Operation Manual

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• Model Number
• Quantity
• Serial Number
• Symptoms of the problem with the unit if being returned for service.
• Original P.O. Number or Schaevitz® Sales Number if under warranty.

If a Schaevitz® instrument requires service, first contact the nearest Schaevitz® representative. He/she may be able to solve the problem without returning the unit to the factory. If it is determined that factory service is required, call the Repair Department for an RMA number before returning the unit.

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Product Description

General
The new Schaevitz® analog transducer amplifier is a general purpose, AC line powered LVDT/RVDT conditioner that features state of the art design principals. The new SMT design utilizes an embedded microprocessor to generate a PWM shaped sine wave and control all calibration functions. The processor is also employed in the demodulation, filtration and synchronization of the LVDT signal. All settings are stored in non-volatile memory for restoration on power-up. Zero, Span, and Phase adjustments are accomplished via the use of splash proof front panel push buttons and digital voltage dividers, eliminating the need for drift inducing screw adjust potentiometers. All amplifier controls are accessible from the outside of the rugged aluminum enclosure.

The new ATA 2001 is awaiting CE approval, pending the completion of the necessary testing and certification process. This new design is intended for use in the most rigorous, industrial applications. The ATA 2001 has been tested to the highest industrial standards for EMT, RFI and ESD, and was designed to meet the latest Common Europe standards applicable through the end of 1996.

The ATA 2001 LVDT signal conditioner is designed for universal compatibility with all 4, 5, and 6 lead LVDTs and RVDTs. A wide range of oscillator frequencies combined with two excitation voltages, 3.5 and 0.5 Vrms, provide maximum versatility. The high power carrier amplifier has more than twice the drive capability of previous designs. Able to power low impedance LVDTs at higher amplitudes, this new design will provide measurement resolutions beyond any product currently available.

An auto fallback synchronization feature allows reliable master/slave operation, for prevention of amplifier crosstalk without the worry of sync signal loss. If the internal processor in a slaved amplifier detects an unstable or missing sync signal, the internal clock will take over, continuing at the pre-selected nominal frequency. Upon restoration of a normal sync pulse, the oscillator will return to the slave mode.

Physical Construction
The Schaevitz® ATA 2001 analog transducer amplifier is contained within a rugged one piece, extruded, aluminum housing. The one piece design provides optimal amplifier performance under the most rigorous EMT and RIFT conditions. An integral panel mounting system provides for convenient 1/8 DIN standard, panel installation. Prepunched 19" rack adapters are available from Schaevitz® to accommodate up to eight amplifiers per adapter installation. Consult the factory for availability.
Specifications

**Electrical:**

**Power Requirements**
115VAC ± 10% 50 to 400Hz. &
220VAC ± 10% 50 to 400Hz.
(switch selectable)

**Line Voltage Regulation**
±10%, no change in output

**Transducer Excitation:**
- **Voltage**
  3.5 Vrms nominal (switch selectable for 0.5Vrms.)
- **Frequency**
  2.5, 5.0 & 10kHz. (switch selectable)
- **Current**
  45mA rms. (max.)

**Analog Output:**

- **Voltage output:**
  - **Bipolar**
    ±10VDC max. (10 mA max.)
  - **Unipolar**
    0 to 10VDC max. (10 mA max.)
    (with 100% zero suppression)
- **Output impedance**
  <1Ω
- **Noise and ripple**
  <3mVrms. at 2.5kHz. excitation
- **Current output**
  4 to 20mA

**Maximum loop resistance**
- 700Ω (with internal loop supply)
- 100Ω (with 24VDC external loop supply)

**Noise and ripple**
- 10μArms. (max.)

**Frequency Response:**

- **-3 dB down at:**
  - **(nominal)**
    - 250Hz for 2.5kHz excitation
    - 500Hz for 5.0kHz excitation
    - 1000Hz for 10kHz excitation

Schaevitz®
ATA 2001 LVDT Signal Conditioner

**Amplifier Characteristics:**

- **Sensitivity range**
  - high gain: 0.040 to 0.9 VAC rms. in = 10 VDC output
  - low gain: 0.500 to 10.0 VAC rms. in = 10 VDC output
  - note: -5 VDC output = 4.0 mA current output
  - +5 VDC output = 20 mA current output
  - 0 VDC output = 12 mA current output

- **Input impedance**: 100 kΩ

- **Zero suppression**: ± 110% full scale output

- **Phase shift compensation**: ±120° maximum

- **Non-linearity and hysteresis**: < ±0.05% of full scale output

- **Stability**: better than ±0.05% of full scale output (after 20 min.)

- **Tempco**: < ±0.02% of full scale output per deg. F (0.04% per deg. C)

- **Operating temperature**: -40° F to +185° F (-40 to +85° C)
Controls, Adjustments and Indicators

Front Panel (See Fig. 1 on page 6)
The ATA 2001 combined control and indicator panel is manufactured from a Polyester™ membrane assembly with an integral RFI/ESD layer screened onto the rear of the outer surface. All push button controls are provided with tactile feedback for maximum operator interface. The operator is assured verification of control inputs through a system of red and green LED indicator signals.

Keypad Controls

Zero: Sets the zero position or offset within the full measurement range of the sensor.

Span: Sets the full scale output of the amplifier to the desired voltage or current.

Phase: Optimizes amplifier demodulation to compensate for cable or LVDT design induced output phase shift.

Press FINE and COARSE simultaneously to unlock the keypad. The red power LED will extinguish and the green LED will illuminate. Once unlocked, the keypad will automatically re-lock after about 1.5 minutes of inactivity. The green LED will extinguish and the red LED will illuminate.

Note: zero, span and phase settings will be written to non-volatile EEROM upon keypad re-lock.

Press FINE to establish fine resolution mode, or COARSE to set up the coarse mode.

Pressing ZERO+ and ZERO− simultaneously will set the zero offset to approximately 0.0 volts.

Pressing SPAN+ and SPAN− simultaneously will set span to mid-scale. Since span is "logarithmic", "mid-scale" default gain setting is not meaningful in the same sense as the zero default, but is a useful shortcut for returning to the factory default setting.

Pressing PHASE+ and PHASE− simultaneously will set phase correction to zero, or in phase with the oscillator output signal.

The green LED will blink after each setting, to indicate execution of the command.

Holding down ZERO, SPAN or PHASE keys will evoke auto repeat. When auto-repeating, the green LED will flash in approximate proportion to the slew rate. When you reach the setting limit, the flashing stops.

Press COARSE and FINE simultaneously to force EEROM save of settings without waiting for the keypad to auto-disable.
ATA 2001 LVDT Signal Conditioner

Figure 1: ATA 2001 Series Front Panel View

Figure 2: ATA 2001 Series Rear Panel View
Controls and Adjustments

**Rear Panel** *(See Fig.2 on page 6)*

All remaining ATA 2001 controls are found on the rear panel. The following table explains the switch positions and functions.

<table>
<thead>
<tr>
<th>Switch Number</th>
<th>Position/Function</th>
<th>Gain</th>
<th>Oscillator</th>
<th>Frequency</th>
<th>Osc. Sync.</th>
<th>Not Used</th>
<th>Osc. Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>High</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Slave</td>
<td>x</td>
<td>0.5 V rms.</td>
</tr>
<tr>
<td>OFF</td>
<td>Low*</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Master*</td>
<td>x</td>
<td>3.5 V rms.*</td>
</tr>
<tr>
<td>2.5 kHz.*</td>
<td></td>
<td>x</td>
<td>On*</td>
<td>Off</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>5.0 kHz.</td>
<td></td>
<td>x</td>
<td>Off</td>
<td>On</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>10.0 kHz.</td>
<td></td>
<td>x</td>
<td>On</td>
<td>On</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

*Denotes default settings

Note: There are no user accessible controls within the amplifier housing. Do not open the ATA 2001 for any reason as there are high voltages (line voltage) on portions of the circuit board.
Mounting Instructions

Cutout
The ATA 2001 is designed to be mounted in a 1/8th DIN standard panel cut out. The dimensions for the installation opening are: 3.662" +.032 -.000 wide by 1.772" +.024 -.000 high, (92mm +.81 -.0) wide by (45.01mm +.61 -.0) high. This is the same mounting standard used by most common digital panel meters. The minimum recommended panel thickness is .060" (1.52mm). The maximum is .250" (6.35mm). All the necessary hardware for panel installation is provided.

Installation
Remove the recessed socket head set screws from the center holes at the sides of the rear panel. Slide the panel jacks to the rear, out of their slots. Install the ATA 2001 from the front of the mounting hole. Slide the panel jacks back into their slots, pushing them up against the rear of the panel. Be careful not to over tighten, then reinstall the socket head jack screws.

Figure 4: ATA 2001 Series Cut out Panel View
Wiring

Input
The LVDT input connects to P1. The mating connector is a DE9P subminiature 9-pin "D", is supplied in the box with this amplifier. Separate, shielded, twisted, two pair cable, is recommended for hook-up between the LVDT or RVDT and the P1 transducer input connector. Proper low capacitance instrumentation cable should be used to insure best performance and compliance with CE standards for emissions and susceptibility. Belden™ 8723 or equivalent is recommended. The ATA 2001 is a four wire amplifier and does not require connection of the center tap to the input connector for direction sensing. All six wire LVDTs and RVDTs should have external center tap jumpers installed as close to the transducer as possible.

Cable Length
At 2.5kHz, most LVDTs will operate with cable runs of up to 350 feet. Some LVDTs, depending upon design characteristics, are less tolerant of cable capacitance, and may exhibit adverse effect on linearity. If you experience difficulty with calibration, consult the factory for additional information about cabling effects on specific models.

Particular attention must be given to proper shield termination to prevent ground loops and EMI interference with the LVDT signal. Single shield, multiple twisted pair cable is not recommended for multiple LVDT installations (see master/slave operation). Separate cables for each transformer will yield best results. See Figure 5A & 5B (pages 10 & 11) for hook-up diagrams and shielding recommendations.
ATA 2001 LVDT Signal Conditioner

Figure 5A
INPUT CONNECTIONS – LVDT WITH LEADS OR CABLE

BELDEN 8723 OR EQUIVALENT

INPUT CONNECTIONS – LVDT WITH CONNECTOR

Figure 5B
Inputs

The signal output connector, P2, is a five position, "Euro" style, plug-in screw terminal barrier strip. This connector was chosen for its ease of use and small footprint. Once all of the connections are made, the amplifier may be removed and reinstalled without disconnecting the individual wires. The wire clamps are designed to accept stripped and tinned wires with no soldering required. See Figure 6A & 6B (pages 13 & 14) for P2 connection information. The ATA 2001 has several output signal options. They are as follows:

Voltage

Bipolar
Most LVDTs may be calibrated for ±10, or ±5VDC, for plus and minus full scale displacement of the sensor.

Unipolar
Single ended calibration options are, 0 to 10, or 0 to 5VDC. for minus to plus full displacement of the sensor. Half the calibrated full scale voltage is at null. A zero to ten volt calibration would have an output of five volts at the transformer null position.

Current

The 4 to 20mA current output is most beneficial in applications with long signal runs. The 4 to 20 signal maintains a constant current in the control loop for a given sensor position. Changes in loop resistance or voltage, within operating parameters, will not effect the position signal. Current loops also have greater resistance to electromagnetic and radio frequency interference. A shielded, twisted, wire pair is recommended for best immunity.

4 to 20mA internal loop power
This option is used when no external loop power supply is available. The ATA 2001's internal power supply provides the voltage potential necessary for the current loop. This feature should not be used with current receivers configured to supply external loop power.

4 to 20mA external loop power
This option allows operation of the ATA 2001 with powered receivers. As the internal loop supply in the ATA is limited to 18VDC, using external 24 to 28 volt (DC) power, increases allowable loop resistance.
OUTPUT DIAGRAMS

VOLTAGE OUTPUT

4-20mA CURRENT OUTPUT USING THE INTERNAL LOOP SUPPLY

4-20mA CURRENT OUTPUT USING THE EXTERNAL LOOP SUPPLY

Figure 6A
1. ONLY ONE UNIT MAY BE SET UP AS THE MASTER ALL OTHERS MUST BE CONFIGURED AS SLAVES.

2. ALL UNITS MUST HAVE THE SAME CARRIER FREQUENCY SETTING.

3. ONE MASTER CAN SYNC UP TO FOUR SLAVES.

4. A SINGLE, FOIL SHIELDED CONDUCTOR IS BEST FOR SYNC WIRING. A TWISTED, FOIL SHIELDED, PAIR MAY BE USED. USE SHORTEST CABLE POSSIBLE.

Figure 6B
Master/Slave Operation

Carrier Synchronization
Multiple transducer applications, with LVDTs in close proximity to each other, or with long common cable runs, should be synchronized. Failure to do this may result in crosstalk of position signals due to interaction of the oscillators. Select one amplifier as the master, the remaining amplifiers will all be slaves. Set the master/slave switches (S4) in the appropriate positions for each ATA 2001. Check the section on rear panel controls for switch settings. Connector P3 is used for synchronization wiring. This is a three position Euro style connector similar to P2. Proper foil shielded, twisted pair cable with lengths kept as short as possible, should be used. (See figure 6B for connection information.)

Preliminary Set up

About the Numbers
The factory default settings will work for most standard LVDTs calibrated over their nominal linear stroke. Exceptions to this rule are LVDTs with very low primary impedance or high phase shift at lower oscillator frequencies. All MHR series LVDTs will work best at 10kHz. The higher excitation frequency will increase the LVDT’s primary impedance and output sensitivity. This higher impedance will result in lower oscillator current draw, allowing higher drive voltages with less heating effect on the coil. This will reduce the temperature sensitivity of the measurement system. An additional benefit of the higher drive voltage is the reduction in gain required for calibration. This will improve overall signal immunity to external noise or interference. All XS-B series LVDTs should be operated at 0.5Vrms and 10kHz, due to extremely low primary impedance. Any attempt to operate the XS-B at 3.5Vrms may cause damage to the LVDT. The ATA 2001 is protected against overload and will not be harmed. Consult the catalog, or transducer calibration sheet for specific LVDT frequency recommendations.

Preliminary Settings
Unless you are dealing with one of the exceptions above, verify that all switch settings agree with defaults on the controls table. (Fig. 3 on page 7) The ATA 2001 will calibrate for ±10VDC, using the default factory gain with LVDT having full scale outputs ranging from 0.5Vrms and up. If your calculated full scale output is less than 0.5Vrms, use the high gain setting.
Getting Started

Here are some basic formulas before getting started:

Calculating LVDT drive current for a given excitation voltage and primary impedance.

**Drive Current = Osc. Voltage ÷ Pri. Impedance** (at the specified frequency).

**Example 1:** 3.5Vrms ÷ 125 ohms = .028 amps or 28mA (this will work).
**Example 2:** 3.5Vrms ÷ 50 ohms = .070 amps or 70mA (this will not work).

**Question:** Why won't example two work?

**Answer:** If you check the specification table on page 4 of this manual, you will see that the maximum oscillator drive current available is 45mA. Example two exceeds this specification.

**Question:** Will the ATA 2001 still work with my low impedance LVDT?

**Answer:** Yes, you have two options. You may try increasing your oscillator frequency (preferred method) or reduce the drive voltage to 0.5Vrms. If you have primary impedance information for your LVDT at a higher oscillator frequency, and that number exceeds 80 ohms, you may operate the LVDT 10kHz and 3.5Vrms. If you have no data, you may still choose to run at 10kHz, or reduce the oscillator voltage to 0.5Vrms. Unless the LVDT manufacture specifically recommends drive voltages below 3.5Vrms, you will not damage the LVDT or amplifier. Most LVDTs will run quite well at drive levels between 0.5 and 6.0Vrms, as long as they have sufficient primary impedance to prevent oscillator overload. Catalog recommended voltages are normal guidelines, except in the above mentioned example.
Calculating LVDT full scale output (FSO) for a known sensitivity and drive voltage. (sensitivity like impedance, will change with excitation frequency).

**Ose. Voltage x Sen. x ± full scale displacement** 
(*in. 001" or mm, depending on how sensitivity is stated*)

**Example 1:** 
3.5Vrms x 2.8mV/V x 100 = 0.980Vrms FSO (will work in low gain) 
(100 MHR at 10.0 kHz)

**Example 2:** 
3.5Vrms x 6.05mV/V x 10 = 0.212Vrms FSO (must use high gain) 
(010 MHR at 10.0 kHz.)

**Question:** How do I know if I need High or Low Gain?

**Answer:** See the specification page under Amplifier characteristics. It states that in low gain, a ± 10 volt calibration requires a minimum LVDT FSO of 0.5Vrms or 500mV. In example number one, the fso is 0.980Vrms or 980mV. This meets the minimum output requirement for the low gain range. In example number two, the FSO is only 212mV, therefore high gain is required for a ±10 volt calibration.
**ATA 2001 LVDT Signal Conditioner**

**Time to Power Up**

**CAUTION!**
Be sure to verify the position of the voltage selector switch, before applying power! Failure to do so may cause permanent damage to the ATA amplifier. Do NOT operate the amplifier with 230VAC, unless the switch is in the proper position.

**Apply Power**
Allow for a 15 to 20 minute warm-up, prior to the initial calibration. When you first apply power, the red LED on the front panel should illuminate. If the LED is flashing off and on, check to see that switch "S4" is in the off (master) position. A flashing red LED when in the slave mode, indicates a loss of the master sync signal. The ATA 2001 will function normally in this condition, synchronizing with its internal oscillator clock. If "S4" is in the master mode, you may have a checksum error. Pressing the **COARSE** and **FINE** programming buttons simultaneously will stop the flashing and correct the condition.

**Calibration**
Any LVDT or RVDT calibration performed will require a minimum amount of equipment. A good quality digital volt meter, and some type of displacement standard such as a barrel micrometer, gage blocks or protractor for RVDTs. Cabling capacitance affects LVDT scale factor. You must perform the calibration with the required cable in place between the transducer and the amplifier. To perform a traceable calibration, you must use NIST traceable equipment, (meter and gage blocks). For the purpose of calibration, it is assumed that you have the LVDT, RVDT, or gage head mounted in some sort of fixture. A dial indicator stand, or a piece of equipment that you intend to use the transducer in. If you have a fixture gaging application, you may use zero and set masters or zero masters and gage blocks.
Voltage (±10VDC FSO)

1. After proper warm up, connect a digital volt meter to P2, pins 1 and 2. Pin-1 is DC signal out plus, and pin-2 is signal common or minus.
2. With the LVDT still disconnected, unlock the keypad by depressing the FINE and COARSE buttons at the same time.
3. Simultaneously depress the ZER0+ and ZER0– buttons. This should cancel out any zero offset in the amplifier.
4. If there is any residual output, press the FINE control, then use the ZER0+ or ZER0– control to get as close to zero as possible. (A small offset at this point will not adversely affect your calibration).
5. Connect the LVDT to P1.
6. Move the core connecting rod, or plunger in and out, around the approximate mid-stroke position. If the core connecting rod is fixed, you may slide the coil back and forth in its mounting instead. You are trying to find a position within the mid-stroke area, that is as close to zero volts out as possible.
7. When you are satisfied that you are as close to zero as possible, secure the core rod or coil.
8. Move the core toward the lead or connector side of the LVDT, roughly half the positive calibration distance. You do not have to be precise for this part of the calibration.
9. If the keypad has timed out, you will need to unlock it again using the FINE and COARSE buttons. If the output exceeds 5 volts, use the SPAN– button to reduce it.
10. Depress the PHASE+ or PHASE– button, (which ever increases the output). The output will climb until you reach the proper setting, at which point it will peak and start to decline. Stop! That is the correct setting. If at any point during this operation, the voltage exceeds 10 Volts, reduce the span again, then continue the operation.
11. Return the core to the original zero position, it should still be zero volts. If it is not, make a small adjustment with the ZER0+ or ZER0– buttons.
12. Move the core exactly plus full scale, (toward the leads), using your micrometer or gage blocks. This position should be the maximum positive range that you intend to calibrate over.

(Continues on page 20)
13. Using the SPAN+ or SPAN– buttons, adjust the amplifier for +10 volts of output. Use the FINE or COURSE buttons as required, to make the setting easier.
14. Recheck your zero, then displace the core to the minus full scale position, to check for symmetry. You may make small adjustments with the ZERO control, to balance the endpoints. Depress FINE and COURSE simultaneously, to save settings.

**Voltage** (0 to 10 volts dc, with zero suppression)
1. Follow the instructions on the previous page through step 12.
2. Using the SPAN+ or SPAN– buttons as necessary, adjust the amplifier for +5 volts of output. Use the FINE or COURSE buttons as required, to make the setting easier.
3. Recheck your zero, then displace the core to the minus full scale position. Check for -5 Vdc. You may make small adjustments with the ZERO control, to balance the endpoints.
4. Using the ZERO+ button, with the core still at the minus full scale position, change the output from -5 volts down to 0 volts.
5. Move to your original zero position, it should now be plus 5 volts.
6. Move to your original plus full scale position, it should now be 10 volts.
7. Depress FINE and COURSE simultaneously, to save settings, or wait for the keypad to time out and auto save your calibration parameters.

**Current** (4 to 20 mA internal loop power)
1. After proper warm up, connect a digital current meter or receiver, to P2, pins 3 and 4. Pin 3 is I out, or current out. Pin 4 is I in or current return.
2. With the LVDT still disconnected, depress the FINE and COURSE buttons at the same time. This will unlock the keypad.
3. Simultaneously, depress the ZERO+ and ZERO– buttons. This should cancel out any zero offset in the amplifier.
4. Read the current meter, at this point, you should read 12mA. press the FINE control, then use the ZERO+ or ZERO– control to get as close to 12 mA as possible. (A small offset at this point will not adversely effect your calibration).
5. Connect the LVDT to P1.
6. Move the core connecting rod or plunger in and out, around the approximate mid-stroke position. If the core connecting rod is fixed, you may slide the coil back and
Calibration (continued)

forth in its mounting instead. You are trying to find a position within the mid-stroke area that is as close to 12mA as possible.

7. When you are satisfied that you are as close to 12mA as possible, secure the core rod or coil as the case may by.

8. Move the core toward the lead or connector side of the LVDT roughly half scale. You do not have to be precise for this part of the calibration.

9. If the keypad has timed out, you will need to unlock it again using the **FINE** and **COARSE** buttons. If the output exceeds 16mA, use the **SPAN−** button to reduce it.

10. Depress the **PHASE+** or **PHASE−** button, which ever increases the output. The output will climb until you reach the proper setting, at which point it will peak and start to decline. Stop! That is the correct setting. If at any point during this operation, the output exceeds 20mA, reduce the span again, then continue the operation.

11. Return the core rod to the original null position, it should still read 12mA. If it does not, make a small adjustment with the **ZERO+** or **ZERO−** buttons.

12. From this point, move the core exactly plus full scale, (toward the leads), using a micrometer or gage blocks. This position should be the maximum positive range that you intend to calibrate for.

13. Using the **SPAN+** or **SPAN−** buttons as necessary, adjust the adjust the amplifier for 20mA output. Use the **FINE** or **COARSE** buttons as required to make the setting easier.

14. Recheck your 12mA position, then displace the core to the minus full scale position, to check for 4mA. You may make small adjustments with the **ZERO** control to balance the endpoints. Depress **FINE** and **COARSE** simultaneously, to save settings or wait for the keypad to time out and auto save your calibration perimeters.

**Current** (4 to 20mA external loop power)

1. After proper warm up, connect the positive side of your current loop to P2, pin 4, (I in), and the load leg of your current loop to P2, pin 2 (I out).

2. Follow steps 2 through 14 in the previous section for calibrating a 4 to 20mA loop, with internal loop power.