SCOPE

This test procedure covers the testing and maintenance of the ABB KLF loss of excitation relay. The Westinghouse Protective Relay Division was purchased by ABB, and new relays carry the ABB label. Refer to IL 41-748 for support information and component level identification.

DESCRIPTION

The Westinghouse KLF is a loss of field relay used for generator protection. The relay is designed to operate on lagging VAR flow (directional unit), a change in impedance (distance unit), and a loss of generator voltage (under-voltage unit). The trip contacts of these elements are in series and the trip output closes when the under-voltage element operates.

The directional unit operates on the interaction between the polarizing circuit flux and the operating circuit flux and closes its contacts for lagging VAR flow into the generator. Its primary function is to prevent operation of the relay during external faults.

The distance unit measures impedance of the generator as viewed from its terminals. This is accomplished by the use of two compensators, designated T_A for long reach and T_C for short reach. Any reach ohm setting can be made within +/_ 1.5 % by auto-transformer taps. Reversing links are included in the short reach compensator, T_C, for including or excluding the origin of R-X diagram from the distance unit characteristic.

The under-voltage unit construction is similar to the directional unit and consists of two pairs of voltage coils. One pair of coils is in series with adjustable resistor R_V which is used to shift the phase angle between the two sets of coils to produce torque.

OPERATION

The contacts of all three units are connected in series to the telephone type relay (designated X). The operation of both the direction and distance unit sounds an alarm. The operation of the under-voltage unit completes the trip circuit to the ICS and trips the generator. Relay X is designed to provide 15 cycles time delay on dropout before energizing the trip coil ICS. This time delay insures positive contact coordination under all possible operating conditions.

PRE-TEST CONDITIONS

Reversing links are set in vertical position. (T_C +)

Calculations:

Assume Long Reach, Za = 19.04 ohm, Short reach, Zc= 1.95 ohm. Use IL 41-748 (pg. 10ff) calculations as a guide for setting T, S, and M. (See Appendix A for assistance with calculations.)

Test connections:

Use IL 41-748, figures 4 and 13 for relay connections
Va = Terminal 5
Vb = Terminal 6
Vc = Terminal 7
I1 = 9 +, 8 –
Sensing = 1 to 10 (Close distance unit and under-voltage contacts)

NOTE: If relay is cold, connect three phase voltage to the relay and run for 15 minutes at 120 Vac, otherwise use single phase voltage as directed.

IMPEDANCE UNIT

Test connections:

Va = 5 (polarity) to 4
Ia = 9 (polarity) to 8
Sensing = 1 to 10
BLOCK the directional unit and under-voltage unit contacts closed

MTA TEST

Unit MTA = 90 degree I lag

$I = 1.2V / Z$

$V = 60$, $Z = Z_A$

Set I to calculated value, $V = 60$. Rotate current angle CW and CCW until dropout on both sides. The average of the two dropout values is the MTA.
Tolerance is 85 – 95 degrees
Adjustment is resistor Rb (lower rear)

LONG REACH TEST

All tests:

Calculate I as required. $V = 60$.
Start ramp at .8 * I to PU Z_A Long Reach at 90 degree I Lag
Tolerance = +/- 3%
Adjustment is spiral spring adjuster or T_A taps.

$I = V / (1.5 * Z)$ where $Z = Z_A$

Z_A Long Reach at 150 degree I Lag
Tolerance= +/- 20%

$I = V / (1.5 * Z)$, $Z = (X^2 + R^2)^{0.5}$

$R = (Z_A + Z_C) / 2$ radius of characteristic

$X = Z_A - R$ origin to center of characteristic

NOTE: V is derived by vectorially adding voltage across T_A and T_C

Z_A Long Reach at 30 degree I Lag
Tolerance= +/- 20%
Calculations same as 150 degrees
NOTE: If reach is not approximately same as 150 degree reach, adjust resistor Rb and retest. Check 90 degree and 150 degree reach.

SHORT REACH TEST

All tests

Calculate I as required. $V = 23$
Start ramp at $.8 * I$ to PU

Z_C Short Reach at **270** degrees I **lag**
Tolerance=+/- 3%
Adjustment is Tc taps
$I = V / (1.5 * Z)$, $Z = Z_C$

Z_C Short Reach at 210 degrees I lag
Tolerance= +/- 20%
$I = .6V / Z$, $Z = (Z_C * 1.6)$

Z_C Short Reach at 330 degrees I lag
Tolerance= +/- 20%
Verify 330 reach is approximately same as 210 reach.
$I = .6V / Z$, $Z = (Z_C * 1.6)$

DIRECTIONAL UNIT (IL Pg. 7)

Va= 6 (polarity) to 7
Ia = 9 (polarity) to 8
Sensing = 1 to 10
BLOCK the distance and under-voltage contacts closed

MTA TEST

V=2, I=5amp@13degrees.
Rotate current angle CW and CCW until dropout on both sides. The average of the two dropout values is the MTA.
Tolerance =+/- 5 degrees
Adjust reactor Xd as required

DIRECTIONAL UNIT PICKUP

V=1, I=5.0 amp @ MTA
Ramp I up to pickup
Tolerance = +/- 10%
Adjustment: Spiral spring adjuster.

UNDERVOLTAGE UNIT (IL Pg. 7)

Va = 5 (polarity) to 4
Block directional and distance contacts closed.
The spiral spring adjusts this setting between 65% and 85% of normal system voltage.
Start at nominal voltage (80v) and ramp down until contacts close.

AUX RELAY

DC voltage = 10(+) to 3(-)
Sense on unused N.O. contacts of telephone relay
Pickup
- Pickup = 55 Vdc
- Start ramp 0.5 * PU
- Tolerance = +/- 20%

Drop Out
- DC voltage = 120 Vdc to 10(+) and 3(-)
- Drop to zero
- Contact DO =250ms
- Tolerance = +/-20%

ICS

Check the target unit pickup tap to determine the setting
Connect DC current to terminals 1 and 10
Block the directional and impedance contacts closed
Raise the dc current until the target unit just picks up
Verify that the target drops smoothly.
Release the trip contact and verify that the target unit remains sealed in.
Lower the dc current until the target unit drops out.

3 PHASE TEST

If you have a 3 phase test set, you can mimic the field wiring, per IL Figure 3, pg 6.
Va < 0 = terminal 5
Vb < 240 = terminal 6
Vc < 120 = terminal 7
I1 = terminals 8(+) – 9
Sense = terminals 1 – 10

Tests:

Apply 30 volts to all 3 phase voltages. This should be low enough to close the undervoltage unit.
Apply 2 amps at 103 degrees. This should be enough to close the impedance unit.
Vary the phase angle to determine the maximum torque angle.

Similarly vary voltage and current to determine when the impedance and undervoltage units operate. Example: 60v, 1a < 95 – 100^0, directional unit should pick up, ramp voltage down until UV element picks up, continue ramping down until impedance unit picks up – should be around 19v.

Figure 1

KLF Internal Schematic

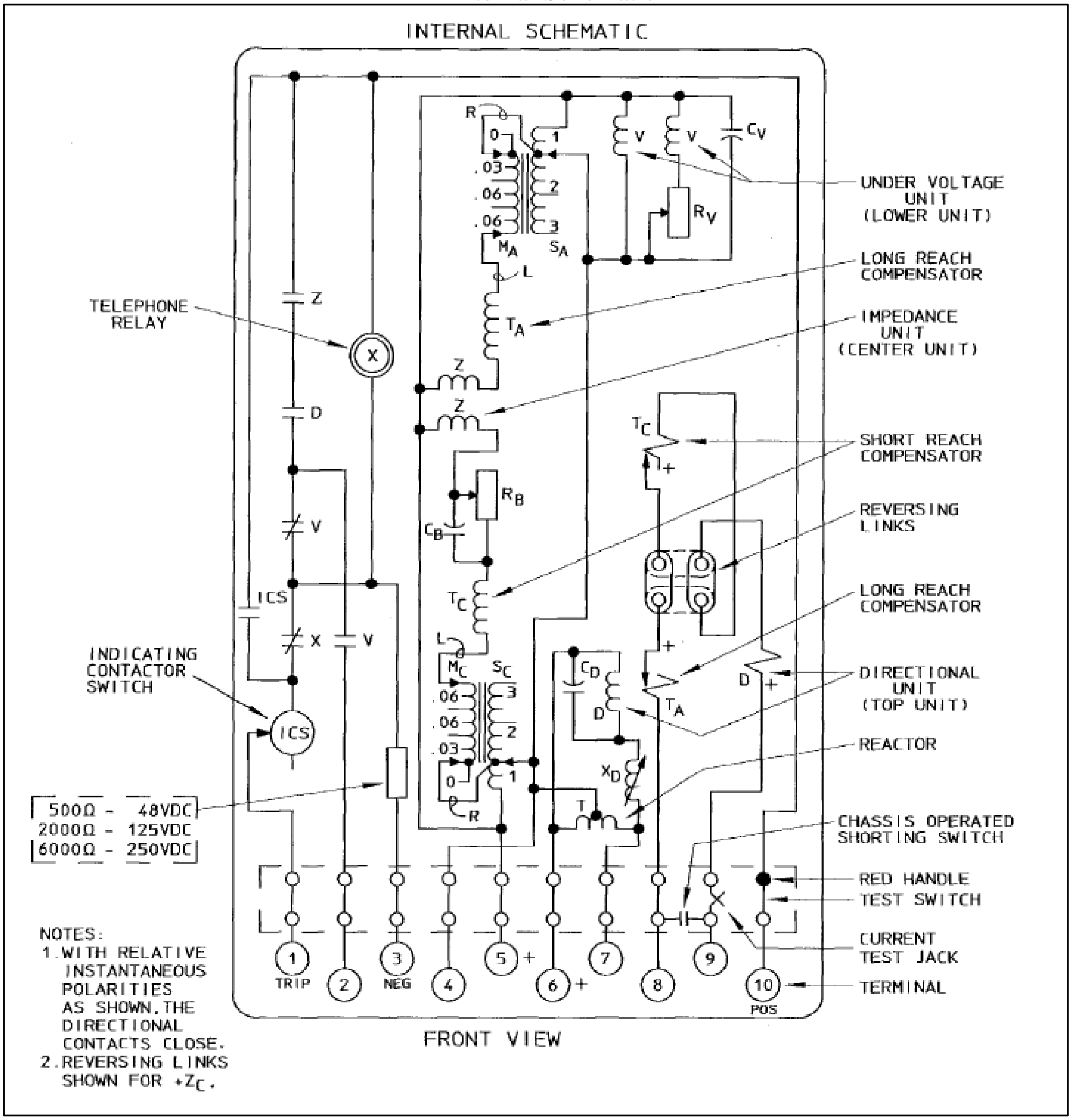
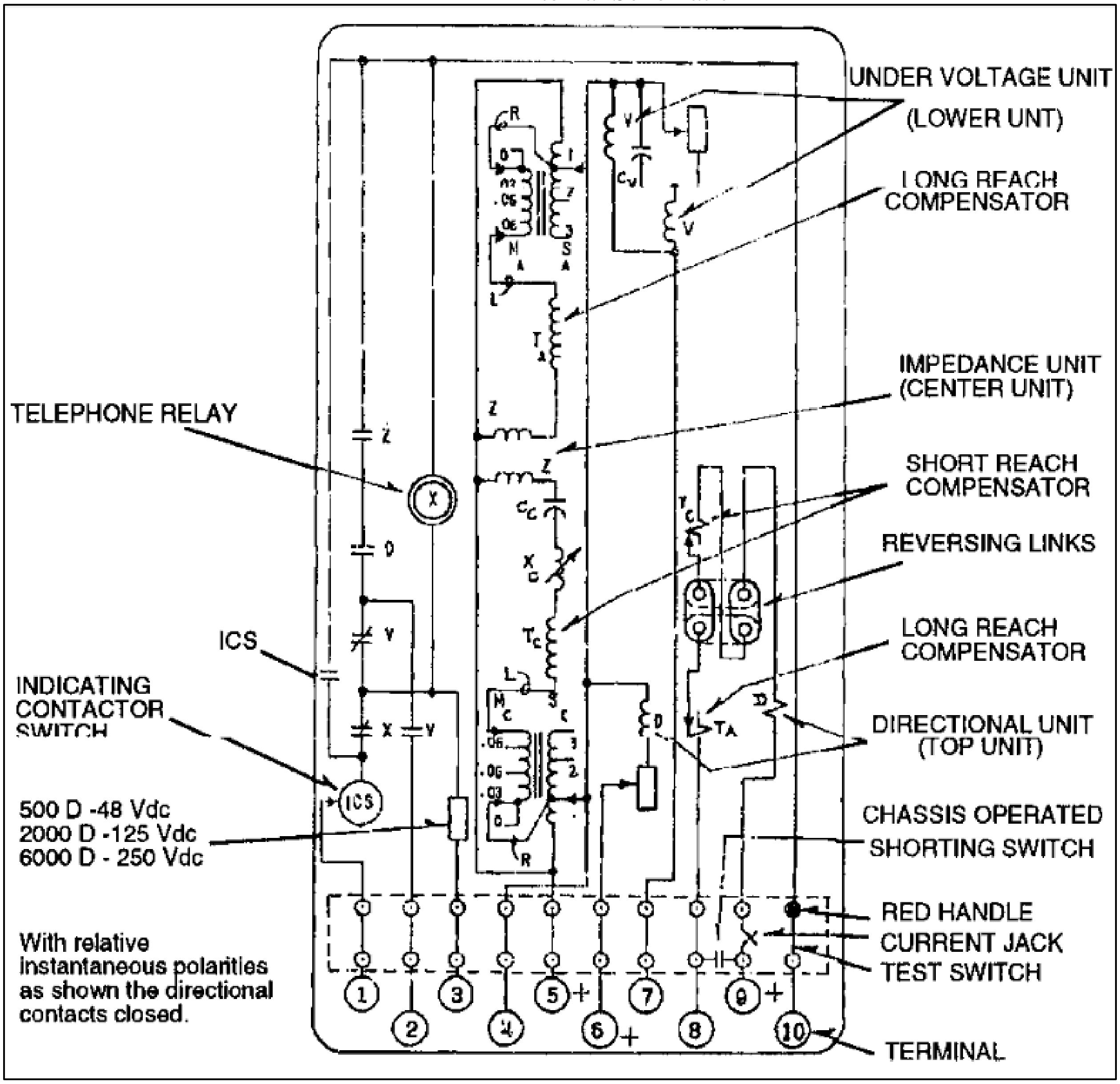


Figure 2

KLF-1 Internal Schematic



Appendix A Setting Calculations for Za = 19.04 ohms and Zc = 1.95 ohms.

IL 41-748 walks you through these calculations beginning on page 10 with Equation (5).
The steps begin on page 12:

Set Long Reach taps:

Step 1. 18.65 x Sa > 19.04, choices are 1, 2, 3, (1 x 18.65 < 19.04; 2 x 18.65 > 19.04) so set Sa at 2.

Step 2. Ta nearest to 19.04 / 2 = 9.52, set Ta at 8.3.

Step 3. TaSa / Za – 1 = 8.3 x 2 / 19.04 – 1 = - 0.128 set M = -0.12

Actual Za = TaSa / 1+/- M = 8.3 x 2 / 1 – 0.12 = 18.86 which is 99% of 19.04

Set Short Reach taps:

Step 1. 6 x Sc > 1.95, set Sc = 1

Step 2. Tc nearest to 1.95 / Sc = 1.95 set Tc = 1.82

Step 3. TcSc / Zc – 1 = 1.82 x 1 / 1.95 – 1 = -0.07 set M = -0.06

Actual Zc = TcSc / 1+M = 1.82 / 0.94 = 1.94 which is 99.3% of 1.95