General Testing Notes for a CEY51A Phase Distance Relay
CEY51A consists of Three ph-ph MHO UNITS
Upper Mho Unit is Aph-Bph
Middle Mho Unit is Bph-Cph
Lower Mho Unit is Cph-Aph

We will test each Mho Unit separately and you can test each Mho Unit with one voltage source and one current source. You move the voltage source and current source appropriately for each Mho Unit.

Voltage jumpers: Jumper 14 to 15, Jumper 13 to 16 to 17 and Jumper 18 to 20 to 19.
Current jumpers: Jumper 6 to 8 to 10.
Monitor: Monitor with a simpson on ohms on the Rx10 or on the Rx100 scale.
Upper Mho Unit from 1 to 11.
Middle Mho Unit from 2 to 11.
Lower Mho Unit from 3 to 11.
Apply AC Test Voltage from:
15 to 17 for Upper Mho Unit
17 to 19 for Middle Mho Unit
19 to 15 for Lower Mho Unit
Apply & Ramp AC Test Current from:
5 to 7 for Upper Mho Unit
7 to 9 for Middle Mho Unit
9 to 5 for Lower Mho Unit
Note your test current is really 2*I because you are pumping current in to two phases of current coil primaries (Transactors), and they are 180 degrees out from each other because of above connections. This is just like what happens during a phase to phase fault.

The impedance equation is Eph-ph/2*I for a phase to phase fault or phase to phase mho unit. The single voltage you are applying to a mho unit is essentially the Eph-ph voltage.
The single current you are applying to the respective mho unit is essentially the 2*I current and you still have to multiply it by 2. Example; If you are applying 5 amps on the upper mho unit, in 5 and out 7 with 6 to 8 to 10 jumpered, than that is actually 10 amps to the relay.

Let’s say your relay is supposed to have a 60 degree MTA and reach 6 ohms secondary @ 60 degrees and the basic minimum tap setting is equal to 3. Your restraint tap setting would be (100 * basic minimum tap setting)/6 ohms of reach at the MTA. Your restraint tap then = 50

So set your basic minimum tap on 3 for each of the six transactors. Tap blocks are in the back of the relay.

Then set your restraint taps on the two auto transformers to 50. Each auto transformer has two windings, (a course winding in 10% steps from 15% to 95%) and (a fine winding which you can add or subtract in 1% increments to the course winding). The fine winding is tapped at 0%, 1%, 3% & 5%.
We want 50% restraint tap on both sets of restraint taps and you can do that in two ways:

1) Set one end of restraint tap jumper lead to 45% and the other end to 0%. Then take the restraint tap lead marked No.1 to 5%. Note the 5% setting of the fine winding adds to the course winding now tapped at 45% for a total restraint tap of 50%.
2) Set one end of restraint tap jumper lead to 55% and the other end to 5%. Then take the restraint tap lead marked No.1 to 0%. Note the 5% setting of the fine winding subtracts from the course winding now tapped at 55% for a total restraint tap of 50%.

Please read page 11 in IL GEK-1275K for a better explanation.

General mho unit notes:
If your MTA is + or – 2degrees from ideal and your reach is + or – 5% of ideal than the mho characteristic will test fine. All angles given below are the angle that the test current lags the test voltage.

I test five points to test the characteristic and they are the MTA reach, + & - 15 degrees off of the MTA and + & - 30 degrees off of the MTA. So with a MTA of 60 degrees that would be reach at 90 degrees, 75 degrees, 60 degrees, 45 degrees and 30 degrees.

Never test the MTA by swinging angles beyond 30 degrees from the MTA.

Never test below an expected current of 5 amps.

Specifics for this example relay settings:
Pick a test voltage that the expected current calculates out to 5 amps at the MTA(The highest impedance reach). With relay set on six ohms reach at a MTA of 60 degrees,
than Eph-ph= 5amps*2 * 6ohms = 60volts. Remember the test current is actually 2*I already because of your current connections but you still have to multiply the test current by 2.

Now for all other test angles leave your test voltage at 60 volts.
Your reach at 90 degrees is calculated by;
    reach at MTA * cos|MTA-90 degrees| which is 6 ohms * cos|60-90| which is 5.196 ohms
reach at 75 degrees is 6 ohms * cos|60-75| which is 5.796 ohms.
reach at 60 degrees is 6 ohms * cos|60-60| which is 6.0 ohms.
reach at 45 degrees is 6 ohms * cos|60-45| which is 5.796 ohms.
reach at 30 degrees is 6 ohms * cos|60-30| which is 5.196 ohms.

Expected current @ 90 & 30 degrees reach is 60 Volts/5.196 ohms * 2 which is 5.77 amps
Expected current @ 60 degrees reach is 60 Volts/6.0 ohms * 2 which is 5.0 amps
Expected current @ 75 & 45 degrees reach is 60 Volts/5.796 ohms * 2 which is 5.18 amps

I generally test MTA at 20 degrees off from the MTA so I calculate the expected current for 40 & 80 degrees. 6 ohms * cos|60-80| = 5.638 ohms and 40 degrees is also 5.638 ohms.
So expected current = 60 Volts/5.638 ohms * 2 which is 5.32 amps
So I apply 60 volts and 5.32 amps at 60 degrees and swing that angle away from 60 until the mho unit contact just drops out. Than I do it the other direction and mark the angle again that the mho unit contact just drops out. Let's say those angles are 82 degrees and 39 degrees.
Than MTA would = (82 + 39)/2=60.5 degrees.

I like getting MTA close by adjusting variable reactors X11, X12 & X13 first. Than adusting reach @ the MTA with potentiometers R11, R12 & R13 next. I go back and forth with these tests until both MTA and reach @ MTA is within tolerance.

X11 & R11 are for the upper mho unit, A-B phase.
X12 & R12 are for the middle mho unit, B-C phase.
X13 & R13 are for the lower mho unit, C-A phase.

This should do it.
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