Resolvers

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Purpose:

Test the Accuracy of a resolver for measuring angular position. Consider the issues involved when the calibration standard has less resolution than the sensor under test.

Equipment Required:

*   Agilent 54600 - Series Oscilloscope
*   Resolver/RDC

Introduction:

We usually measure the performance of a transducer with instrumentation that has five or even ten times the accuracy of the device under test. We always do this if it is practical and economical.

When this is not the case, we still want to evaluate the transducer. If it is not economical to purchase a 10x instrument just to test this one sensor, then we test the whole product or system that contains the sensor.

An example is the evaluation of the resolver/resolver-to-digital converter system using the optical encoder as a reference instrument. This system outputs a 16 bit number proportional to position. Thus the resolution is (360 degrees/revolution)($1/2_{16}$ revolution/count)= 0.00549 degrees/count. The 800 count optical encoder has a resolution of (360 degrees/revolution) (1/800 revolution/count) = 0.45 degrees/count. So instead of a five times better instrument, the encoder has 1/82 the resolution of the resolver system we are testing. Still, we will be able to verify the resolver performance to within about half a degree using this test setup.

A final test (not done in this experiment) would be to integrate the resolver into a control system and evaluate the performance. The inverted pendulum experiment (ele458) in fact uses the resolver to measure the pendulum position.[1] In that application the performance of the device has been quite adequate.

There are two further points: <1> The vendor or manufacturer supplying the device under test can be relied upon to provide calibration data for the specific device (more expensive sensors are tested before shipping). If data for the specific unit cannot be supplied, then an accuracy statement that covers all units of that particular model may be obtained. <2> With the increased use of microcomputers for data acquisition and control, the technique of calibration compensation is becoming more common. A completed system that is found to be repeatable but insufficiently linear can be corrected by entering a look-up table in computer memory. The look-up table is just a correction curve that relates the non-linear sensor outputs to their ideal values. In this manner, the system as a whole can be made repeatable and quite linear. This

is a common practice in the use of thermo-couple temperature sensors which are intrinsically non-linear.

Part 1:

Before you come to the lab consider the following graphical problem that illustrates the calculation done by the resolver-to-digital converter:

- Plot the amplitude of the two sinusoids that appear on the secondaries as a function of the input angle. $S1amp = Vmax \cos \theta$ and $S2amp = -Vmax\sin \theta$. Where S1 and S2 are the output amplitudes, $Vmax$ is the maximum amplitude attained on a secondary at any input angle, and θ is the input angle.

- What is the smallest angle θ at which the following combination of S1 and S2 might appear?

1	S1 = Vmax,	S2 = 0
2	S1 = 0,	S2 = -Vmax
3	S1 = -Vmax,	S2 = 0
4	S1 = 0	S2 = Vmax
5	S1 = 0.707Vmax	S2 = -0.707Vmax

Part 2:

In this section we examine the hardware. The resolver is physically connected to the optical encoder and electrically connected to the resolver-to-digital converter (RDC). The computer will be used to read the RDC. The encoder will be read either using the computer or using the counter on one of the URI power amplifiers. (Is there an advantage to using one or the other?)

- Confirm that the resolver and encoder are properly coupled and that both of the output counters are operating.

- Using the oscilloscope with AC input coupling, characterize the excitation that the RDC supplies to the primary of the resolver. See Fig. 1

- Now connect the oscilloscope to the two secondaries. Be careful with your ground connection. Display both channels as you take your data. Do you notice any unexpected behaviors.

- Set the resolver angle to -180 degrees and zero the encoder counter. Take three cycles of data over the -180 to +180 degree marks.

- Check the behavior of the resolver as it passes from +180 directly to -180. How does the output counter change? How do the waveforms on your 'scope change?

- With both channels of the 'scope on the same scale, touch the MAIN/DELAYED Key and use the soft keys to go to the X-Y mode. This displays channel 1 on the x-axis and channel 2 on the y-axis. What do you observe? How does this change with variations of the input angle θ?

Connector on edge of RDC board
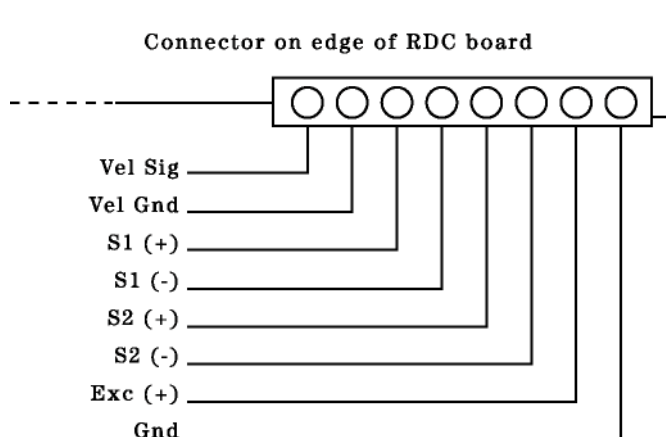
Figure 1: Intercept signals at RDC board

Lab Writeup:

Follow the standard format. Comment on the linearity, repeatability, and hysteresis of the resolver system. How did the resolution of the resolver and encoder effect this experiment. Include graphs of "interesting" waveforms you noticed during this lab.

[1] The resolver-to digital converter currently in use also provides an analog output voltage that is proportional to the angular velocity of the pendulum. This is supplied so that the resolver can be used to replace both the encoder and tachometer commonly found on DC servo-motors.