Testing the CEH51A

Hands On Relay School

Generation Track

Bill Unbehaun

Tacoma Power

Prepared for HRS lab exercises, not intended as a thorough test plan

In a loss of field condition, the generator produces low MW and absorbs MVAR. If we think about this on the power plane, in normal operation the mw and mvar plot near the positive mw axis. With loss of field that plot shifts to a position much closer to the negative mvar axis. The same is true of the impedance plane (see the drawing on page 21 of the CEH IL). When we come to voltage and current signals from the PTs and CTs, the current will lead the voltage due to the angle and flux relationships of the rotor to the armature. With the test set correctly wired to the relay, it will operate when current leads voltage by 900.

 Read the nameplate for rated voltage, amperage, minimum ohms, and offset range. (They should all be 115v, 5a, min 5 ohms, 0/4 offset.)

Check that the relay is set at 4.0 ohms offset. This is done on the horizontal tap block with L and H at the ends. The setting is the difference between the 2 taps. With the left tap at 0 and the right tap at 4, the offset will be 4 ohms (+/- 10%). If we want to set the offset at 1.5, we would set the left tap at 1 and the right tap at 2.5 (2.5 – 1 = 1.5)

So with the Offset at 4 ohms, the top of the characteristic (closest to the origin on the R – X plane) will be at 4 ohms.

Using phase – to – phase voltage: 115 volts / 4.0 ohms = 28.75 amps through a single current coil. You can series the 2 current coils and cut the input current in half (14.4 amps).

Using phase – to – neutral voltage: 66.4 volts /4.0 ohms = 16.5 amps (single coil) or 8.25amps (series).

The tests below use phase – to – neutral with 2 coils in series.

If you do the math, you’ll see that as the offset gets smaller, the current necessary to identify the offset point on the characteristic gets quite high.

Now verify the offset with your relay. Connect AC voltage to terminal 7+ and terminal 8-; connect AC current to terminal 3+ and terminal 6- with a jumper 4 – 5. If you want to use the test set contact sense function, put one lead on relay terminal 1 and use an alligator to connect the other lead to the stationary contact. The CEH51 has a telephone relay in the trip circuit to prevent misoperation from vibration or bounce. We’ll check this later.

Loss of field is connected so that the relay trips for current leading voltage and the maximum torque angle is 900. Apply 66.4v < 00 and 6.5a < 900. The relay should pickup (6.5amps should fall within the characteristic). Ramp the current up until the contact drops out. This should happen between 7.5 and 9 amps.

Next we’ll look at the maximum torque angle. To test this we can apply current and voltage to close the contact (66.4v, 7amps), then vary the angle first one way until the contact opens, then the other way and average the 2 dropout angles. Do this now.

We can also check the diameter of the mho characteristic. First check the vertical tap block setting along the right side of the relay. The leads with the hex screws (inputs) should be at 90 and 10 (100% input). The No.1 leads should be at 80 and 10. (Add the 2 to get 90% restraint setting.) From Eq. 1 on page 7 of the IL:

Restraint Tap Set % = (Basic min diameter x 100) / Desired diameter in secondary ohms.

Our relays have a 5 ohm minimum and the restraint should be set at 90% so

 Characteristic diameter = 500 / 90 = 5.56 ohms

The characteristic is offset by our setting of 4, so the lowest point on the characteristic should be

 5.56 + 4 = 9.56 ohms

If voltage = 66.4v, then 66.4 / 9.56 = 6.95amps with 1 coil, 3.5amps with 2 coils.

You can test this 2 ways: you can ramp current from a closed contact condition, say 66.4v and 7amps, down until the contact opens, or start low at 2.5amps and ramp up until the contact closes. Do this now.

Using some geometry and trig, the point at which a line from the origin will just touch the circle will be at 6.9 ohms at -65.7 degrees from the axis. Inject 9.6 amps at 65.70 (I leads V). Calculate the point on the other side of the reactance axis.

More geometry and trig will take us to the complementary point in the lower half of the characteristic at 8.3 ohms at 17.8 degrees from the reactance axis.

You can verify operation of the trip circuit telephone relay by applying 125VDC (or the appropriate magnitude) to terminals 1 and 10. Apply AC voltage and current sufficient to close the contact. If you want to sense, put one sense lead on terminal 10 and the other on the stationary contact with an alligator, and sense for DC voltage.

If you have time, plot the mho characteristic by applying different levels of current with 66.4v, swing the angle back and forth to find dropout points, calculate the impedance and angle, and plot. At each current level, you can also verify the maximum torque angle again.