MODEL 491
PRECISION OVERSPEED MONITOR

The Ectron Model 491 is a high-speed precision overspeed monitor (OSM) that offers protection for turbine engines that may be damaged by excessive speed. A state-of-the-art design offers outstanding response, reliability, and versatile performance.

FEATURES OF THE OSM

- 6 ms response time for frequency >2 kHz.
- ±5 ppm/°C stability over operating range.
- Provides an accurate 4 mA to 20 mA analog output of the speed signal.
- –20°C to 85°C operating temperature range.
- 153 Hz to 25 kHz operating frequency range.
- Provides very high non-failsafe reliability.
- Complies with CSA, NEC, IEC, and CE.
- Proven design with over 6,000 units operating on turbine engines worldwide.

PRIMARY FUNCTIONS OF THE OSM

- Responds to an overspeed condition by instantly issuing a shutdown command via relay.
- Set points programmable: 100% speed, overspeed, start speed, and diagnostics/health speed.
- Provides excitation to and accepts frequency input from a speed sensor.
- Allows user diagnostics and set-point review via the RS-232 port.
- Provides system test capability.

The algorithm used to detect an overspeed event uses a combination of averaging plus the mean of several pulses. When the frequency signal is derived from blade sensing, this algorithm allows for blade flutter without causing an overspeed event. After considerable testing, Ectron engineers were able to develop an algorithm which reduces blade flutter of ±7.5% to only ±0.5% variation of actual rotor speed. Also, when operating with gear-tooth sensing, cyclic signal frequency variation is improved.

Internal encapsulation and rugged construction permit use in unprotected areas including mounting on a turbine engine sled.

OPERATIONAL OVERVIEW

Three relays are incorporated in the OSM. Enclosed in a hermetically sealed housing, these relays provide the following functions:

- Diagnostics and fault relay provides a running indication of the health of the Model 491.
- Overspeed relay normally used for direct engine shutdown.
- Low-speed relay normally used to determine correct engine start-up as well as open-probe detection.

Typical set-point assignments could be as follows:

Set Point	Frequency	Percent
Full Speed	19,000 Hz	100%
Overspeed Trip	20,900 Hz	110%
Health Indicator	18,620 Hz	98%
Low Speed	1,900 Hz	10%

HEALTH INDICATOR

- Normally Open (NO) contact.

With a speed signal greater than the Health Indicator set point, this relay is energized, and the normally open contact is closed. A *green* LED, located on the OSM's front panel, will illuminate.

A hysteresis of approximately 1% of the frequency equivalent to 100% is part of the design. This minimizes relay oscillations when crossing through the Health Indicator set point.

The Health Indicator set point can be modified using the User Interface Menu. The allowable set point range is from 5% to 115% of the 100% frequency set point.

OVERSPEED RELAY

- NO contact – Typically used to interrupt fuel flow to the engine.
- Normally Closed (NC) contact – Control system annunciator.

In the event of an overspeed condition or loss of power, the relay is de-energized and the relay's NO contact is opened. The overspeed relay will remain in the de-energized state until the frequency is less than 153 Hz or 5% of the 100% frequency, whichever is greater, *and* a Reset command is received.

RELAY FOR LOW SPEED AND OPEN-PROBE DETECTION (LSOP)

- NO contact – Enable contact.
- NC contact – Available for annunciator or control functions.

Normal Operation

With no power applied to the OSM, the LSOP relay is de-energized, and the relay's Enable contact is open. With the application of power, the LSOP relay remains de-energized, and the Enable contact is open until the operating frequency signal exceeds the low speed set point. At this time the relay is energized, and the relay's Enable contact is closed.

If speed is reduced to below the low-speed set point, the LSOP relay is de-energized, and the Enable contact opens. The relay will re-energize and close the Enable contact if the speed signal is increased above the low-speed setting. As with the health indicator, a hysteresis of 1% minimizes signal oscillations near the low-speed setting.

Whenever an open probe is detected the LSOP relay will not energize or if energized it is de-energized.

OSM Diagnostics/Fault

Several diagnostics are provided to determine faults within the OSM in the event of a failure. A CRC/Checksum of the NV PROM and the NV EEPROM are included.

The OSM diagnostic/fault will cause the LSOP relay to de-energize, opening the Enable contact, and a *red* LED located on the front panel of the OSM will illuminate. The LSOP relay will remain de-energized with the contact open until the frequency is less than 153 Hz or 5% of the frequency (Hz) equivalent to 100%, whichever is greater, *and* a Reset command is received.

ANALOG OUTPUT

The OSM provides a linear 4 mA to 20 mA source – analog output indicating speed.

- 4 mA is equal to 0 Hz.
- 20 mA is 120% of the frequency (Hz) equivalent to 100%.
- The frequency-to-current accuracy is 0.1% for frequencies from 305 Hz to 20,000 Hz over the operating temperature range.

PROCESSOR TEST FUNCTION

The processor test function provides verification of processor integrity during normal engine operation. The 4 mA to 20 mA analog output is reduced to 50% of the running speed by sending a Reset command. The current output will remain in this state until the voltage is removed from the Reset input. If the current does not change in proportion to this change, there is a problem with the OSM, and appropriate action should be taken.

SYSTEM TEST/OVERSPEED TRIP SET POINT

During engine operation, when the OSM receives an 18 V dc to 33 V dc System Test command, the Overspeed Trip set point is reduced at a rate of 1% per second until it reaches 40% of the frequency equivalent to 100%. When the command is removed, the normal Overspeed Trip set point is restored.

The System Test will force the OSM to trigger a full Overspeed System Test. Calculations can be made using the time elapsed from the application of the System Test input until a backup overspeed trip is initiated to verify proper operation of the OSM.

USER INTERFACE MENU

The menu is accessed from the RS-232 port.

- The User Interface Menu allows the user to view all set-point information in both Hz and percent of frequency (Hz) equivalent to 100%.
- Allows modification of the Health Indicator set point.
- Provides event and status indications and data.
- Provides high-level diagnostics for module failures. Nonvolatile data indicates speed at last overspeed event, maximum speed since last overspeed event, system test request and reset.

SPECIFICATIONS

Response Time: 12 ms maximum to trigger an Overspeed Shutdown over the operating frequency range. Response time is less than 6 ms for frequencies greater than 2 kHz.

Frequency Range: 153 Hz to 25 kHz.

Input Impedance: 10 kΩ resistive.

Input Signal: 0.6 V peak to peak or greater.

Accuracy of 4 mA to 20 mA output:
0.40% of measurement below 305 Hz.
0.10% of measurement from 305 Hz to 20 kHz.
0.15% of measurement from 20 kHz to 25 kHz.

Operating Temperature: –20°C to 85°C.

Stability: ±5 ppm/°C over operating range; ±40 ppm @ 25°C.

Conversion Algorithm: Running median plus median averaging filter.

Reliability: Mean time before safe failure is greater than 160,000 hours at 85°C. Calculated mean time before unsafe failure is greater than 5,500,000 hours. Actual failure rate of 6,000 operating units in the field is 10,095,000 hours mean time to safe failure; there have been no reported unsafe failures.

INPUT SENSORS

- Active variable reluctance sensor (9 V up to 15 mA provided).
- Passive variable reluctance speed sensor.
- Intrinsically safe passive variable reluctance speed sensor.

GROUNDS AND SHIELDING

The OSM's grounds, commons, and filters are isolated from the monitor case. Pins on the I/O connector are available to allow selection of a grounding scheme that best suits the application.

A separate chassis ground pin is available for grounding of the OSM case.

The speed sensor shield is isolated from the electronics and the OSM case.

LOSS OF POWER

The OSM requires a Reset command to return to normal operation upon the restoration of power.

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SPECIFICATIONS

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MEMORY

Configuration Data: Nonvolatile (NV) EEPROM.

Program: (NV) PROM.

INPUT AND OUTPUT

Reset/Processor Test Function Command: 18 V dc to 33 V dc input.

Reduced Set Point: 18 V dc to 33 V dc input.

RELAY RATINGS

Overspeed Relay: 4 A, 32 V dc.

Low-speed Relay/Diagnostic Fault: 4 A, 32 V dc.

Health Indicator: 4 A, 32 V dc.

OTHER

Analog Output: 4 mA to 20 mA.

Maximum Resistive Load: 550 Ω.

Accuracy: ±0.1% of full scale from 305 Hz to 20 kHz.

RS-232 Port: Configuration, testing, and review of set-point data.

Health Indicator: *Green* LED on front panel.

OSM Diagnostics/Fault: *Red* LED on front panel.

ENVIRONMENTAL/MECHANICAL

Storage Temperature: –55°C to 120°C.

Operating Temperature: –20°C to 85°C.

Humidity: 0% to 95%, noncondensing.

Encapsulation: The circuit boards and components are protected from humidity, fungus, vibration, and shock.

Mounting Options:

Flange mount standard.

DIN-rail option available (DIN Type 35).

POWER

Range: 18 V dc to 33 V dc.

Protection: Reverse polarity; –42 V dc continuous.

DIMENSIONS

Dimensions are given excluding terminals and connectors.

	Height	Width	Length
Case Size	60.2 mm (2.37″)	60.5 mm (2.38″)	86.4 mm (3.40″)
With Flange Mount		88.9 mm (3.50″)	
With DIN-Rail Mount	63.38 mm (2.50″)		88.9 mm (3.50″)

CERTIFICATIONS

Compliance with NEC for Class 1, Div. 1 hazardous locations.

- Ambient temperature range: –20°C to 85°C (D).
- Gas group A, B, C, D.
- Temperature code T5.
- Agency and certification # CSA 157789-1349478.
- File # LR35592.

Compliance with CSA for use in Class I, Div. 1 hazardous locations.

- Ambient temperature range: –20°C to 85°C (D).
- Gas group A, B, C, D.
- Temperature code T5.
- Agency and certification # CSA 157789-1349478.
- File # LR35592.

Compliance with applicable publications of The International Electrotechnical Commission (IEC) and certified for use in Category 3 Zone 2 hazardous areas per ATEX directive.

- Ambient temperature range: –20°C to 85°C (D).
- Method of protection EEx nA.
- Gas group IIC.
- Temperature code T5.
- Notified body KEMA.
- Certification number pending.

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