

U-01d: Troubleshoot Feedback Device (Heidenhain Linear Scale)

SAFETY FIRST

- Follow all Caterpillar facility safety standards when performing this task.
- Lock and tag required when troubleshooting a scale still installed to machine.

EQUIPMENT

- Oscilloscope
- Electrician hand tools
- Heidenhain PWM7 Tester

RESOURCES

- Heidenhain linear scale manufacturer's specifications
- Heidenhain PWM7 test equipment manufacturer's manual

Troubleshoot Feedback Device (Heidenhain Linear Scale)

Note: Whenever possible, troubleshoot the Heidenhain linear scale (scale) while it is attached to the machine. If available and applicable, use the Heidenhain PWM7 diagnostic tool and go to step 12.

1. Set the oscilloscope's horizontal deflection.

- Adjust the time coefficient (time basis) to 0.5 msec/division.
- Switch channels A and B to Chopper operation (CHOP).

2. Set the trigger on the oscilloscope.

- Turn the trigger mode to AUTO.
- Set the reading to Channel 1 (A).
- Set the trigger level on the Positive Going Edge.

3. Calibrate the oscilloscope.

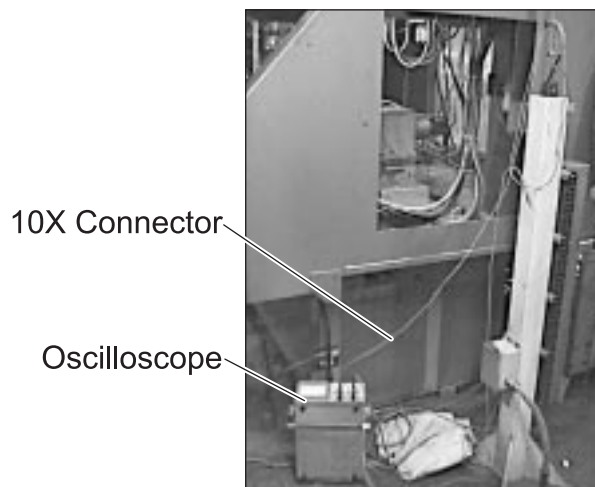
- Switch the Input Coupling Switch (AC/DC/GND) of channels A and B to GND.

- Adjust the positioning potentiometers to shift the electron beams vertically on the screen until Channel A and Channel B are in the Center of the screen.
- Switch the Input Coupling Switch (AC/DC/GND) of channels A and B to DC.

4. Set the oscilloscope vertical deflection.

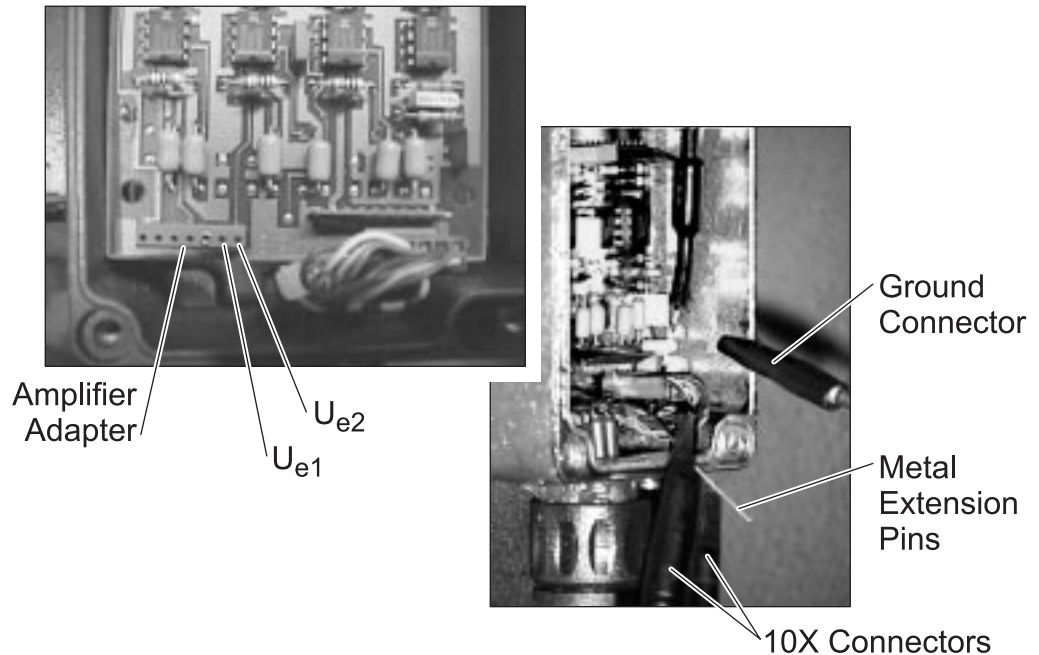
- Adjust the Deflection Coefficient (Sensitivity) of channels A and B to 2 V/Div.

5. Connect the oscilloscope to the EXE amplifier.



- Remove the cover from the amplifier housing.
- Connect the oscilloscope ground to the side of the amplifier housing.

- Connect each oscilloscope lead to the corresponding amplifier test connector. The amplifier manufacturer's specifications show test connections. An example of EXE amplifier test connections is shown below.



6. **Ask an Operator to jog the machine the entire length of the axis, if possible.**
7. **Observe the oscilloscope.**
 - Expect to see two equal amplitude sine waves with 90-degree phase shifts. (Refer to the manufacturer's specifications for the voltage level.)
8. **Verify lamp voltage to the scale if amplitude is less than manufacturer's specifications.**
 - Adjust the lamp voltage to the manufacturer's specifications if necessary.
9. **Perform the procedure U-03d: Clean Linear Scale (Heidenhain) if the voltage level is correct.**
10. **Perform the procedure U-02d: Replace Feedback Device (Heidenhain Linear Scale) if the scale is still suspect after cleaning.**
11. **Perform the following Troubleshoot Linear Scale (Heidenhain) with the Heidenhain PWM7 Diagnostic Tester steps, if the scale is still suspect.**

Troubleshoot Heidenhain Linear Scale with the Heidenhain PWM7 Diagnostic Tester

12. Set the oscilloscope's horizontal deflection.

- Adjust the time coefficient (time basis) to 0.5 msec/division.
- Switch channels A and B to Chopper operation (CHOP).

13. Set the trigger on the oscilloscope.

- Turn the trigger mode to AUTO.
- Set the reading to Channel 1 (A).
- Set the trigger level on the Positive Going Edge.

14. Calibrate the oscilloscope.

- Switch the Input Coupling Switch (AC/DC/GND) of channels A and B to GND.
- Adjust the positioning potentiometers to shift the electron beams vertically on the screen until Channel A and Channel B are in the center of the screen.
- Switch the Input Coupling Switch (AC/DC/GND) of channels A and B to DC.

15. Set the oscilloscope vertical deflection.

- Adjust the Deflection Coefficient (Sensitivity) of channels A and B to 2 V/Div.

16. Connect the scale, oscilloscope, and diagnostic tester.

- Connect channel 1 to the Yellow input on the PWM7.
- Connect channel 2 to the Green input on the PWM7.
- Connect the scale cable to the input (Eingang) on top of the PWM7.

17. Measure the operating voltage of the scale.

- Set the PWM7 switch 2 to +5V (yellow), +5V (green).
- Oscilloscope readings should be 5 volts on both channels.
- Set the oscilloscope channel in AC mode to measure the AC component (ripple) of the operating voltage on both channels.

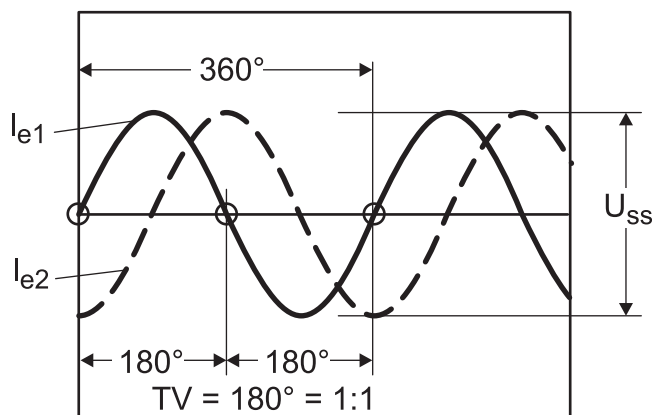




18. **Measure the phase angle shift between the scale output signals (I_{e1} and I_{e2}).**
- Set both channels to DC mode.
 - Set both channels to 1 V/div.
 - Set the PWM7 selector switch 1 to position “Phf” and PWM7 selector switch 2 to the “I_{e1}, I_{e2}” position.
 - Slowly move the read head (scanning unit) through the scale while watching the PWM7 meter. Permissible phase shift is $\pm 10^\circ$.
19. **Measure the signal On-to-Off ratio of the scale.**

Note: The signal on-to-off ratio is the ratio of the positive to the negative sine half wave measured at the zero crossovers.

- Set the PWM7 selector switch 1 to position “TV 1” to check the I_{e1} signal.
- Manually slide the scanning unit at a uniform speed.
- Set the PWM7 selector switch 2 to position “TV 2” to check the I_{e2} signal.
- Manually slide the scanning unit at a uniform speed.
- Expect a 1:1 (180°:180°) On-to-Off ratio with a tolerance of $\pm 10^\circ$ as shown below in the symmetrical sine wave (50% on – 50% off).



20. Verify the measuring signal amplitude of the scale.

- Set the PWM7 selector switch 2 to position “Ie1, Ie2.”
- Check the amplitudes of the scale signals on the oscilloscope.
- Verify amplitude data with the scale manufacturer’s technical appendix.

21. Verify the reference mark signal.

- Set the PWM7 selector switch 2 to position “Ie0/Ie1+Ie2.”
- Slide the scale forwards and backwards through the entire length of the scale until the reference signals are correct as shown by the reference light on the PWM7. Compare the oscilloscope waveforms to the manual specifications at the reference marks.

22. Replace the scale, as needed.