pm 0.1\%$ 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 – 60
Threshold mode	Auto / Manual
Threshold detection	Transistion / Level
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
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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 0.09Hz
Roll off 20dB / decade

Other Probe options

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

Mark – Space Differential Expansion

Measurement Mode

Based on timing measurements made with a proximity probe against a series of plates fixed to a shaft. Plate pattern consisting of a number of pairs of tapered teeth and slots equidistantly placed around the shaft. $Y = mX + c$ results.

Y is the desired calibrated measurement
X is the timing measurement translated to displacement
m is a scaling factor resulting from calibration
c is an offset factor resulting from calibration

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

Performance 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
Speed Range	0 – 5000 rpm 0 – 100 Hz

Input Settings

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

Measurement Units

Displacement mm, um, mil or inch

Filter Characteristics

Low Pass

Gap Filter Fixed 3dB at 0.09Hz
Roll off 20dB / decade

Measurement Range, Accuracy and Resolution

Displacement 0–100mm max, ±0.2% typ, ±1.0% max
Resolution of displayed readings shall be < 1%

Transducer Configuration

Eddy Current / Proximity Probe option
Sensitivity 3.94mV/um or 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 0.09Hz
Roll off 20dB / decade

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 shall be < 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 °C or °F

Measurement Range, Accuracy and Resolution

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

Resolution of displayed readings shall be < 1%

Integrity Alarm

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

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	Auto / Manual
Threshold detection	Transition / Level
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 @ 50mA max
 Integrity window -19.0V to -1.0V
 Gap measurement -20.0V to -0.1V

Gap Filter Fixed 3dB at 0.09Hz
 Roll off 20dB / decade

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

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

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 Auto / Manual
 Threshold detection Transistion / Level
 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 @ 50mA max
 Integrity window -19.0V to -1.0V
 Gap measurement -20.0V to -0.1V
 Gap Filter Fixed 3dB at 0.09Hz
 Roll off 20dB / decade

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 @ 50mA 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, $\pm 1.0\%$ typ, $\pm 2.0\%$ 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 'Summary' Alarm (logical OR of all four channel parameter 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.

Analogue Outputs

Current and Voltage Outputs

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

Accuracy $\pm 0.5\%$ of range
Amplitude Linearity $\pm 1\%$ 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 $\pm 1\%$

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.

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

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

Communications

USB interface for front panel user set up

RS-485 Modbus slave at rear terminals

Power Supply

Module Supply Voltage	+24V ± 5%
Module Power Consumption	20W typ 25W max
Rack Supply Voltage	90 - 264Vac 50/60 Hz
Rack Power Consumption (with 6 modules)	120W typ 150W max

Mechanical

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

Temperature

Operating	-20 °C to +65 °C
Storage	-30 °C to +85 °C



Sensonics Ltd,
Berkhamsted,
Herts, HP4 1EF,
England
Tel: +44 (0)1442 876833.
Fax: +44 (0)1442 876477.

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