

## **UNIVERSAL RELAY TEST KIT**

### **1.1 RELAY TEST KIT**

#### **1.1.1 General**

Each relay test kit shall comprise the equipment as detailed here under.

The relay test kit shall be a computer based fully automatic type and shall have following features. Relay test kit should be already supplied to our utility. Manufacturer should have a calibration set-up and service centre in India. Also, manufacturer would be having registered office for technical support in India.

#### **1.2 Functional requirement**

The equipment is required functionally to test the following electromechanical, solid state and numerical protection relays.

- Distance relays (ground and phase distance)
- Over current relays (directional and non-directional, definite time and inverse time)
- Frequency relays (over-and under)
- Voltage relays (over and under)
- Power relays (directional)
- Differential relays (including harmonic restraint feature)
- Bus bar protection relays (biased low/high impedance)
- Other associated protection relay functions: auto-reclose function, power swing, Sync-check, etc.
- Single and three phase transducers (voltage, current, power (W, VA, VAR), phase and frequency)

#### **1.3 Hardware Specification**

- Relay test kit should not exceed more than 20 KG and portable unit to carry & capable of testing Electromechanical relays, static Relays & Microprocessor Based relays.
- **Voltage outputs shall be protected from short circuits and prolonged overloads. Current outputs shall be protected from open circuit and overloads. During Open Circuit & short circuit, kit should detect automatically as safety precautions.**
- **The testing system must generate at least 4 independent voltages and 6 independent current sources, with the facility to control their amplitudes and phase angles independently. The kit should have facility to test  $df/dt$  (i.e. frequency variation with respect to time).**
- The amplifier neutrals, the measurement inputs and the main power supply to be galvanically isolated from each other.
- The setting range of voltage generators shall be as under or better. Setting ranges 0-300 V for 4-phase AC (Ph-N), 0-300V for 1-phase AC (Ph-Ph), 0-300V for DC (L-N). Output power- Setting range 50VA for 4-phase AC (Ph-N), 250VA for 1-phase AC (Ph-Ph) . Accuracy requirements for the voltage generators are error < 0.08 % rd. + 0.02 % rg. guar. (0...300 V) as guaranteed deviation and resolution should be 5mV for lower range below 10V & 10mV for 10 -300V
- The setting range and output of current amplifiers shall be continuous 6 x 25A at 400VA(Ph-N), 3 x 0-50A at 800VA(Ph-N), 1 x 0-120A(Ph-N) at 1000VA, 6 x 0-20A DC at 250W Guaranteed(L-N). Accuracy for current source should be < 0.15 % rd. + 0.05 % rg. as guaranteed deviation and resolution should be 1mA
- The auxiliary DC supply must provide a power of 50 W and with the following ranges: 0 ... 264 VDC, 0.2 A / 0 ... 132 VDC, 0.4 A / 0 ... 66 VDC, 0.8 A. The auxiliary DC supply error shall not exceed 2% typically and 5% guaranteed

- Distortion (THD+N) not to exceed 0.15% for both current and voltage generators
- Shall be able to generate continuous sine waves with a frequency between 0.1 and 1000 Hz and to generate transient files with a bandwidth from dc up to 3.1 kHz. Frequency accuracy and drift shall not exceed:  $\pm 0.5$  ppm /  $\pm 1$  ppm and resolution shall not exceed 10  $\mu$ Hz
- Phase angle range must cover from  $-360^\circ$  to  $360^\circ$  with a resolution of  $0.001^\circ$ . Phase error to be less than  $\pm 0.2$  deg Guaranteed for both current and voltage generators.
- Minimum number of outputs shall be 4 and are completely independent from internal amplifier (voltage & current Source) outputs.
- Minimum number of binary inputs shall be 10nos, should sense both potential (Upto300V AC/DC) and potential free contacts. Resolution of time measurement shall be 1 ms or better
- Kit shall have 2 nos of Ethernet ports & USB for PC communication.

#### 1.4 SOFTWARE SPECIFICATION:

##### A. General functions:

- The software must be compatible to RIO & XRIO Standard. Software should have provision to Import Direct software settings which should eliminate the need for feeding settings. All manufacturers templates should be available with respect to various protections like Distance, Differential, OC and Generator protections. It should be upgradeable free-of charge
- The testing software must have the possibility of adding test points in manual and automatic mode directly as Symmetrical components values (Direct, Inverse (Positive, Negative and Zero sequence)
- The testing software must have Vector Diagram representation that shows the test point quantities during the test and at any time after the test is finished if the specific test point is selected. The vector diagram must also be part of the report.
- The testing software must have the possibility of fault quantity ramping (voltage or current, amplitude or phase) for all fault loops Ph-E, Ph-Ph, Ph-Ph-Ph
- The testing software must have the possibility of creating sequence of minimum 100 states for typical prefault, fault postfault applications with flexible trigger conditions time, binary inputs with logical AND and OR, Key Pressed, or External Triggers from GPS. The sequence must be executed in real time, delays between the states are not permissible. When working with a sequence of states it must be possible to trigger them with a GPS signal
- The testing software must have the possibility of adding test points in manual and automatic mode directly as Power (input values as power)
- The testing software must have possibility of power S,P,Q quantity ramping as 3-phase or single –phase powers
- Control of the GPS satellite receiver must be possible within test software. PTP protocol must be supported to perform end-to-end testing.
- Test software must have possibility to operate in primary or secondary values (Z, R, X, S, P, Q, V, I) and allow toggling between these 2 operation modes at any time (before during or after the test)
- The testing software must have the possibility of Impedance quantity ramping as IZI, Phi, R, and X for fault loops LE, LL, and LLL
- The test software must have the possibility to export the automatically generated test report as .rtf (Rich Text Format) file, csv format (Comma Separated Values) & .xml format (Extensible Mark up Language)
- **Relay software should have a facility to vary 2 parameters or more like Voltage Amplitude & Current Amplitude at a time to create a real fault simulation.**

- **Kit should have internal PTP source.**

#### **B. COMTRADE Playback:**

- The test software must provide a signal view that shows the analog signals and the binary inputs and outputs. This signal view must be exportable to COMTRADE format and also it must be possible to insert the graphics in the test report
- The software must include a tool to playback IEEE COMTRADE files and WAV files. The tool must allow scaling of the signals. It must be possible to play back files that have a recording duration longer than 60 minutes at a sampling rate of 3kHz. It must be possible to select multiple transient files that will be played back as a sequence.
- The test software must reproduce transient playback supporting COMTRADE (Binary or ASCII), TRF and PL4 formats. SW must allow also simulation with user defined binary signals
- It must be possible to generate repetitions for the transient playback
- It must be possible to insert a prefault sine simulation with a definable length before the actual COMTRADE playback
- The test software must provide a possibility to create flexible reference signals (binary) at any time in the transient file. And then create measurement conditions to check any binary input with tolerances for automatic pass/fail conditions comparing the actual binary signals to the binary reference signals
- It must be possible to see the state of all the binary inputs and outputs of the test set at any time. In case of fast changes, the software must indicate it with a visual alarm.

#### **C. DISTANCES RELAY TESTING:**

- Manual and automatic tests for impedance plane, starter characteristic, auto recloser,  $Z/t$  grading diagram shall be possible.
- The test software must have a functionality to define and perform tests of distance relays by impedance element evaluations using single-shot definitions in the Z-plane with graphical characteristic display
- Test models to be supported: constant current, constant voltage.
- Software must have the possibility of importing relay characteristic from relay manufacturer which are supporting RIO/XRIO export
- Testing of relays with simulation of the arc resistance must be possible & The software must have the possibility of simulating DC offset and setting the fault inception angle
- XRIO file format for the transfer of relay setting parameters to be supported.
- It must be possible to add sequence of prefault, fault & postfault shots and then to execute this automatically including automatic assessment of the correct trip time according to given tolerances
- Adding test points as Z and Phi or as R and X must be possible
- The testing device must provide the voltage and current terminals as 4 mm banana plugs and (at least 3 voltages and 3 currents plus neutrals) in a common connector. It should be connected to the generator combination Socket where 3 voltages and 3 currents can be used directly for the testing.

#### **D. DIFFERENTIAL RELAY TESTING:**

- **Templates for all manufacturers should be available to perform automatic testing**
- **Kit software should import the relay settings from Relay software using XRIO**
- **Kit should perform automatic Slope characteristics testing by Shot test as well as reach test**
- **Kit should be capable to inject 25A both sides (Primary and secondary) for Generator slope test in automated method for 5A Secondary ratio**
- **Kit should perform automatic harmonics testing**
- **Kit software should have provision to inject 1phase fault (L1-E, L2-E and L3-E), 2-Phase faults(L-L) and 3-phase faults on slope characteristics and verify it.**

## **E. OVER CURRENT RELAY TESTING:**

- Manual and automatic test modes shall be available.
- Feeder Protection /OC protection templates for respective manufacturer should be available for automatic testing to avoid settings complications.
- The test software must have a functionality for testing overcurrent protection covering ground fault, phase fault, positive, negative and zero sequence fault models
- It must be possible to test directional and non-directional overcurrent relays and provide test points in backward direction that are automatically assessed positive if the relay blocks
- Library with all standard definite and inverse characteristic (IEC, ANSI, IAC, I2t) must be available and it must be possible to model a non-standard characteristic easily point by point
- It must be possible to extract (digitize) overcurrent inverse-time characteristics from graphical representations (e.g. from a relay manual image)
- Relay test kit Software must test both IDMT Characteristics as well as Directional feature at a time and same should display characteristics of both IDMT as well as Direction during testing.
- Templates should be available for feeder protection to perform automatic testing which should eliminate on understanding Relay Characteristics angle as per relay and possible to perform the faults automatically with respect to different relay manufacturers like Siemens, ABB, Alstom, GE & Etc

## **H. Automatic test plan creation to easy maintenance testing:**

- Test Plans can easily be built, maintained and distributed.
- Common test object data, hardware configuration, and test modules for the different device functions can be collected in one test plan which eliminate testing time during periodic maintenance time.
- *The test plan automatically executes the test modules – one by one, results being stored in the included dynamic report*
- The modules Pause, Execute, and Text View make the test plan interactive and let it include the power of other programs
- Test Plan should be one-time investment and later stages it should help to test the respective protection IEDS without feeding settings, creating different faults & etc.
- All major Protections to be available in the template

## **1.5 Power supply requirements to the equipment shall be as follows:**

Nominal input voltage	- 100 – 240 VAC, 1-phase
Permissible input voltage	- 85 ... 264 VAC
Nominal frequency	- 50/60 Hz
Permissible frequency range	-45 ... 65 Hz
Rated current	-12 A at 115 V / 10 A at 230 V
Connection	Standard AC socket (IEC 60320)
Operation temperature	- 3 0 ... +50 °C (+32 ... +122 °F)
Storage temperature	-25 ... +70 °C (-13 ... +158 °F)
Humidity range	Relative humidity 5 ... 95 %, non-condensing

## **CONFORMANCE Standards:**

HIGH CURRENT PORTABLE DIGITAL MICRO-OHM METER / CONTACT RESISTANCE METER(200A)	
SL.NO.	PARTICULARS

**Safety:** IEC 61010-1

**Shock:** MIL-PRF-28800F (30 g/11ms half-sine)

IEC 60068-2-27 (15 g/11 ms half-sine)

**Vibration:** MIL-PRF-28800F (10-500 Hz, 2.05 g rms)

IEC 60068-2-6 (10-150 Hz, 2 g)

**Transit Drop:** MIL-PRF-28800F (10 drops, 46 cm), ISTA 1A

**Electromagnetic Compatibility**

**Emissions:** IEC 61326-2-1, IEC 61000-3-2/3,

FCC Subpart B of Part 15 Class A

**Immunity:** IEC 61000-4-2/3/4/5/6/8/11

Above said Conformance standard should meet or equal.

1	<p><b>APPLICATION :</b></p> <ol style="list-style-type: none"> <li>1. The Contact Resistance meter (CRM) shall be microprocessor based and suitable for measuring low value resistance of circuit breaker, switch, disconnecter, isolators, welding joints etc.</li> <li>2. The CRM shall be suitable to conduct measurements in charged substation up to 400 kV, with both side grounded</li> </ol>
2	<p><b>GENERAL :</b></p> <ol style="list-style-type: none"> <li>1. The CRM should be portable ; microprocessor based with LCD Display, and shall be suitable for use in high voltage sub-station environment.</li> <li>2. The CRM should be compatible with PC and will have features for measurement storage and reporting.</li> <li>3. The CRM should have in built software to enable individual test or and entire series of test and store the results.</li> </ol>
3	<p><b>FUNCTIONAL REQUIREMENTS :</b></p> <ol style="list-style-type: none"> <li>1. The resistance reading shall be digital and displayed directly without any need for any balancing or calculations.</li> <li>2. The CRM shall also indicate output current value as percentage of set value and this shall be achieved without any need for manual control</li> <li>3. The current output of the CRM shall be true ripple free DC.</li> <li>4. The CRM shall have built- in memory for storing the test results for minimum 50 values.</li> <li>5. The measurement shall have date &amp; time stamped and can be easily transferrable to PC or on USB port.</li> </ol>
4	<p><b>RANGE &amp; ACCURACY :</b></p> <p>Test Current :</p> <ul style="list-style-type: none"> <li>• 10-200 A DC with Resolution of 1 A or better</li> <li>• Up to 100 Amp should be possible to inject continuously without overloading.</li> </ul> <p>Resistance :</p> <ul style="list-style-type: none"> <li>• Range : 0.1 <math>\mu\Omega</math> to 1.0 <math>\Omega</math></li> <li>• Accuracy : 1 % of reading <math>\pm</math> 1 digit of FS</li> <li>• Resolution : 0.1 <math>\mu\Omega</math> to 0.1 m <math>\Omega</math> (lower range to Higher Range)</li> </ul>
5	<p><b>MEASUREMENT :</b></p> <ul style="list-style-type: none"> <li>• Test lead cables should be provided with suitable clips to make proper contact with test equipment surface whose resistance is to be measured.</li> <li>• Measurement method employed should eliminate the error that may be introduced by test lead resistance and contact resistance between probe and material to be tested.</li> </ul>

6	<p><b>OTHER REQUIREMENTS :</b></p> <ul style="list-style-type: none"> <li>• The CRM should be equipped with thermal and over current protection. It should comply with various relevant International standards such as International standards IEC 61010-1, Electromagnetic Compatibility (EMC) as follows: <ul style="list-style-type: none"> <li>&gt; CE conformity EMC standard 89/336/EEC</li> <li>&gt; Emission EN 50081-2, EN 61000-3-2/3</li> <li>&gt; Interference Immunity EN 50082-2</li> </ul> </li> <li>• Supplier should provide details of laboratories where this instrument can be get calibrated in India, in case of imported equipment.</li> <li>• The performance certificates of the similar equipment supplied in last five years shall be provided with contact details of user.</li> <li>• Calibration certificates should be traceable to International Standards and date of issue of this certificate should not be older than 1 month from date of dispatch.</li> </ul>
7	<p><b>EXTERNAL INTERFACE SPECIFICATIONS :</b></p> <p><b>* optional</b></p> <ul style="list-style-type: none"> <li>• SD card Interface : * <ul style="list-style-type: none"> <li>&gt; Saving of binary data, saving and Loading setting files, saving and loading screen copies.</li> <li>&gt; Slot : SD standard compliant</li> <li>&gt; Memory Capacity : Maximum 32 GB</li> <li>&gt; Download data from the SD memory card</li> </ul> </li> <li>• RS-232 Interface <ul style="list-style-type: none"> <li>&gt; Measurement and control using GPS synchronized time</li> </ul> </li> <li>• LAN Interface* <ul style="list-style-type: none"> <li>&gt; HTTP server function (Remote operation application function)</li> <li>&gt; Measurement start and stop application function</li> </ul> </li> <li>• USB Interface*</li> </ul>
8	<p><b>MAINS POWER SUPPLY :</b></p> <ul style="list-style-type: none"> <li>• 230 V <math>\pm</math> 10%, The modular in-built rechargeable battery shall be maintenance free type. Supplier shall mention the following : Type &amp; make <ul style="list-style-type: none"> <li>- Size</li> <li>- Rating of battery.</li> </ul> </li> </ul>
9	<p><b>MANUAL :</b></p> <ul style="list-style-type: none"> <li>• Operation manual in English - 1 set along with softcopy</li> <li>• Maintenance manual in English - 1 set along with softcopy</li> </ul>
10	<p><b>TESTING &amp; TRAINING :</b></p> <ul style="list-style-type: none"> <li>• Training for two OPTCL Engineers shall be provided for 2 days at manufacturer's works.</li> </ul> <p>Scope of training:</p> <ul style="list-style-type: none"> <li>• Operation, utilization, maintenance &amp; upkeep of the instrument for field testing and demonstration of its utilization by arranging testing at site.</li> </ul>
11	<p><b>ACCESSORIES :</b></p> <p>One additional set of measurement cables* (optional)</p> <p>Carry case which is normal weather proof and shock / vibration proof to protect inside equipment.</p>

12	<b>SAFETY :</b> <ul style="list-style-type: none"> <li>• Shock proof, Vibration proof, EMC compliant &amp; Safety requirements as per relevant International Standards.</li> <li>• In case of sudden opening of test leads, the equipment should automatically shut down instantaneously.</li> </ul>
13	<b>CALIBRATION :</b> The CRM should have valid calibration certificate traceable to National & international standards