# U-01c: Troubleshoot Feedback Device (Encoder)

## SAFETY FIRST

- ☐ Follow all Caterpillar facility safety standards when performing this task.

## EQUIPMENT

- ☐ basic Electrician hand tools
- ☐ Oscilloscope
- ☐ Heidenhain PWM7 Encoder Diagnostic Kit
- ☐ encoder
- ☐ hand drill

## RESOURCES

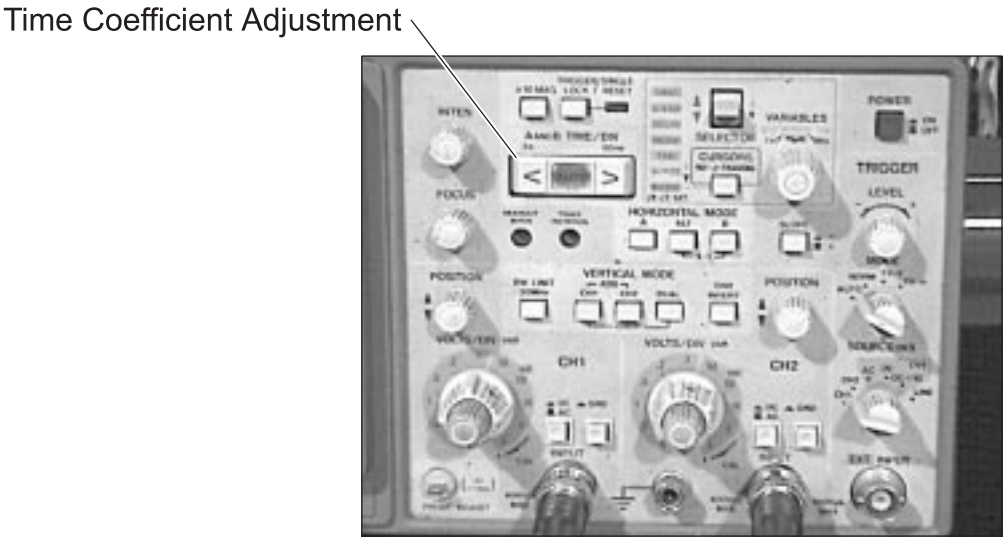
- ☐ Encoder manufacturer's specifications
- ☐ Diagnostic equipment specifications
- ☐ Oscilloscope manufacturer's specifications

## Troubleshoot Feedback Device (Encoder)

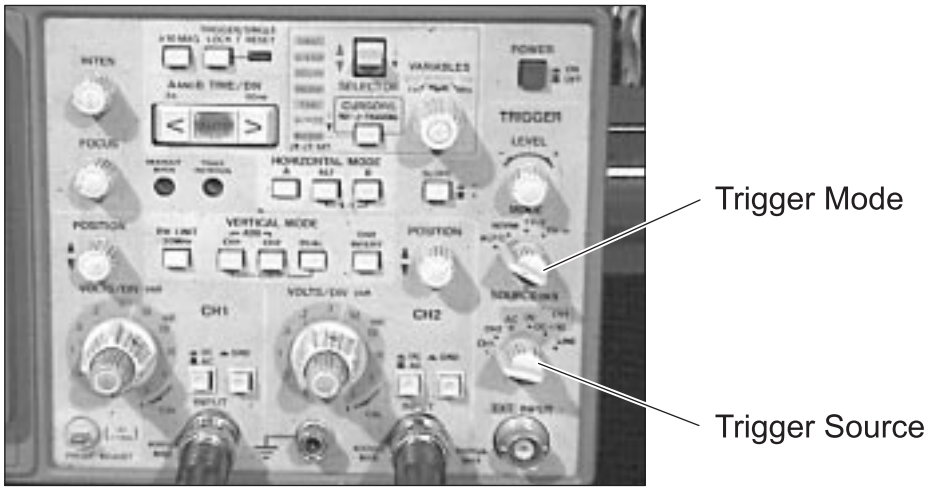
**Note: The Heidenhain PWM7 Diagnostic tool is used in this task to troubleshoot the encoder. Other manufacturer's diagnostic equipment may operate differently or require different settings.**

**1. Set the oscilloscope's horizontal deflection.**

☐ Adjust the time coefficient (time basis) to 0.5 msec / div.



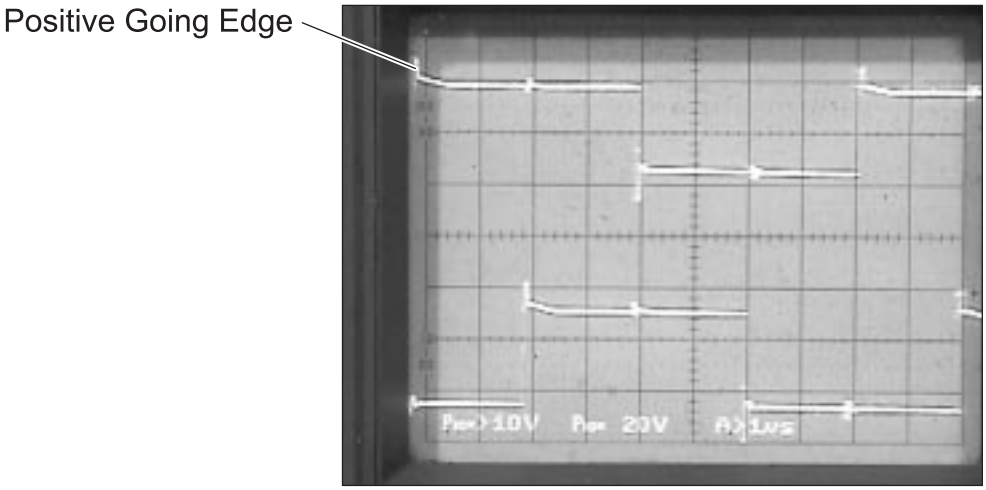

**2. Set the trigger on the oscilloscope.**




☐ Turn the trigger mode to AUTO.

☐ Set the source to Channel 1 (A).

- ☐ Set trigger level on the Positive Going Edge.



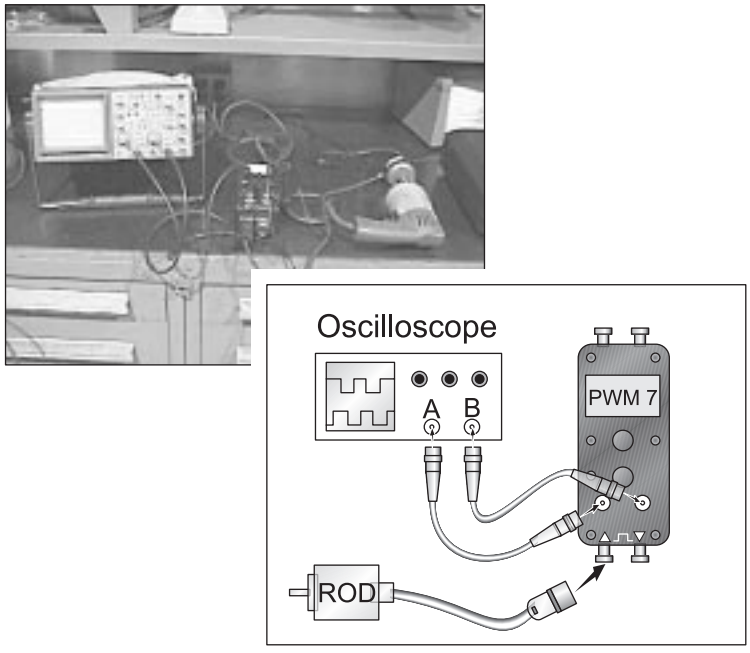

## 3. Calibrate the oscilloscope.


- ☐ 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 is in the Center of the Screen and Channel B is at the lowest division line 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 large knob of the volts / division switch for channels A and B to 2 V / Div.
- ☐ Adjust the small knob of the volts / division switch fully counterclockwise.


## 5. Connect the encoder, oscilloscope, and diagnostic tester.

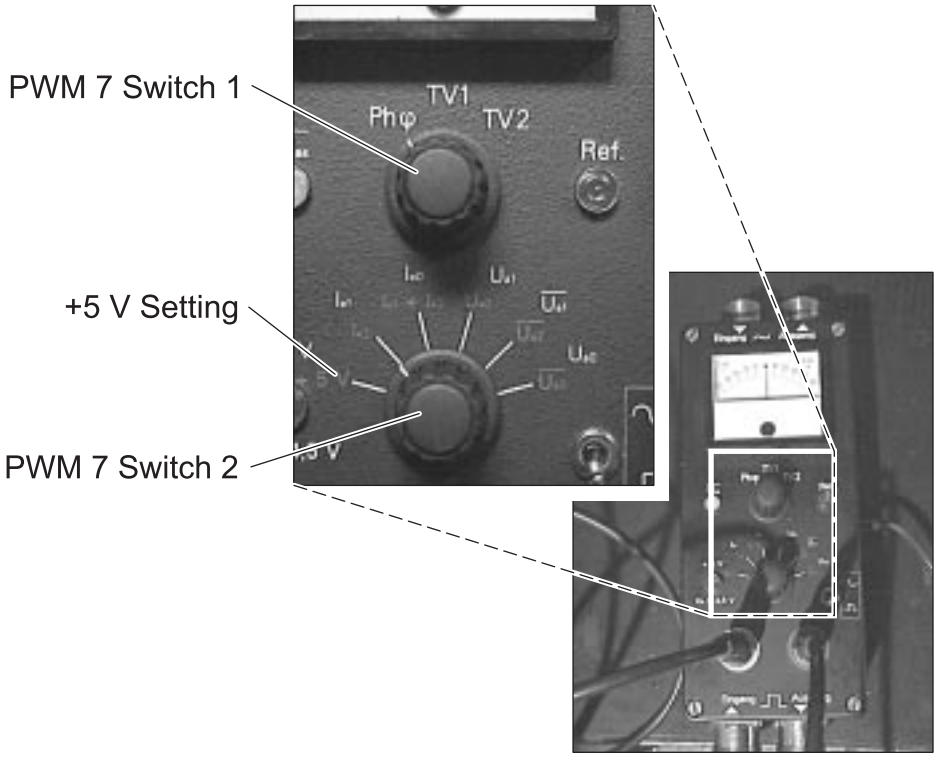



**Connection Diagram**

## 6. Measure the operating voltage of the encoder.

**Note: Connect the diagnostic tester as close as possible to the encoder to avoid voltage drop in the cable.**

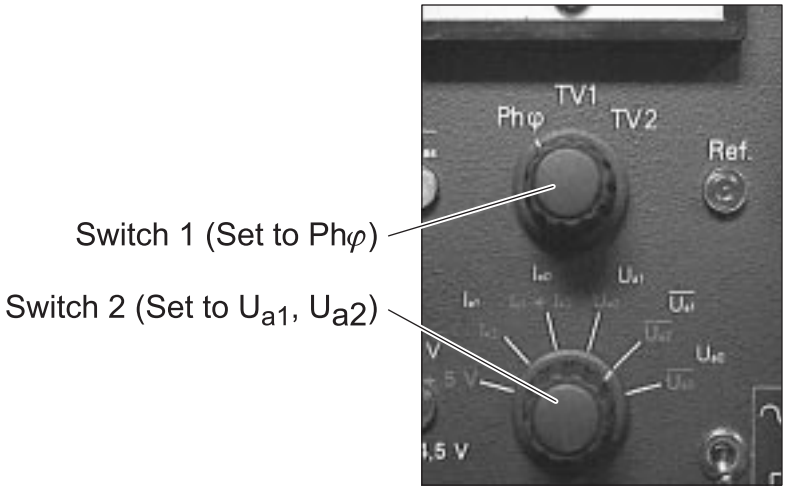
- ☐ Set the PWM7 selector switch 2 to position "+5V, +5V."
- ☐ Check the operating voltage (lamp voltage) at both encoder output sockets with the oscilloscope.




- ☐ Set the oscilloscope channel in AC mode to measure the AC component (ripple) of the operating voltage.

**7. Measure the phase angle shift between the encoder output signals (Ua1 and Ua2).**

- ☐ Set the PWM7 selector switch 1 to position "Phf" and PWM7 selector switch 2 to the "Ua1, Ua2" position.



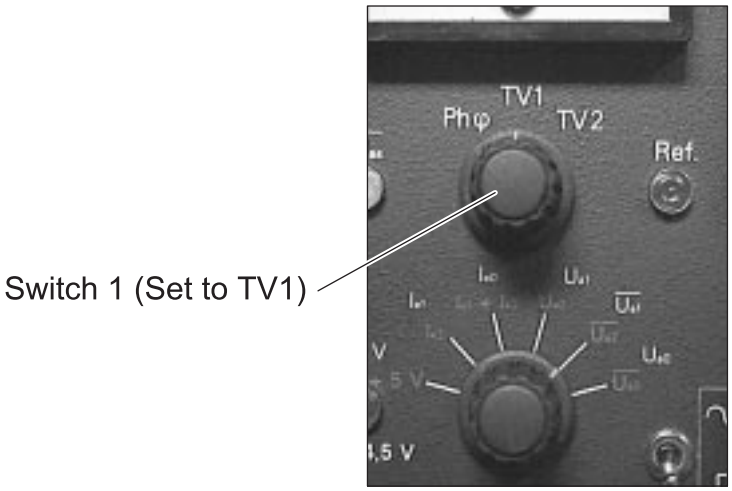

- ☐ Set the trigger adjustment on the oscilloscope to manual operation, and adjust the trigger level of Ua1 to start on the positive going signal.
- ☐ Manually rotate the encoder shaft at a uniform speed, by moving the machine, if possible, or remove the encoder from the machine and connect to a hand drill.

**Note: Expect a 90-degree phase difference between the A (Ua1) and B (Ua2) signals.**

**8. Measure the signal On-to-Off ratio of the encoder.**

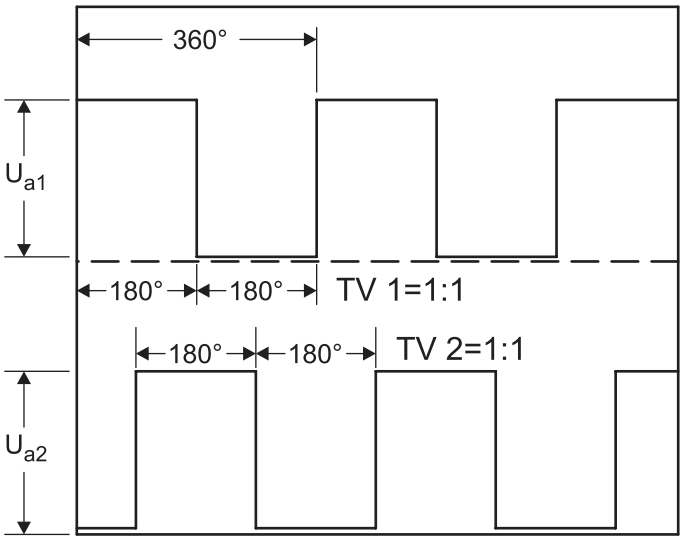
**Note: The signal on-to-off ratio is the ratio of the High signal width to the Low signal width of a square-wave signal.**

- ☐ Set the PWM7 selector switch 1 to position “TV 1” to check the Ua1 signal.




- ☐ Manually rotate the encoder shaft at a uniform speed, by moving the machine, if possible, or remove the encoder from the machine and connect to a hand drill.
- ☐ Set the PWM7 selector switch 1 to position “TV 2” to check the Ua2 signal.
- ☐ Leave the PWM7 selector switch 2 in position “Ua1, Ua2”.
- ☐ Manually operate the encoder or connect it to a hand drill for a consistent reading.

- ☐ Expect a 1:1 (180º:180º) On-to-Off ratio with a tolerance of ±10º (as shown below) in the symmetrical square wave (50% on – 50% off).




**9. Verify the measuring signal amplitude of the encoder.**

- ☐ Set the PWM7 selector switch 2 to position "Ua1, Ua2."
- ☐ Check the amplitudes of the encoder signals on the oscilloscope.
- ☐ Set the PWM7 selector switch 2 to position "$\overline{\text{Ua1}}$, $\overline{\text{Ua2}}$" to check the amplitudes of the inverted output signals.
- ☐ Verify amplitude data with the encoder manufacturer's technical appendix.

**10. Verify the reference mark signal.**

- ☐ Set the PWM7 selector switch 2 to position "Ua0, $\overline{\text{Ua0}}$."
- ☐ Rotate the encoders shaft forwards and backwards until the reference signals Ua0, $\overline{\text{Ua0}}$ are correct.

**11. Replace the encoder as needed.**