Stator Insulation Monitoring System

Bently Nevada* Asset Condition Monitoring

Description

The Bently Nevada* Stator Insulation Monitoring System uses state of the art technologies to measure the leakage current of motors sized up to 7.5 kV and 1000 Amps. The measurements are made while the motor is online and the system processes the measured data in real time to determine the condition of the stator insulation in the motor. The system consists of a 9-channel 3500/82 monitor that accepts inputs from the 350820 High Sensitivity Current Transformer (HSCT), 350822 High Voltage Sensors (HVS), and 4-20 mA process signals corresponding to motor temperature measurements. The 3500/82 processed data and results can be displayed on the 3500/94 Display. The user can configure the 3500/82 using the 3500 Rack Configuration Software to perform the following functions:

- Display instantaneous stator leakage current on each phase of the motor.
- Display compensated dissipation factor and change in dissipation factor from a given reference point.
- Display motor stator temperature and average temperature.
- Display line voltage and frequency data values.
- Retrieve historic data stored on board the monitor for data analysis.
- Set alarm levels for annunciation.
- Configure the temperature range and time period for learn and extend modes for temperature learning, and view the current learning state.
- View the number of temperature samples, vs. operating temperatures, that builds the learning curve used for temperature compensation.

Note: The 3500/82 monitor should not be used for machine protection.

The 3500/82 can accept 3 HSCT, 3 HVS, and 3 4-20mA process inputs from stator RTD temperature measurements. Since the interface modules are capable of driving long field cables, the monitor can be situated in a control or instrumentation room up to 330 meters (1,000 feet) away from the motor or the interface modules.

The 3500/82 is featured with measurement trending by comparing the current measurements to any historical data taken in the last 10 years (if the historical data is available). The time window for comparison is user configurable.

The 3500/82 monitor has eight buffered outputs for diagnostic purposes, 3 each HVS and HSCT values for each of those corresponding inputs, an average temperature from the temperature inputs, and a synchronization phase pulse reference signal.
Monitor Specifications

Parameters are specified from +20 °C to +30 °C (+68 °F to +86 °F) and at 50/60 Hz unless otherwise indicated.

**Note:** Operation outside these specified limits may result in a larger variation in readings from what is listed below, or a loss of machine monitoring all together.

### Inputs

**Input Signals**
Accepts 3 HSCT, 3 HVS, and 3 4-20mA temperature inputs.

**Input Impedance**
- 150 kΩ // 1nF (for HSCT & HVS)
- 200 Ω (for 4-20 mA temperature)

**Input Frequency Range**
40 to 70 Hz

**Power Consumption** (not including external power supply)
15 watts, typical

**HSCT External Power Required**
+24V ± 2% @ 0.75 A Nominal Over temperature

### Outputs

**Front Panel LEDs**

- **OK LED**
  Indicates when the system is operating properly.

- **TX/RX LED**
  Indicates when the 3500/82 is communicating with other modules in the 3500 rack.

- **Bypass LED**
  Indicates when the 3500/82 is in Bypass Mode.

### Buffered Outputs

The front of the monitor has eight coaxial BNC connectors for each of the HVS and HSCT outputs and average temperature output, and a phase reference pulse (Sync). Each connector is short-circuit protected. The output from all 8 BNCs is voltage proportional to the input signals.

**Output Impedance**
499Ω ±1%

**Output Range**

- **HVS and HSCT Channels (6 BNCs)**
  Dynamic: 1.6 to 10.4V, ±5%.
  Bias: 6V ±5%.

- **Average Temperature Channel (1 BNC)**
  2.0 to 10.0V, ±5%, for -40 to 200 °C (default, but can be user configurable)

- **Sync (1 BNC)**
  Digital Pulse: 0 to 10.0V, ±5%.

### Sensor Specifications

Parameters are specified from +20 °C to +30 °C (+68 °F to +86 °F) and at 50/60 Hz unless otherwise indicated.

**Note:** Operation outside these specified limits may result in a larger variation in readings from what is listed below, or a loss of machine monitoring all together.

**Sensitivity**

- **HSCT Output Sensitivity**
  3.3mV / mA nominal, each unit marked with its specific sensitivity ±1%
  Linearity: ±0.25%

**Phase**
6° nominal, each unit marked with specific phase shift for that unit, ±0.5°.
Linearity: ±0.5°
Temperature impact on phase: +2° at minimum operating temperature,
-1° at maximum operating temperature.

Current
1.4 A peak to peak (sine wave) full-scale.

HVS Output
0.76mV / V ±5%
8 kVrms full-scale line to neutrall

Interface Module Outputs
HSCT Interface Module Output
Gain: 3V/V

HVS Interface Module Output
Gain: 0.625V/V with 77 kΩ source impedance

Temperature Interface Module Output
66.6 µA / °C ±2%, (default)
-40 to 200 °C full-scale (user configurable)

Signal Conditioning in 3500/82 Monitor

HVS and HSCT
Overall Frequency Response

Direct
1 Hz to 8.5 kHz ±3.0 dB
User configurable

1X Filter
50 or 60 Hz
User configurable

Overall Accuracy Amplitude
±1% of full-scale, Typical

±2% of full-scale, Maximum

Phase
±1°, Typical
±2°, Maximum

Filter Quality
High-Pass
2-pole (40 dB per decade)

Low-Pass
2-pole (40 dB per decade)

Overall Accuracy
±1% of full-scale, Typical
±2% of full-scale, Maximum

Temperature
Overall Frequency Response
3 Hz -3.0 dB

Overall Accuracy
±1% of full-scale, Typical.
±2% of full-scale, Maximum.

Filter Quality
Low-Pass
2-pole (40 dB per decade)

Overall Accuracy
±1% of full-scale, Typical.
±3% of full-scale, Maximum.

System Alert/Alarm Setting

Alarm Setpoints
The user can use software configuration to set Alert levels for each value measured by the monitor and Alarm setpoints for any values measured by the monitor. Alarms are adjustable from 0 to 100% of full-scale for each measured value.
Alarm Time Delays
The user can program alarm delays using software as follows:

Alert & Danger
From 1 to 60 seconds in 1 second intervals.

Note: Applies to temperature, voltage and current measurements. The 3500/82 system Alert/Alarms are for annunciation only and should not be used for machine protection.

Environmental Limits

Operating Temperature Range

Transducers & Interface Modules
-20 °C to +70 °C
(-4 °F to +158 °F)

3500/82 Monitor
-30 °C to +65 °C
(-22 °F to +149 °F)

MTL and P+F Barriers
-20 °C to +60 °C
(-4 °F to +140 °F)

Storage Temperature

Transducers / Interface Modules
-40 °C to +85 °C
(-40 °F to +185 °F)

3500/82 Monitor
-40 °C to +85 °C
(-40 °F to +185 °F)

MTL Barriers
-40 °C to +80 °C
(-22 °F to +149 °F)

P+F Barriers
-25 °C to +70 °C
(-13 °F to +158 °F)

Shock Survivability

Transducers
100 g peak, maximum

Interface Modules

Reliability

MTTF
> 100,000 hours

MTBF
> 100,000 hours

Physical

Monitor Module
Dimensions
(Height x Width x Depth)
241.3 mm x 24.4 mm x 241.8 mm
(9.50 in x 0.96 in x 9.52 in)

Weight
0.97 kg (2.14 lb.)

I/O Module
Dimensions
(Height x Width x Depth)
241.3 mm x 24.4 mm x 91.1 mm
(9.50 in x 0.96 in x 3.90 in)

Weight
0.41 kg (0.91 lb.)

Rack Space Requirements

Monitor Module
1 full-height front slot

I/O Module
1 full-height rear slot

HVS and HSCT Interface Modules
Dimensions
(Height x Width x Depth)

3500/82 Monitor
200 g peak, maximum

Relative Humidity
95% non-condensing
(75% non-condensing for P+F barriers)

Magnetic Field Susceptibility
<500µV/gauss (50 gauss, 50-60Hz)

Transducers

Common Mode Line Current
Up to 1,000A rms, nominal

Line Voltage
Up to 7.5kV† rms, nominal

†Operating voltage less than 2kV has limitations from the HVS.
**Weight**

0.21 kg (0.46 lb.)

**Signal Input Connector**

2-pin circular Lemo (HVS)
3-pin circular Lemo (HSCT)

**Power/Sig out Connector**

5-pin spring compression

**HSCT Overall Diameter**

See Figure 4

**Height**

See Figure 4

**Weight**

4.2 kg (9.25 lb.)

**Case Material**

Aluminum

**Connector**

2-pin Mil-C- 26482

**Polarity**

Pin A = Positive Signal
Pin B = Negative Signal

**Mounting**

Bracket Mount

**Temperature Interface Module**

**Dimensions**

(Height x Width x Depth)

See Figure 7

**Weight**

0.13 kg (0.28 lb.)

**Mounting**

DIN rail mount

**Entity Parameters**

The following parameters apply for both CSA-NRTL/C and ATEX approvals.

**HVS and HSCT Channel Approval Parameters**

**MSIM Circuit Parameters**

\[ V_{\text{max}} \text{ (PWR)} = 28 \text{ V} \]
\[ I_{\text{max}} = 60 \text{ mA} \]
\[ V_{+/-\text{SIG}} = 12 \text{ V} \]
\[ I_{+/-\text{SIG}} = 10 \text{ mA} \]
\[ R_{\text{min (PWR)}} = 253 \Omega \]
\[ R_{+/-\text{SIG}} = 253 \Omega \]

**Channel Parameters (entity)**

\[ V_{\text{max}} \text{ (PWR)} = 28 \text{ V} \]
\[ I_{\text{max}} = 119 \text{ mA} \]
\[ R_{\text{min (PWR)}} = 253 \Omega \]
\[ R_{+/-\text{SIG}} = 253 \Omega \]

**Interface Module Circuit Parameters**

\[ V_{\text{max}} \text{ (PWR)} = 15 \text{ V} \]
\[ I_{\text{max}} = 50 \text{ mA} \]
\[ V_{+/-\text{SIG}} = 12 \text{ V} \]
\[ I_{+/-\text{SIG}} = 10 \text{ mA} \]
\[ R_{+/-\text{SIG}} = 253 \Omega \]

**Temperature Interface Module Approval Parameters**

**MSIM Circuit Parameters**

\[ V_{\text{SIG}} = 15 \text{ V} \]
ISIG = 20 mA  
R_{SIG} = 100 \, \Omega

Channel Parameters

\( V_{SIG} = 15 \, \text{V} \)  
\( I_{SIG} = 20 \, \text{mA} \)  
\( R_{SIG} = 100 \, \Omega \)

Interface Module Circuit Parameters

\( V_{MAX \, (PWR)} = 35 \, \text{V} \)  
\( I_{MAX} = 200 \, \text{mA} \)  
\( V_{SIG} = 12 \, \text{V} \)  
\( I_{SIG} = 20 \, \text{mA} \)

Compliance and Certifications

EMC

Standards:
- EN 61000-6-2 Immunity for Industrial Environments
- EN 55011/CISPR 11 ISM Equipment
- EN 61000-6-4 Emissions for Industrial Environments

European Community Directives:
- EMC Directive 2004/108/EC

Electrical Safety

Standards:
- EN 61010-1

European Community Directives:
- 2006/95/EC Low Voltage

Hazardous Area Approvals (Sensors and Interface Modules)

North America

CSA Zone 2 / Class I, Division 2
CSA Zone 0 / Class I, Division 1 (when installed with barriers)

European/ATEX

ATEX Zone 0 (when installed with barriers)

For further certification and approvals information please visit the following website:
www.ge-mcs.com/bently

Ordering Considerations

General

The 3500/82 monitor requires 50% more power than other 3500 monitors. To prevent overloading the 3500 systems power budget on a full size rack, a blank slot is recommended for each 3500/82 monitor installed.

3500/82 Stator Insulation Monitors added to an existing 3500 Monitoring System, require the following (or later) firmware and software versions:

3500/82 Firmware

Version 1.00, or later, for approvals certification

3500/22M RIM Firmware

Revision 1.70 or later

3500 Rack Configuration Software

Version 4.9 or later

3500/93 System Display Firmware

Version 3.0 or later

3500/94 VGA Display Firmware

Version 3.0 or later

System 1™ Software

Version 6.0 or later

Hazardous Area Approvals (3500/82 Monitor)

North America

CSA Zone 2 / Class I, Division 2

European/ATEX

No approvals, must be installed in a non-hazardous area.
### System Components

The following hardware components are required for a successful installation:

- Three (3) 350820 High Sensitivity Current Transformers (HSCTs)
- Three (3) 350821 HSCT Interface Modules
- Three (3) 350825 HSCT Interface Cables
- A minimum of Two (2) 350822 High Voltage Sensors (HVSs). Three (3) are recommended.
- One (1) 350823 High Voltage Sensor Interface Module for each 350822 ordered.
- Three (3) barriers for each HSCT and HVS to be installed. *Applicable to Hazardous Area installations only*.
- One (1) 350824 RTD temperature convertor. Three (3) are recommended.
- One (1) 3500/82 Stator Insulation Monitor with corresponding I/O module.
- One (1) 181945 24 VDC 3.5A external power supply for each 3500/82 monitor. Larger power supplies can be used to power multiple 3500/82 monitors. Consult the input power requirements when selecting a different power supply.

### Ordering Information

#### Monitor

**3500/82-AXX-BXX-CXX**

- **A:** I/O Module Type
  - 00: MSIM I/O Module with Internal Terminations
  - 01: DIN Mount

- **B:** External Power Supply Option
  - 00: Not Provided
  - 01: 24Vdc, 3.5A DIN Rail Mount

- **C:** Agency Approval Option
  - 00: None
  - 01: CSA (Class 1, Zone 2 / Div 2)

#### HSCT

**350820-AXX-BXX**

- **A:** Inner Diameter
  - 01: Up to 7.5 kV*

*Operating voltage less than 2kV has limitations from the HVS.

- **B:** Agency Approval Option
  - 00: No Approvals
  - 04: CSA C/US Zone 2 / Div 2
  - 05: Multi-Approvals Zone 0 / Div 1

#### HSCT Interface Module

**350821-AXX-BXX**

- **A:** Mount configuration
  - 00: Panel Mount
  - 01: DIN Mount

- **B:** Agency Approval Option
  - 00: No Approvals
  - 04: CSA C/US Zone 2 / Div 2
  - 05: Multi-Approvals Zone 0 / Div 1

#### HSCT Cable

**350825-AXX**

- **A:** Cable Length
  - 05: 5 meters

#### HVS

**350822-AXX-BXX**

- **A:** Voltage Divider
  - 01: 15 kV Full Scale Range

- **B:** Agency Approval Option
  - 00: No Approvals
  - 04: CSA C/US Zone 2 / Div 2
  - 05: Multi-Approvals Zone 0 / Div 1

#### HVS Interface Module

**350823-AXX-BXX**

- **A:** Mount configuration
  - 00: Panel Mount
  - 01: DIN Mount

- **B:** Agency Approval Option
  - 00: No Approvals
  - 04: CSA C/US Zone 2 / Div 2
  - 05: Multi-Approvals Zone 0 / Div 1

#### Temperature Interface Module

**350824-AXX**

- **A:** Preconfigured Temperature Range & Sensor Type
  - 01: -40 °C to +200 °C
(-40 °F to +392 °F)
3-wire 100Ω PT RTD

Barriers
Barriers are required to protect the HSCT and HVS when installing them in Zone 0 hazardous areas. Barriers are installed between the 3500/82 monitor and the HSCT/HVS interface modules. There are 3 barriers required for each sensor, 1 barrier for power, and 2 for signal (SIG + and SIG -).

MTL Barriers

100M1770
MTL 7715+ safety barrier for signal

100M1771
MTL 7728P+ safety barrier for power

For further information on these MTL barriers, please visit the following website:

Pepperl+Fuchs Barriers

100M5332
P+F Z715+ safety barrier for signal

100M5333
P+F Z779.H safety barrier for power

For further information on these P+F barriers, please visit the following website:

Spares

100M2907-01 3500/82 Stator Insulation Monitor

324197-01 MSIM I/O Module

181945 28 Vdc 3.5A Power Supply (Din Rail Mount)

100M1761 Base unconfigured MTL5575 temperature isolator. Requires 143324-01 to configure.

102M0274-01 3500/82 Stator Insulation Monitor Manual

Field Wiring Considerations

4 wire shielded 18 AWG shielded cable.

02171490 Belden 89418
Graphs and Figures

Figure 1: 3500/82 Stator Insulation Monitor and I/O Module

1. 3500/82 Monitor (front view)
2. Status LEDs
3. Buffered Transducer Outputs (HSCT & HVS)
4. Buffered Transducer Output (Average Temperature)
5. Buffered Transducer Output (Phase Synchronization)
6. MSIM I/O Module
7. External 28 Vdc Power Input
8. HVS Inputs
9. HSCT Inputs
10. Temperature Inputs (4-20 mA)
1. 350821/350823 Mounting Option AXX = 00

**Figure 2: Panel Mount HSCT/HVS Interface Module**

1. 350821/350823 Mounting Option AXX = 01
2. 35mm DIN rail (Not Included)
3. Additional 3 mm \(0.120\) in required to remove from DIN rail.

**Figure 3: DIN Rail Mount HSCT/HVS Interface Module**
Figure 4: High Sensitivity Current Transformer
Note: Dimensions above represents AXX option = 01.

Figure 5: HSCT Interface Cable

1. 300V, 105°C, 22 AWG twisted shielded pair PVC cable
2. 5.5 mm [0.216 in] maximum diameter
3. MIL-C-26482 circular connector (connects to HSCT)
4. LEMO 3-pin circular connector (connects to the HSCT interface module)
5. Cable Length = 5 +/- 0.2 meters
1. ¼-20 High Voltage Terminal
2. 3/8-16 Earth Ground Terminal†
3. 300V, 105°C, 22 AWG twisted shielded pair PVC cable (4.5 meters)†
4. LEMO 2-pin circular connector (connects to the HVS interface module)

Figure 6: High Voltage Sensor
†This terminal is an electrically isolated mounting terminal on the intrinsically safe HVS. Consult field wiring drawing 100M5071 for important grounding requirements for hazardous area installations.

1. Top of DIN rail
2. 35mm DIN rail (Not Included)

Figure 7: Temperature Interface Module