

6. Metering Test Data

Verify the relay’s metering data to ensure you have your test set connected correctly and to prove that the analog-to-digital converters are operating correctly. It is easiest to apply three-phase rated voltage and current and record all of the available information. If the relay monitors VARs or Watts, vary the three-phase phase angle and record the Watts and VARs at the various test angles as shown below:

METERING							
CURRENT (AMPS)							
SEC INJ INPUT	A PH	B PH	C PH	MFG	% ERROR		
PHASE ANGLE							
SEC INJ INPUT	In			MFG	% ERROR		
@ 0 degrees				In RATIO=120			
VOLTAGE (VOLTS)							
SEC INJ INPUT	A PH	B PH	C PH (kV)	MFG (kV)	% ERROR		
PHASE ANGLE							
SEC INJ INPUT	Vs (kV)			MFG (kV)	% ERROR		
@ 0 degrees				Vs RATIO = 60			
3 PHASE METERING							
FREQUENCY (Hz)				POWER FACTOR			
SEC INJ INPUT	3 PH (Hz)	MFG (Hz)	%ERROR	SEC INJ INPUT	3 PH	MFG	%ERROR
57.50		57.50		30 Degrees Lag		0.866	
60.00		60.00		0 degrees		1.000	
62.50		62.50		30 Degrees Lead		-0.866	
POWER (MW)				VARS (MVAR)			
SEC INJ INPUT	3 PH (MW)	MFG (MW)	%ERROR	SEC INJ INPUT	3 PH	MFG	%ERROR
COMMENTS:							
RESULTS ACCEPTABLE: <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> SEE NOTES							

Figure 4- 5: Example Test Sheet with Metering

7. Input / Output Tests

All input and output operation (even inputs/output not used) should be verified to ensure the relay is fully functional. Inputs in-use should be verified with their end devices. Inputs not in use should be verified with control power, when applicable, or rated test voltage as a last resort. Not all inputs use external voltages and be careful before applying any voltages. Outputs in-use are verified during pick-up, timing, and logic-verification tests to operate their end devices. Outputs not in use can be verified with an ohmmeter or relay test-set input and a pulse command from the relay or other simulation necessary to close the output contact.

INPUT/OUTPUT CHECKS								
OUT101	OUT102	OUT103	OUT104	OUT105	OUT106	OUT107	ALARM	
IN101	IN102	IN103	IN104	IN105	IN106	IN107		
COMMENTS:								
RESULTS ACCEPTABLE: <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> SEE NOTES								

Figure 4- 6: Example Test Sheet with Input / Output Verification

8. Element Test Results

The most important part of the test sheet is the test results section. Separate the test results into sections to organize the tests into categories. The results should be easily understood and include the following information.

- **Settings** – the settings applied during test should be readily available to allow the reviewer to confirm or calculate the expected values. Most of our test sheets automatically calculate expected values based on the entered settings to add incentive for the additional data entry. The reviewer could search for the appropriate setting in the attached setting sheets, but it is in your best interest to keep things simple for the reviewer and yourself.
- **Pick-up Values** - Pick-up test results should be included for every test on every phase tested. Clearly define the unit of measure. Pick up test results can be in ohms (Ω), amperes (A or Amps), Volts (V or Volts), kilovolts (kV), Frequency (Hz) or in degrees ($^{\circ}$). You never want the reviewer to assume which unit of measure actually applies. Verify and document blocking elements internal to the element-under-test such as loss-of-potential or blocking inputs. Blocking elements added in the user-defined logic scheme will be confirmed later.
- **Timing Test Results** - Every timing test is performed with some input (Volts, Amps, Frequency, impedance, etc) and this value must be clearly documented with the result. The reviewer is unable to verify your results without knowing the applied input. Clearly document the actual timing results with the units clearly defined in seconds (s) or cycles (c).
- **Manufacturers Expected Result** – All test results (pick-up and timing) must include the manufacturer’s specified values as per the applied settings. Compare this value to your test results to determine if the relay is acceptable for service. A perfect test sheet would also include the manufacturer’s tolerances, but you will hard-pressed to fit all of this information on one test sheet. Manufacturers expected results from different phases with the same expected result could be entered as one value assuming that it is easily understood which expected result relates to which test results.
- **Percent Error** – The percent error or manufacturers tolerance for every test result should be calculated and evaluated against manufacturer’s tolerances. Percent error calculations or difference between test and tolerances should be placed as close as possible to the test value to ease understanding.
- **Notes** – Detail any problems, necessary changes, re-configurations, concerns, and questions as notes for each element section. Summarize critical items on the first or last page for easy reference. Examples of notes include “50-element blocked for timing test” or “Loss-of-potential block tested” or “Setting does not coordinate with downstream device”. If another setting was blocked to allow a test, always add a note stating that the element has been returned to service.