

SCOPE

This test procedure covers the testing and maintenance of Westinghouse HU and HU-1 transformer differential relays. The Westinghouse Protective Relay Division was purchased by ABB, and new relays carry the ABB label. Refer to IL 41-347.1 for testing support information and component level identification.

SAFETY

Current-shorting test switches used for HU and HU-1 relays may malfunction and develop high voltage levels. Use caution when using the test switches; make sure they are functioning properly.

INTRODUCTION

Type HU and HU-1 are high-speed relays used for differential protection of transformers. Harmonic restraint circuitry in the relays alleviates false tripping caused by transformer inrush current. HU relays are designed for two-winding transformers; HU-1 relays are designed for three-winding transformers. Each is available with sensitivities of 30% or 35%.

TOOLS, EQUIPMENT, AND MATERIALS

- Two variable ac current, variable phase-angle sources
- Variable dc voltage/current source and latch timer
- Variable harmonic current source

INSPECTION

1. Take the cover off the relay, taking care to not shake or jar the relay or other relays around it.
2. Open the relay test switches to disable the trip circuit and remove the current inputs.
3. Lift the relay out of the case.
4. Visually check the relay for any obvious problems.
5. Clean the relay thoroughly.

6. Burnish the surfaces of all contacts, making sure to remove any tarnish.
7. Check that all relay connections are tight.
NOTE: The current input hardware on Westinghouse relays is frequently loose and requires special attention.
8. Check that the contact gap on the harmonic restraint unit (upper unit) is 0.046 inches and the gap on the differential unit (lower unit) is between 0.065 and 0.070 inches. Adjust the gap setting if necessary.
9. After setting the contact gap, check that the contacts move freely.

TESTING THE MINIMUM PICKUP

Differential Unit (Lower Polar Unit)

1. Block the contact on the harmonic restraint unit (upper polar unit) to the pickup position.
2. Monitor contact continuity at Terminals 1 and 10.
3. Connect the variable ac current source to each winding circuit, one at a time
Check Table 1 to determine which relay terminals are associated with each winding.
4. Initiate current at 20% of the tap setting. Continue initiating current at successively higher levels until the differential unit just picks up. Note the pickup level.
5. Decrease the current until the differential unit just drops out.
6. Determine if the pickup and dropout levels meet specifications.
NOTE: The pickup current should be between 30% and 31% of the tap setting for 30% relays and between 34% and 36% for 35% relays. The dropout current should be greater than 15% of the tap setting.

If the pickup or dropout level does not meet specifications, go to Step 7.

If the pickup and dropout currents meet specifications, go to the Harmonic Restraint Unit section.

7. Momentarily initiate the current at 20 times the tap setting to polarize the relay.
NOTE: Leaving the current on too long may damage the relay.
8. Repeat Steps 4 and 5.
NOTE: Performing the test more than once may yield different results. The only valid result is the one obtained immediately after the relay has been polarized.

If the differential unit does not pick up at the specified level, adjust the pickup side shunt screw on the differential unit, momentarily initiate current at 20 times the tap setting to polarize the relay, and repeat Steps 4, 5, and 6.

If the differential unit does not drop out at the specified level, adjust the relaxed side shunt screw on the differential unit, momentarily initiate current at 20 times the tap setting to polarize the relay and repeat Steps 4, 5, and 6.

NOTE: Turning the pickup side shunt screw out *decreases* pickup current. Turning it in *increases* pickup current. Turning the relaxed side shunt screw out *increases* dropout current. Turning it in *decreases* dropout current.

Table 1

Winding terminal designations

Winding	Tap Position	Relay Terminals
1	Upper	5 to 3
2	Middle	7 to 3
3*	Lower	9 to 3

*For HU-1 relay only

Harmonic Restraint Unit (Upper Polar Unit)

1. Block the contact on the differential unit (lower polar unit) to the pickup position.
2. Monitor contact continuity at Terminals 1 and 10.
3. Connect the variable ac current source to each winding circuit, one at a time. Check Table 1 to determine which relay terminals are associated with each winding.
4. Initiate current at 20% of the tap setting. Continue initiating current at successively higher levels until the harmonic restraint unit just picks up. Note the pickup level.
5. Decrease current until the harmonic restraint unit just drops out.
6. Determine if the pickup and dropout levels meet specifications.
NOTE: The pickup current should be between 27% and 33% of the tap setting for 30% relays and between 34% and 36% for 35% relays. The dropout current should be greater than 15% of the tap setting.

If the pickup or dropout current does not meet specifications, go to Step 7.

If the pickup and dropout current meet specifications, go to the Testing the Differential Characteristic section.

7. Momentarily initiate current at 20 times the tap setting to polarize the relay.
NOTE: Leaving the current on too long may damage the relay.
8. Repeat Steps 4 and 5.
NOTE: Performing the test more than once may yield different results. The only valid result is the one obtained immediately after the relay has been polarized.

If the harmonic restraint unit does not pick up at the specified level, adjust the pickup side shunt screw on the harmonic restraint unit, momentarily initiate current at 20 times the tap setting to polarize the relay, and repeat Steps 4, 5, and 6.

If the harmonic restraint unit does not drop out at the specified level, adjust the relaxed side shunt screw on the differential unit, momentarily initiate current at 20 times the tap setting to polarize the relay and repeat Steps 4, 5, and 6.

NOTE: Turning the pickup side shunt screw out decreases pickup current. Turning it in increases pickup current. Turning the relaxed side shunt screw out increases dropout current. Turning it in *decreases* dropout current.

TESTING THE DIFFERENTIAL CHARACTERISTIC

1. Block the contact on the harmonic restraint unit (upper polar unit) to the pickup position.
2. Monitor the contact continuity at Terminals 1 and 10.
3. Connect the variable ac current source as shown in Figure 1.
NOTE: Current ISR should be connected to the winding circuit with the lower tap setting. The common return should be connected to the winding circuit with the higher tap setting.
4. Apply ISR current as specified in Table 2 and raise the IAC current until the differential unit just picks up.

If the pickup current does not meet the specifications in Table 2, adjust the resistor on the top front of relay.

NOTE: Increasing the resistance, increases the IAC pickup current

Repeat Steps 1 through 4 in this section and retest minimum pickup as directed in the Differential Unit (Lower Polar Unit) section.

5. If this is an HU-1 relay, disconnect the current source from one winding circuit and connect it to all windings circuits that have not yet been tested. Repeat Steps 3 and 4.
NOTE: The relay should pickup at the currents specified in Table 2.

Table 2

30% and 35% HU and HU-1 relay tap combination currents

Restraint Transformer Tap	Larger	2.9	3.2	3.5	3.8	4.2	4.6	5.0	8.7
Smaller	Current in Amperes								
2.9	ISR	8.7	8.7	8.7	8.7	8.7	8.7	8.7	5.8
	IAC (min.)	2.6	3.7	5.0	5.8	7.8	9.0	10.4	16.2
	IAC (max.)	2.8	4.0	5.5	6.4	8.6	10.0	11.6	17.9
3.2	ISR		9.6	9.6	9.6	9.6	9.6	9.6	6.4
	IAC (min.)		2.7	4.0	4.9	6.9	8.1	9.6	15.7
	IAC (max.)		3.1	4.4	5.4	7.6	9.0	10.6	17.3
3.5	ISR			10.5	10.5	10.5	10.5	10.5	7.0
	IAC (min.)			3.0	3.8	5.7	6.9	8.3	14.5
	IAC (max.)			3.3	4.2	6.3	7.7	9.2	16.1
3.8	ISR				11.4	11.4	11.4	11.4	7.6
	IAC (min.)				3.2	5.2	6.5	7.9	14.1
	IAC (max.)				3.6	5.7	7.2	8.7	16.0
4.2	ISR					12.6	12.6	12.6	8.4
	IAC (min.)					3.5	4.7	6.2	12.9
	IAC (max.)					3.9	5.2	6.9	14.2
4.6	ISR						13.8	13.8	9.2
	IAC (min.)						3.9	5.3	12.4
	IAC (max.)						4.3	5.9	13.7
5.0	ISR							15.0	10.0
	IAC (min.)							4.3	11.6
	IAC (max.)							4.8	12.9
8.7	ISR								17.4
	IAC (min.)								5.0
	IAC (max.)								5.5

TESTING THE INSTANTANEOUS UNIT

1. Pick up the instantaneous unit manually. Ensure that the contacts have a 1/32-inch wiper and that the target drops freely when the contacts pick up.

If necessary, adjust the instantaneous unit so the target drops freely when the unit picks up.

2. Monitor contact continuity at Terminals 1 and 10.
3. Connect the variable ac current source to the winding circuit with the highest tap setting. Check Table 1 to determine which relay terminals are associated with each winding.
4. Initiate current. Continue initiating current at successively higher levels until the contact on the instantaneous unit just picks up. Verify that the instantaneous target drops smoothly.

NOTE: The instantaneous pickup level should be 10 times the tap setting of +/- 5%.

If the measured pickup current does not meet specifications, adjust the core screw on the instantaneous unit.

NOTE: Moving the core screw in decreases the pickup current. Moving it out increases the pickup current.

TESTING THE HARMONIC CURRENT RESTRAINT

1. Block the contact on the differential unit to the pickup position.
2. Monitor contact continuity at Terminals 1 and 10.
3. Set one variable ac current source to 120 Hz and the other ac current source to 60 Hz.
4. Connect the two current source outputs in parallel.
5. Connect the current output to the winding circuit with the highest tap setting.
6. Check Table 1 to determine which relay terminals are associated with each winding. Set the 60 Hz current source to 2 times the tap setting.
7. Initiate current. Continue initiating the 60 Hz current at the same level and the 120 Hz current at successively higher levels until the polarized relay just fails to pick up.
8. Calculate the harmonic restraint percentage using the following formula:

$$\text{Harmonic restraint percentage} = \frac{1.2267 \times 2\text{nd Harmonic Current}}{\sqrt{(\text{Fundamental})^2 + (2\text{nd Harmonic})^2}} \times 100$$

NOTE: The harmonic restraint percentage cannot be adjusted independently of the harmonic restraint unit pickup, but should be between 17% and 21%.

TESTING THE TARGET AND SEAL-IN

1. Pick up the target unit manually. Ensure that the contacts have a 1/32-inch wipe and the target drops freely when the contacts pick up.
2. If necessary, adjust the target unit so the target drops freely when the unit picks up. Connect the variable dc current source to Terminals 1 and 10.
3. Manually close the differential unit contact and the harmonic restraint unit contact.
4. Raise the dc current until the time target unit picks up. Verify that the target drops smoothly.
NOTE: The pickup current should meet the specifications listed in *Table 3*.
5. Release the differential unit contact and verify that the target unit remains sealed in.
6. Lower the dc current until the target unit drops out.
NOTE: The dropout current should meet the specifications listed in *Table 3*.

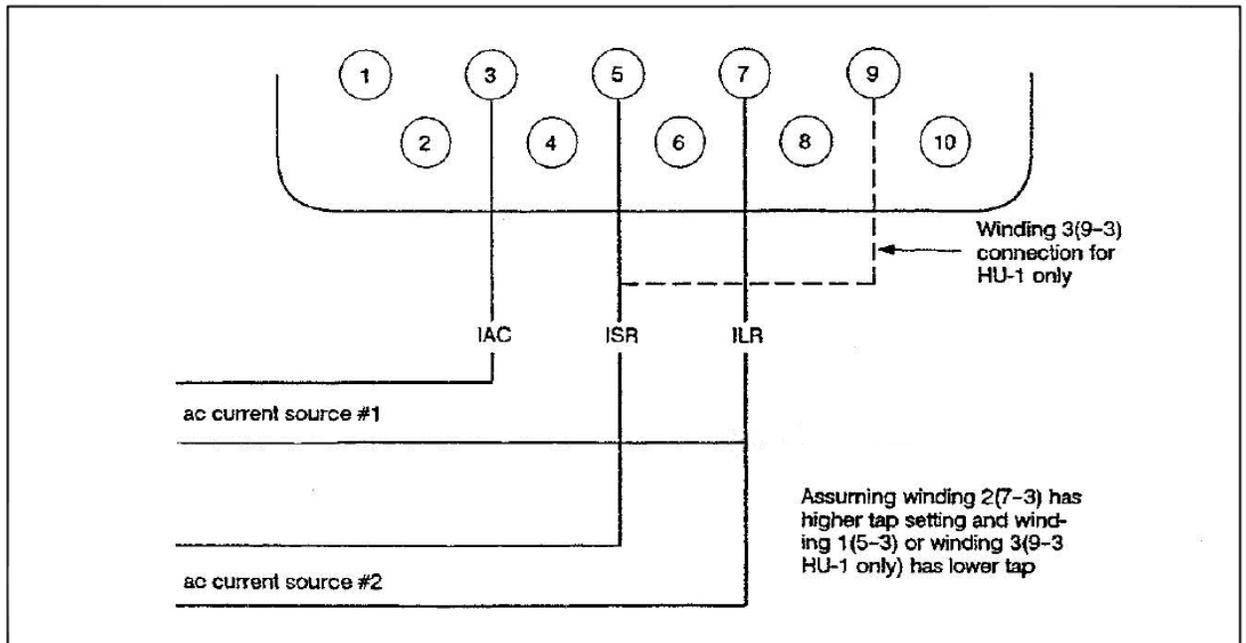
Table 3

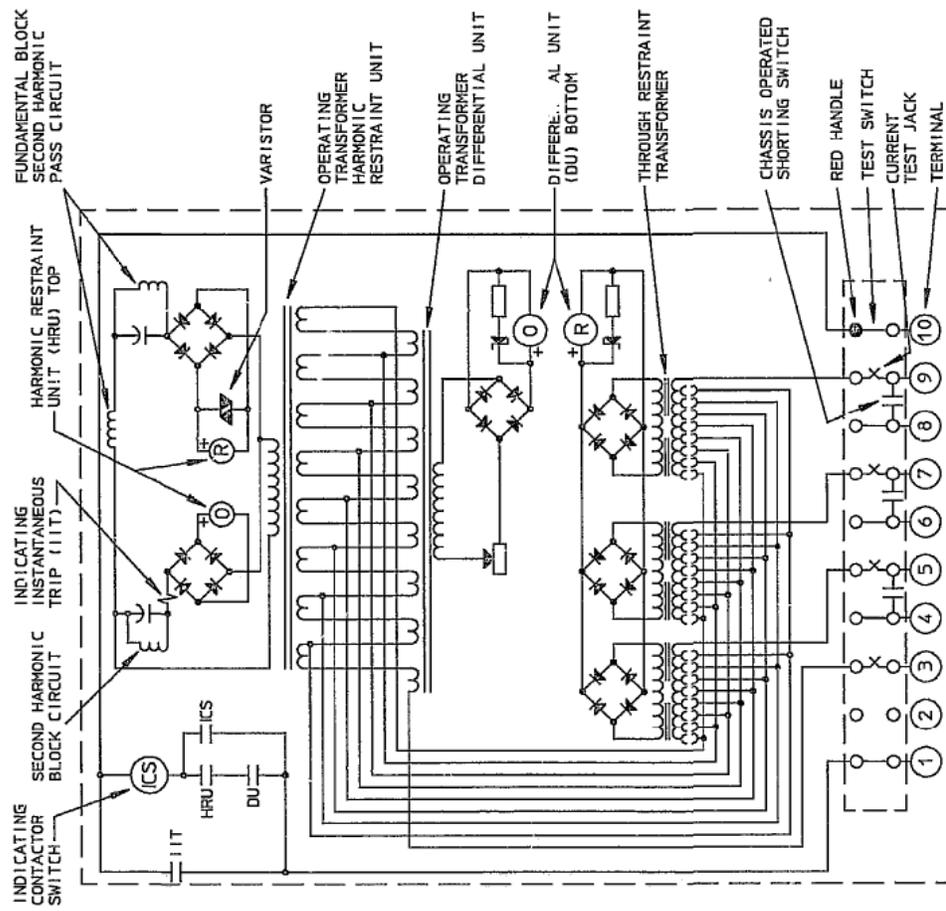
Target Unit Specifications

Tap Setting	Pickup Current	Dropout Current
0.2	0.15 to 0.195 A	0.05 A or more
2.0	1.50 to 1.95 A	0.55 A or more

Figure 1

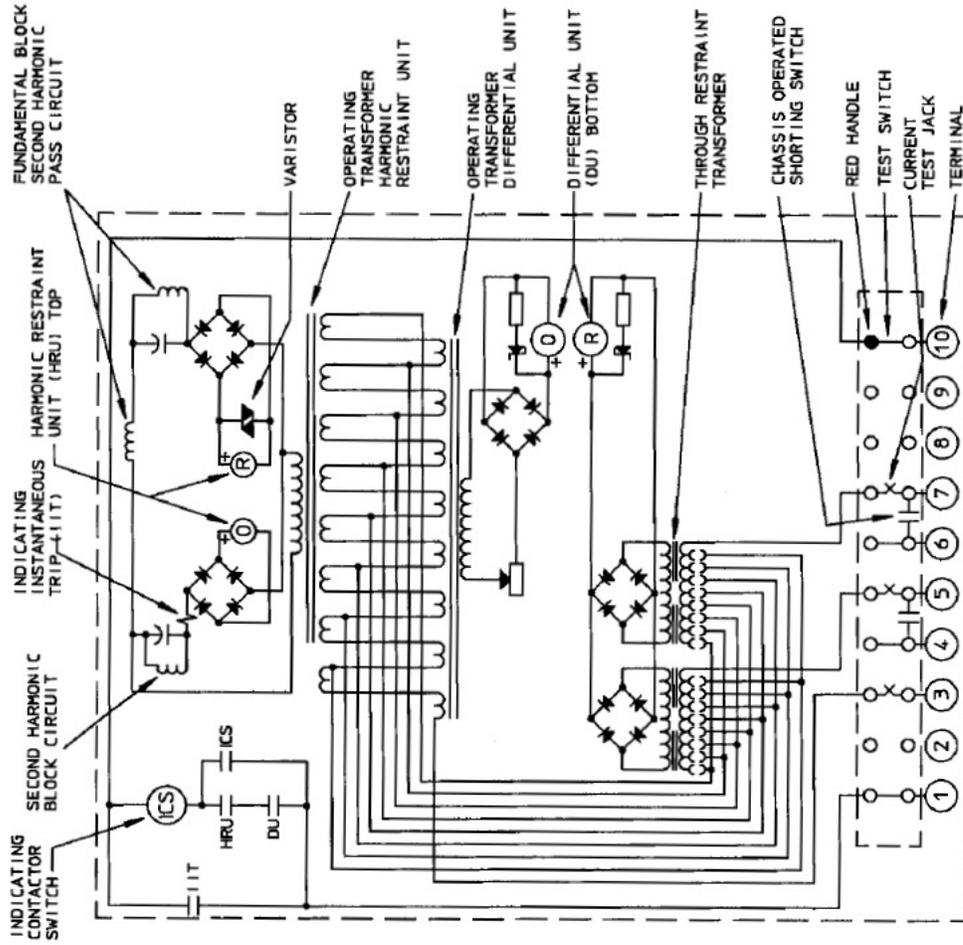
Terminal Identification schematic





Sub 3
3520A72

Figure 4. Internal Schematic of the Type HU-1 Relay in FT-31 Case.



*Sub 3
3520A49

Figure 3. Internal Schematic of the Type HU Relay in FT-31 Case.