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0.1 Circulation List

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FOREWORD

This specification has been prepared by Research and Development Department in collaboration with Technical Services Department (Electrical Plant Section-Mt Kenya Region) both of the Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for a **portable multifunctional test system set** and its **accessories**. The specification is intended for use by KPLC in purchasing the equipment.

The supplier shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

1.1. This specification is for a **portable multifunctional test system set** and its **accessories** for use when commissioning and maintaining electrical plant equipment and after major electrical plant repairs and component replacement. The equipment and its accessories shall test the whole system and detect defects in the electrical plant equipment. The set shall consist of :

a) Portable multifunctional primary test system.
b) Accessories including :
   i) Tan-delta Unit
   ii) Coupling Unit
   iii) Grounding box
   iv) 12kV Oil Test Cell
   v) Current Booster
   vi) Polarity Checker
   vii) Fast Fourier Transformation (FFT) Voltmeter with adapter
   viii) Switch Box

1.2. The specification also covers inspection and test of the equipment and its accessories as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

1.3. The specification stipulates the minimum requirements for the equipment acceptable for use in the company (KPLC) and it shall be the responsibility of the supplier to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the test equipment for KPLC.

1.4. The specification does not purport to include all the necessary provisions of a contract.

2. REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this specification. Unless otherwise stated, the latest edition of the referenced documents (including any amendments) applies:

IEC 61010-1:	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
IEC 60950	Information technology equipment –Safety – Part 1: General requirements
IEC 60664-1& 3:	Insulation Coordination for Equipment within Low-Voltage Systems - Part 1: Principles, Requirements and Tests; Part 3: Use of coatings to achieve insulation coordination of printed board assemblies.
IEC 62680-1:	Universal serial bus interfaces for data and power - Part 1: Universal serial bus specification
IEC 60112:	Method for the determination of the proof and the comparative tracking indices of solid insulating materials
IEC 61326:	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements
IEC 60068:	Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal) Part 2-27: Tests – Test Ea and guidance: Shock
IEC 60529:	Degrees of protection provided by enclosures (IP Code)

3. TERMS AND DEFINITIONS

3.1. For the purpose of this specification, the definitions given in the reference standards shall apply together with the following abbreviations.

MU: Merging Unit
CTI: Comparative Tracking Index
PLC: Performance Level Category
CT: Current Transformer
VT: Voltage Transformer

4. REQUIREMENTS

4.1. Service Conditions

The portable multifunctional primary test system shall be suitable for continuous operation outdoors in tropical areas at:

a) Altitudes of up to 2200m above sea level,
b) Humidity of up to 95%,
c) Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C and
d) Heavy saline conditions along the coast.

4.2. Design And Construction

4.2.1. The portable multifunctional test system and its accessories shall be designed ,manufactured and tested in accordance with IEC 61010-1, IEC 60664-1 & 3 and IEC 60950 standards including the requirements of this specification.

4.2.2. The equipment shall be designed for conducting electrical tests on power transformers, current transformers, voltage transformers, grounding systems, lines, cables and circuit breakers. It shall also be suitable for Tan delta and ground system impedance tests.

4.2.3. The module design shall constitute of different key components. Each of the components shall be engineered to operate effectively in harsh electrical and environmental conditions associated with the testing of HV apparatus.

4.2.4. **Control unit**

4.2.4.1. This shall be the "brain" of the multifunctional test system and shall consist of two signal processing units and an embedded computer that shall provide application knowledge for all of the incorporated testing procedures for up-to-date, practical and efficient measurement functions.

4.2.4.2. It shall generate digital test voltage or current that:

a) Enables independence from the mains signal quality.
b) Enables independence from the mains frequency.
c) Assures a high level of reproducibility of measurements

4.2.4.3. It shall provide safety function features such as ground connection checks, self-diagnostics, overload, overcurrent and over temperature management that:

a) Reduces the risks to the user and the device under test (DUT),
b) Prevents damage to the test set and its accessories.

4.2.4.4. It shall provide data storage using onboard flash memory and/or external USB memory to save time through its automatic storage and reporting functions.

4.2.5. **Power electronic unit**

4.2.5.1. This shall be adjustable, controlled voltage and current source with variable frequency to be supplied from a single phase wall outlet (220 V - 250 V, 50 Hz) that can be used everywhere in the substation or power plant.

4.2.5.2. It shall have a DC intermediate circuit that guarantees reactive power generation inside the unit as the only active power shall be taken from the supply wall socket.

4.2.5.3. The generation of voltage or current with variable frequency feature shall help to:
a) Avoids mains frequency related noise,
b) Perform accurate measurements in noisy environments,
c) Tests apparatus with different frequency rating (for example, for factory tests in the supplier's home country),

4.2.5.4. It shall be able to generate different periodic wave shapes (sine wave, saw tooth, etc.) to perform special measurements (polarity verification, IEC 61850 merging unit (MU) and channel detection).

4.2.6. **Measurement unit**

4.2.6.1. The equipment measuring unit shall be able to:
a) Measure voltage, current, ratio, frequency, phase,
b) Verify polarity (for example, on CTs and VTs),
c) Calculate power (P, Q, S) and impedance (R, L, C, Z, X),

4.2.6.2. It shall have a frequency selective measurements feature (measuring signals at the same frequency as the multifunctional test system source signals)
a) This shall suppress all disturbances, including mains frequency related noise
b) Shall be able to measure small signals in electromagnetically disturbed environments.

4.2.6.3. The inputs shall be galvanically separated from each other to avoid the wrong measurement results due to unintended ground loops.

4.2.6.4. All inputs shall be equipped with overvoltage and surges protection devices to avoid damage to the test equipment as per IEC 61010-1 standard.

4.2.6.5. Connection of external sensors (CTs, VTs and current clamps) shall be supported by the test sets inbuilt software to allow advanced measurement capabilities (for example, integral of a signal for measuring Rogowski coil CTs)

4.2.7. **Interface**

4.2.7.1. The test set shall have an easy and intuitive graphical user interface for efficient, time-saving testing with different selectable test standards (for example, IEEE, IEC, etc.) to allow different users to effectively use the device and to enable reports be generated in different formats.

4.2.7.2. The wiring connections shall have LEDs indications for quick wiring set-up and to avoid wiring errors.

4.2.7.3. There shall be different operation modes from the front panel with test cards or controlled by a PC to enable each user to operate the tester according to personal preferences.

4.2.7.4. The test set shall be equipped with a standard data communication interface for connection to remote data processing such as computer, or control equipment.

4.2.7.5. The interfaces shall use IEC 62680-1, USB 3.0, device class DCh or FEh with a signaling speed of 5 Gbit/s and a usable data rate of up to 4 Gbit/s (500 MB/s) and RS232 serial communication line, with the length of the connection not exceeding 20 meters. The tester shall be capable of being remotely controlled by such equipment.

4.2.7.6. For remote transmission of remote data, ***if specified in the tender***, the portable multifunctional test system shall support both RS-485 and Ethernet (TCP or UDP) communication ports allowing a wide range of modem / radio devices to be used.

4.3. Ratings

4.3.1. Generator Outputs

The output parameter for voltages and currents for the multifunctional test system shall be given in Table 1 and 2 with the tolerances given in Table 3.

Table 1: Current Outputs

No.	Range	Amplitude	t_{max} [1]	V_{max} [2]	$Power_{max}$ [2]	f
1	800 A AC[3]	0 --- 800 A	25 s	6.0 V	4800 VA	15 Hz – 400 Hz
		0 --- 400 A	8 min.	6.4 V	2560 VA	15 Hz – 400 Hz
		0 --- 200 A	> 2 h	6.5 V	1300 VA	15 Hz – 400 Hz
2	6 A AC[10]	0 --- 6 A	> 2 h	55 V	330 VA	15 Hz – 400 Hz
3	3 A AC[10]	0 --- 3 A	> 2 h	110 V	330 VA	15 Hz – 400 Hz
4	400 A DC	0 --- 400 A	2 min.	6.5 V	2600 VA	DC
		0 --- 300 A	3 min.	6.5 V	1950 VA	DC
		0 --- 200 A	> 2 h	6.5 V	1300 VA	DC
5	6 A DC[4,10]	0 --- 6 A	> 2 h	60 V	360 VA	DC
2000 A AC[3] shall be achieved with an interface to a **Current Booster**						

Table 2: Voltage Outputs

No.	Range	Amplitude[5]	t_{max}	I_{max}	$Power_{max}$ [5]	f
1	2 kV AC[3]	0 -- 2 kV	1 min	1.25 A	2500 VA	15 Hz – 400 Hz
		0 -- 2 kV	> 2 h	0.5 A	1000 VA	15 Hz – 400 Hz
2	1 kV AC[3]	0 -- 1 kV	1 min	2.5 A	2500 VA	15 Hz – 400 Hz
		0 -- 1 kV	> 2 h	1.0 A	1000 VA	15 Hz – 400 Hz
3	500 V AC[3]	0 – 500 V	1 min	5.0 A	2500 VA	15 Hz – 400 Hz
		0 – 500 V	> 2 h	2.0 A	1000 VA	15 Hz – 400 Hz
4	130 V AC [10]	0 – 130 V	> 2 h	3.0 A	390 VA	15 Hz – 400 Hz

Table 3: Internal measurement of outputs (Accuracy[5])

			Amplitude		Phase
No.	Output	Range	Reading error	Full scale error	Full scale error
1	800 A AC	-	<0.10 %	<0.10 %	$<0.10^0$
2	400 A DC	-	<0.20 %	<0.05 %	-
3	2 kV AC	2000 V	<0.05 %	<0.05 %	$<0.10^0$
		1000 V	<0.05 %	<0.05 %	$<0.15^0$
		500 V	<0.05 %	<0.05 %	$<0.20^0$
		5 A	<0.20 %	<0.05 %	$<0.10^0$
		500 mA	<0.05 %	<0.05 %	$<0.10^0$

4.3.2. Generator inputs

The input parameters for voltages, currents and resistances for the multifunctional test system shall be are given in Table 4 and 5 complete with the tolerances and input output synchronization data given in Table 6.

Table 4: Measuring inputs (Accuracy[6])

				Amplitude		Phase
No.	Input	Impedance	Range	Reading error	Full scale error	Full scale error
1	I AC / DC[4,7]	<0.1 Ω	10 A AC	<0.05 %	<0.05 %	$<0.10^0$
			1 A AC	<0.05 %	<0.05 %	$<0.15^0$
			10 A DC	<0.03 %	<0.08 %	-
			1 A DC	<0.03 %	<0.08 %	-
2	V1 AC[8]	500 kΩ	300 V	<0.05 %	<0.05 %	$<0.10^0$
			30 V	<0.05 %	<0.05 %	$<0.10^0$
			3 V	<0.10 %	<0.05 %	$<0.10^0$
			300 mV	<0.15 %	<0.05 %	$<0.10^0$
3	V2 AC[8,11]	10 MΩ	3 V	<0.03 %	<0.08 %	$<0.10^0$
			300 mV	<0.08 %	<0.08 %	$<0.10^0$
			30 mV	<0.10 %	<0.25 %	$<0.15^0$
4	V DC[4,7]		10 V	<0.03%	<0.08 %	-
			1 V	<0.03 %	<0.08 %	-
			100 mV	<0.05 %	<0.10 %	-
			10 mV	<0.05 %	<0.15 %	-

Table 5: Resistance Measurements

4-wire measurement with 400 A DC output and 10 V input				
No.	Current	Resistance	Voltage	Accuracy(full scale)
1	400 A	10 μΩ	4 mV	Error < 0.70 %
2	400 A	100 μΩ	40 mV	Error < 0.55 %
3	400 A	1 mΩ	400 mV	Error < 0.50 %
4	400 A	10 mΩ	4 V	Error < 0.50 %
4-wire measurement with 6 A DC output and 10 V input				
No.	Current	Resistance	Voltage	Accuracy(full scale)
1	6 A	100 mΩ	0.6 V	Error < 0.35 %
2	6 A	1 Ω	6 V	Error < 0.35 %
3	1 A	10 Ω	10 V	Error < 0.25 %
2-wire measurement with 10 V VDC input				
No.	Current	Resistance	Voltage	Accuracy(full scale)
1	>5 mA	100 Ω	-	Error < 0.60%
2	>5 mA	1 kΩ	-	Error < 0.51 %
3	>5 mA	10 kΩ	-	Error < 0.50 %

Table 6: Output to input synchronization

No.	Particulars	Test cards Quick Sequencer, Ramping	Amplifier test card
1	Frequency range	48 Hz – 62 Hz	48 Hz – 62 Hz
2	Synchronization Inputs	V1 AC	V1 AC, V2 AC, I AC
3	Input magnitude	10 % of output range full scale	
4	Output magnitude	5 % of output range full scale	
5	Settling time	100 ms after 5 % of output range full scale is reached	1000 ms after 5 % of output range full scale is reached
6	Signal changes	All quantities must be ramped within 20 signal periods	No changes of frequency and phase. Magnitude changes without limitation. Output follows within 250 ms.
7	Phase tolerance	0.5^0 within the limits as specified above	

NOTE

1. *With a mains voltage of 230 V using a 2 × 6 m high-current cable at an ambient temperature of 23 °C ± 5 °C / 73 °F ±10 °F.*
2. *The power and maximum voltage may be reduced above 60 Hz or below 50 Hz.*
3. *Output can be synchronized with V1 AC in Quick, Sequencer, Ramping and Amplifier test cards.*
4. *The inputs and outputs are protected with lightning arrestors between the connector and against the protective earth. In the event of application of energy exceeding a few hundred Joule the lightning arrestors apply a permanent short-circuit to the input / output.*
5. *The power and amplitude may be reduced above 200 Hz or below 50 Hz.*
6. *98 % of all units have accuracy better than specified as "typical".*
7. *This input is galvanically separated from all other inputs.*
8. *V1 and V2 are galvanically coupled but separated from all other inputs.*
9. *There are power restrictions for mains voltages below 190 V AC.*
10. *Fuse-protected.*
11. *When using the CT Rogowski test card, the 3 V V2 AC input uses an additional software based integration method. In the range of 50 Hz < f < 60 Hz, this results in a phase shift of 90 ° as well as an additional phase error of ± 0.1 ° and an additional amplitude error of ± 0.01 %. For frequencies in the range of 15 Hz < f < 400 Hz, the phase error is not specified, and the amplitude error can be up to ± 0.50 %*

4.3.3. The power supply and mechanical performance technical data for the multifunctional test system set shall be given in Table 7.

Table 7: Power Supply and Mechanical Data

No	Particulars		Test Performance
1	Power Supply	Single-phase, nominal	220 V AC ... 250 V AC, 16 A
		Single-phase, permissible	215 V AC ... 264 V AC (L-N or L-L)
		Frequency, nominal	50 Hz
		Power consumption	<3500 VA (<7000 VA for short time < 10 sec)
		Connection	C22 conforming to IEC 60320
2	Environmental conditions	Operating temperature	-1 ... +40 °C (+14 ... +131 °F)
		Storage temperature	-20 ... +70 °C (-4 ... +158 °F)
		Humidity range - Rel. humidity	< 95 %, non-condensing
		Shock (operating)	15 g / 11 ms half sine as per IEC 60068-2-27
		Vibration (operating)	Frequency range from 10 Hz to 150 Hz, continuous acceleration 2 g (20 m/s^2), 10 cycles per axis as per IEC 60068-2-6
3	EMC immunity	Performance criteria of the equipment	IEC 61326-1 Class A,
4	Safety	Rated Impulse Voltage for equipment -1.2/50µs	6000 V as per IEC 60664-1, table 1
		Overvoltage category	Class IV as per IEC 61010-1
		Pollution category	Class 2 as per IEC 61010-1
		Insulation material group	Group II - 400≤CTI<600 (PLC=1) as per IEC 60112
		Minimum clearances for equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	5.5 mm as per IEC 60664-1
		Creepage distance for equipment subject to long term stresses, min	1.8 mm as per IEC 60664-1
		Minimum acceptable creepage distances on printed circuit boards	1.0 mm as per IEC 60664-1
		Maximum recurring peak voltage related to creepage distance on printed wiring boards	913 V as per IEC 60664-1
		Width of grooves by pollution degree on printed circuit boards	0.4 mm as per IEC 61010-1
		Partial discharge requirements	< 5pC as per IEC 60664-1 Annex C
		IP protection category	IPX5
		Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3

* If the internal emission source(s) is operating at a frequency below 9 kHz then measurements need only to be performed up to 230 MHz.

4.3.4. Additional features for measurement inputs shall be:

a) Automatic range switching (except Amplifier test card),
b) Galvanically separated potential groups: I AC/DC ; V1 & V2 ; V DC,
c) AC frequency range: 15 Hz to 400 Hz (except Amplifier test card),
d) Protection of I AC/DC input: 10 A very fast acting (FF) fuse[4] - refer to clause 4.3,
e) Binary input for dry contacts or voltages up to 300 V DC[7] – refer to clause 4.3 ,
f) Trigger criteria: Toggling with potential-free contacts or voltages of up to 300 V,
g) Input impedance: > 100 kΩ,
h) Response time: 1 ms,

4.3.5. All input / output values shall be guaranteed for one year within an ambient temperature of 23 °C ±5 °C / 73 °F ±10 °F, a warm-up time longer than 25 min. and in a frequency range of 45 Hz to 60 Hz or DC.

4.3.6. Accuracy values indicate that the error shall be smaller than ± (value read x reading error + full scale of the range x full scale error).

4.4. Multifunctional Test System Accessories (*Optional, unless specified in the tender*)

4.4.1. Tangent Delta Unit

4.4.1.1. This is an accessory unit to the multifunctional test system, completing its use for power transformer testing with the ultimate insulation diagnosis solution.

4.4.1.2. It shall be controlled by the multifunctional test system, to provide a fully automated testing and reporting capabilities for the comprehensive testing of transformer parameters within one portable system.

4.4.1.3. It shall utilize an application of innovative measurement techniques and the use of high precision components that bring a laboratory precision with a rugged design into the field of insulation condition testing. It shall also offer testing with frequency sweeps.

4.4.1.4. It shall be supplied in a custom-built trolley that allows practical handling on and off-site along with an easy and quick breakdown into portable components.

4.4.1.5. The Tan-delta Unit ratings and tolerances are given in Table 8.

Table 8: Technical design values for Tangent Delta Unit

High Voltage Output			
V	I	t_{max}	At f (Hz)
0 --- 12 kV AC	300 mA	>2 min	15 ---- 400
	100 mA	>60 min	

Voltage / Current measurement		
Range	Resolution	Accuracy
1200 V AC	1 V	error < 0.3 % reading + 1 V
5 A AC	5 digits	error < 0.5 % reading
8 mA AC		error < 0.3 % reading + 100 nA

Capacitance Cp (equivalent parallel circuit)			
Range	Resolution	Accuracy	Conditions
1 pF --- 3 µF	6 digits	error < 0.5 % reading + 0.1 pF	< 8 mA
		error < 0.2 % reading	> 8 mA

Dissipation factor DF (tan δ)			
Range	Resolution	Accuracy	Conditions
0 --- 10 % (capacitive)	5 digits	error < 0.1 % reading + 0.005 %	15 --- 70 Hz
0 --- 100 (0 --- 10000 %)	5 digits	error < 0.5 % reading + 0.002 %	< 8 mA

Power factor cos φ			
Range	Resolution	Accuracy	Conditions
0 --- 10 % (capacitive)	5 digits	error < 0.1 % reading + 0.005 %	15 --- 70 Hz
0 --- 100 %	5 digits	error < 0.5 % reading + 0.002 %	< 8 mA

4.4.2. Coupling Unit

As measurements on high voltage lines need special safety measures, the **coupling unit** shall be used to couple the inputs and outputs of the portable multifunctional test system to the transmission line safely with the technical parameters as per Table 9..

Table 9: Technical design values for Coupling Unit

Current Output Ranges	
Current range	Compliance voltage
0 --- 10 A rms	500 V rms
0 --- 20 A rms	250 V rms
0 --- 50 A rms	100 V rms
0 --- 100 A rms	50 V rms

Measuring Transformers		
VT	600 V : 30 V	class 0.1
CT	100 A : 2.5 A	class 0.1

Mechanical data	
Protection	IP 20
Approx. dimensions	450 x 220 x 220 mm
Approx. weight	28.5 kg

4.4.3. Grounding Box

The **Grounding Box** shall be used to make the connection from the **Coupling Unit** to the overhead line and can be located at a safe distance from the operator. The **Grounding Box** shall be designed to allow the discharge of currents up to 30 kA once its voltage limit is exceeded.

Table 10: Technical design values for Grounding Box

Electrical data		
Nominal ac spark-over voltage	< 1000 V rms	
Short circuit proof	Up to 30 kA for 100 ms	
Output power (MTS)	5 kVA at cos φ < 1.0 for 8 s	
Accuracy[1]		
Measured value	Typical accuracy	Current range
0.05 – 0.2 Ω	1.0 – 0.5 %	100 A
0.2 – 2 Ω	0.5 – 0.3 %	100 A
2 – 5 Ω	0.3 %	50 A
5 – 25 Ω	0.3 %	20 A
25 – 300 Ω	0.3 – 1.0 %	10 A
Mechanical data		
Approx. dimensions (Φ x h)		200 x 190 mm
Approx. weight including ground cable		6.8 kg
Accessories[2]		

[1] At ambient temperature of 23 ^{0}C ± 5 ^{0}C

[2] Special accessories for step, touch and ground impedance shall be provided.

4.4.4. 12 kV Oil Test Cell

4.4.4.1. The oil test cell shall be used in conjunction with the multifunctional tester and the **Tan-delta Unit** to measure the Permittivity and Tangent Delta / Power Factor of insulation liquids, e.g. transformer oil.

4.4.4.2. It shall have a three-electrode design with guard to allow for precise measurements, especially of small losses.

4.4.4.3. The electrodes shall be circular and constructed from rigid stainless steel and shall require a sample of 1.2 to 2 liters of oil.

4.4.4.4. The electrical connection to the Test Cell shall be made using the standard cable provided to interface with the **Tan-delta Unit**.

Table 11: Technical design values for 12kV Oil Test Cell

Technical Data	
Cell Type:	Three-terminal, guarded
Cell Gap Spacing:	11 mm, nominal
Sample Volume:	1.2 liters (min) to 2 liters (max)
Cell Capacitance:	65 pF nominal (in air)
Maximum Test Voltage:	12 kV rms
Voltage Operating Range:	2.5 to 12 kV for a stress of 200 to 1100 V/mm
Connectors:	6 mm sockets for high voltage cable 4 mm sockets for measuring cables – class C22 as per IEC 60320
Approx. dimensions:	22 x 25 cm [diameter x height]
Approx. weight:	6 kg

4.4.5. Current Booster

4.4.5.1. Tests applications requiring up to 2000 A shall require the use of a Current Booster. The output current of the Multifunctional Primary Test Set shall be increased to up to 2000 A by an electronically controlled current booster.

4.4.5.2. The booster shall be connected close to the busbar using short high current leads and to the tester via a long control cable.

Table 13: Technical design values for Current Booster

Current outputs					
Range	Amplitude	T_{max}[1]	V_{max}[2]	$Power_{max}$[2]	f
1000 A AC[3]	0 -- 1000 A	25 s	4.90 V	4900 VA	15 – 400 Hz
	0 – 500 A	30 min	5.00 V	2500 VA	15 – 400 Hz
	0 – 2000 A	25 s	2.45 V	4900 VA	15 – 400 Hz

Internal measurement of outputs						
Output	Guaranteed accuracy			Typical accuracy		
	Amplitude		Phase	Amplitude		Phase
	Reading	Full scale	Full scale	Reading	Full scale	Full scale
2000 A AC	0.25 %	0.25 %	0.50^0	0.13 %	0.13 %	0.25^0
1000 A AC	0.25 %	0.25 %	0.50^0	0.13 %	0.13 %	0.25^0

1 *With mains voltage 230 V at 23 °C ± 5 °C (73 F± 10 F) ambient temperature.*
2 *Signals below 50 Hz or above 60 Hz with reduced values possible.*
3 *Outputs in series.*
4 *Outputs in parallel.*

4.4.6. Polarity Checker (Replacement for Battery Checking Method)

4.4.6.1. The instrument shall checks a series of test points for correct wiring by injecting a special continuous test signal at one point with the Multifunctional Primary Test Set and check the polarity at all terminals with Polarity Checker.

4.4.6.2. A clear indication as to whether the polarity is OK shall be shown by a green LED indication, otherwise, a red LED indication shall show.

4.4.6.3. The software shall be software controlled to perform its functions.

4.4.7. Switch Box

Table 14: Technical design values for Switch Box

Technical Data (with grounding cable)	
Nominal ac spark overvoltage	< 1000 V_{rms}
Impulse spark overvoltage	< 2000 V_{rms}
Short circuit proof with:	
• 16 mm cylindrical or 20 mm ball studs	26.5 kA (< 100 ms) / 67 kA_{peak}
• 25 mm or 1 mm ball studs	30 kA (< 100 ms) / 75 kA_{peak}
Torsional moment for changing arrestors	> 15 Nm
Approx. dimensions	200 x 190 mm
Approx. weight	6.8 kg

4.4.8. Fast Fourier Transformation (FFT) Voltmeter with adapter

4.4.8.1. The FFT voltmeter shall be used in conjunction with the portable multifunctional tester and the coupling unit to measure step and contact voltages.

4.4.8.2. It shall be equipped with inbuilt software that enables measurement of frequency-selective voltage levels through the use of a real-time zoom FFT.

4.4.8.3. Its connection adapter shall be fitted with standardized 1 kΩ testing resistors for body and shoe resistance, as prescribed by relevant standards.

4.4.8.4. This shall allow uncomplicated measurement of step and contact voltages as per the regulation for power installations with rated voltages above 1 kV.

Table 15: Technical design values for FFT Voltmeter with adapter

Frequency	Range	10 Hz to 20 kHz
	Resolution	4-figure
	Accuracy	± 1 %
	Zoom FFT: Resolution	0.73 Hz to 187.5 Hz
Effective value, level	Units	U_{eff} (dBµ, dBV)
	Resolution	4-figure (for display in %) or 3-figure (for display in dB)
	Accuracy	± 1 %
	Bandwidth	20Hz to 20kHz
	Effective input signal level (upper limit for measurement	3.8 V_{eff} (asymmetric); The 1:10 adaptor setting must be used for >3.8 V_{eff} (asymmetric);
Mechanical data	Connections	XLR input and RCA output
	Power supply	3 x 1.5 V batteries (AA/LR6 alkaline type)
	Approx. dimensions (W x H x D)	86 x 205 x 42 mm
	Weight	0.45 kg

NOTE:
The multifunctional test system set accessories shall be supplied on order as specified in every tender. They shall be quoted separately as per the user requirement.

4.5. Measurement Applications

The multifunctional testing device shall provide up to 800 A or 2 kV (2 kA or 12 kV with accessories) with up to 5 kVA over a frequency range of 15 Hz to 400 Hz or 400 A DC and shall be capable for electrical performance measurement tests on the following equipment:

4.5.1. Current Transformer Testing.

4.5.1.1. This test shall require supply from a single phase wall outlet. The multifunctional tester shall generate up to 800 A AC (2 000 A with **Current Booster**) for injecting into the CT's primary side and testing its ratio, polarity and burden.

4.5.1.2. For excitation curve measurement, the multifunctional tester shall offer an output to be connected to the secondary terminals of the core and within an automatic test run, the tester shall measure the excitation curve and display the knee point

voltage and knee point current (according to the relevant IEC or IEEE standard). The tester shall also automatically demagnetize the CT core after the test.

4.5.1.3. It shall have an inbuilt winding resistance measurement function which allows the user to calculate the accuracy limiting factor (ALF) for protection circuits and the instrument security factor (FS) for metering circuits. The CT winding resistance and power / dissipation factor shall also be measured.

4.5.1.4. CT tests to be performed by the multifunctional test system set shall include:

a) C T ratio (with burden) up to 800 A or 2 000 A with **Current Booster**, 5 kVA output power,
b) CT burden up to 6 A AC – secondary,
c) CT excitation curve (knee point) up to 2 kV AC,
d) Polarity check with **Polarity Checker** up to 800 A or up to 2 000 A with **Current Booster**, 5 kVA output power,
e) Accuracy limiting factor (ALF) test,
f) CT ratio with voltage up to 130 V AC - bushing CTs,
g) CT winding resistance up to 6 A DC,
h) CT voltage withstand test up to 2 kV AC,
i) CT ratio Rogowski and CT ratio low power up to 800 A or up to 2 000 A with **Current Booster**, 5 kVA output power,
j) Power / dissipation factor (tan δ) test up to 12 kV, 300 mA - with **Tan-delta Unit**.,

4.5.2. **Voltage Transformer Testing**

4.5.2.1. The multifunctional testing device voltage output of up to 2 kV AC shall be suitable to test VT ratio, polarity and burden by injecting the voltage to the primary and secondary terminals of the VT.

4.5.2.2. Disturbance-free measurement

The multifunctional testing device design shall offer a wide range of frequencies necessary for excellent noise interference suppression even when testing in the harsh HV environment. In cases of strong disturbances, a provision to select a frequency different to that of the power system that utilizes the "frequency selective measurement" function shall be provided.

4.5.2.3. VT tests to be performed by the multifunctional tester shall include:

a) VT ratio up to 2 kV AC - polarity and burden.
b) VT burden up to 130 V AC – secondary.
c) VT secondary voltage withstand test up to 2 kV AC.

d) Polarity check with **Polarity Checker** up to 2 kV AC.
e) VT electronics up to 2 kV AC.
f) Power / dissipation factor (tan δ) test up to 12 kV, 300 mA interfaced with **Tan-delta Unit**.

4.5.3. Power Transformer Testing

4.5.3.1. The multifunctional test set shall provide an easy and accurate 4-wire connection for winding resistance measurement of Power Transformers.

4.5.3.2. It shall also have an automatic measurement feature for tapped windings (by using a **Switch Box** with the on load tap changer) for speedy measurements and an ability to automatically discharge the inductive energy for measurements to be safe.

4.5.3.3. The tester shall have an integrated algorithm which interfaces with the **Switch Box** to demagnetize the core of the transformer caused by DC signals applied to the transformer.

4.5.3.4. It shall be able to measure the ratio and excitation current by providing the 2 kV output, delivering 2.5 MVA. The test voltage shall be generated digitally and the current measured automatically offering speed, safety and accuracy of measurement.

4.5.3.5. Power/dissipation (PF/DF) measurement of power transformers and bushings shall be done together with a **Tan-delta Unit.**

4.5.3.6. There shall be an inbuilt comprehensive PC software guide for the user for every test supported by wiring diagrams for each connection.

4.5.3.7. Power transformer testing shall include:

a) DC winding resistance up to 100 A DC
b) Transformer demagnetization with a **Switch Box.**
c) Dynamic load tap changer diagnostics (on load tap changer test) up to 100 A DC - optionally with a **Switch Box,**
d) Transformer turns ratio (TTR) per tap up to 2 kV AC ; including polarity and excitation current; IEC 61387-1 support for transformer with unconventional vector groups,
e) Leakage reactance / short circuit impedance up to 6 A AC

f) Transformer, bushing: power / dissipation factor (tan δ) + insulation capacitance up to 12 kV, 300 mA; frequency from 15 Hz to 400 Hz - with a **Tan-delta Unit**.
g) Insulating fluids: power / dissipation factor (tan δ) up to 12 kV, 300 mA - with a **Tan-delta Unit** and a **12 kV Oil Test Cell.**
h) Excitation current per tap up to 12 kV, 300 mA - with **Tan-delta Unit.**
i) Frequency response of stray losses (FRSL)
j) Surge arrestors: leakage current and watt losses up to 12 kV, 300 mA - with **Tan-delta Unit.**

4.5.4. HV Cable And Power Line Testing

4.5.4.1. Line parameter measurement

The multifunctional test system interfaced to a **Coupling Unit** shall measure the impedance of cables and power lines with accuracy, speed (in approximately two hours) and safely.

4.5.4.2. Line impedance and k-factor

4.5.4.2.1. The tester together with the **Coupling Unit** shall inject current into the different phase-phase and phase-ground loops of a power line / cable, grounded at the other end, to measure voltage, current and phase angle.

4.5.4.2.2. With the measured data of the different loops, line parameters shall be calculated and displayed. Variable frequency injection shall allow measurements to be made despite coupling from live parts or neighboring lines.

4.5.4.3. Mutual coupling

With the unique testing features of this equipment, the mutual coupling factor of parallel lines shall also be determined, allowing the correct parameterization of the mutual coupling algorithm of modern line protection relays.

4.5.4.4. Cable and transmission line diagnosis done by the multifunctional test system shall include;

a) Line impedance and k-factor up to 100 A ; with a **Coupling Unit,**
b) Mutual coupling up to 100 A; with a **Coupling Unit** and a **Grounding Box.**
c) Positive or zero sequence impedance

4.5.5. **Substation Grounding Analysis**

4.5.5.1. **Ground grid impedance**

4.5.5.1.1. The multifunctional test system and the **Coupling Unit** combined shall inject current at non-network frequencies into the soil at a remote station via the existing power lines in order to measure ground impedance (Zgrid) using Current-Voltage Method and then selectively measure the voltage rise at the used frequencies and not at the measurement frequency.

4.5.5.1.2. The measurements performed shall be in accordance with international standards including IEEE Std 80-2000 and IEEE Std 81-1983.

4.5.5.2. **Touch and step voltages**

The tester shall be able to measure the touch and step voltages (V_{touch} and V_{step}) of the local station by itself or when coupled with the **FFT Voltmeter with adapter** – a handheld selective voltmeter which minimizes wiring.

4.5.5.3. Ground system analysis shall include:

a) Ground grid impedance for large systems up to 100 A interfaced with **Coupling Unit** and a **Grounding Box,**
b) Step and touch voltage up to 100 A interfaced with **Coupling Unit, Grounding Box** and **FFT Voltmeter with adapter,**
c) Ground grid impedance for small systems up to 6 A AC,
d) Soil resistivity up to 6 A AC,
e) Integrity check of grounding connection up to 400 A DC,
f) Reduction factor / current split factor,
g) Measure multiple current paths with Rogowski coil.

4.5.6. **Switchgear and Circuit Breaker Testing**

4.5.6.1. **Contact resistance measurement**

The multifunctional test system shall be able to measure contact resistance by injecting a current of up to 400 A DC into the contacts and measuring the voltage drop (using the 4-wire method). The resistance value shall be compared to the value given by the manufacturer as well as to previous records.

4.5.6.2. **Insulation testing of circuit breakers**

For power / dissipation factor (tan δ) measurements of circuit breakers, the tester shall be interfaced with the **Tan-delta Unit**. Measuring this factor over a

wide frequency range in addition to mains frequency shall help to assess the insulation condition.

4.5.6.3. **Timing of CBs with overcurrent elements**

4.5.6.3.1. For testing of CBs or load break switches which have integrated overcurrent elements, the tester shall inject AC primary currents up to 800 A (or 2000 A together with the **Current Booster**), and measure the time from the start of the injection to the interruption of the current.

4.5.6.3.2. The tester shall also be able to measure the contact pressures of the connections and contacts within the switchgear to check insulation and contact resistance as poorly maintained or damaged contacts can cause arcing, single phasing or even fire which can lead to the total loss of the asset.

4.5.6.4. Switchgear / circuit breaker testing shall include:

a) Contact resistance up to 400 A DC
b) Bushing: power / dissipation factor (tan δ) + insulation capacitance 12 kV, 300 mA at frequencies from 15 Hz to 400 Hz interfaced with **Tan-delta Unit.**
c) Overcurrent relays with primary injection (MV) up to 800 A or 2 000 A with **Current Booster**, 5 kVA output power
d) Circuit breaker: power / dissipation factor (tan δ) up to 12 kV, 300 mA; frequency from 15 Hz to 400 Hz, with **Tan-delta Unit.**
e) Insulating fluids: power / dissipation factor (tan δ) up to 12 kV, 300 mA | with **Tan-delta Unit** and 12 kV oil test cell.

4.5.7. **Commissioning and Trouble Shooting of Protection Systems**

4.5.7.1. **Commissioning protection systems**

4.5.7.1.1. The multifunctional test system shall allow the verification of the ratio and polarity of CTs and VTs – preventing wrong connections, especially in the case of tapped CTs. By injecting current or voltage into individual CTs / VTs and checking the reading at the relay, it shall ensure that the phases are not mixed up and that the CT and VT ratio setting in the relay is correct.

4.5.7.1.2. It shall also be able to measure the burden on the CTs and VTs and determine the CT's excitation curve and ensuring that the protection circuits are connected to the appropriate CT cores.

4.5.7.1.3. The tester shall also help to verify that the secondary wiring is correct. It shall inject a saw tooth signal into the CT or VT, to enable the operator to verify

with a handheld device that the signal has the correct polarity at the connection points of the secondary systems. Primary faults shall also be simulated to check if overcurrent, differential or distance relays operate correctly.

4.5.7.1.4. The tester shall also offer ability to measure the total trip time including the CB operating time.

4.5.7.2. Protection installation testing with the multifunctional test system shall include:

a) CT ratio (with burden) up to 800 A or 2000 A interfaced with the **Current Booster**, 5 kVA output power
b) CT burden up to 6 A AC - secondary
c) CT excitation curve (knee point) up to 2 kV AC
d) VT ratio up to 2 kV AC - polarity and burden
e) VT burden up to 130 VAC - secondary
f) Overcurrent relays with primary injection (MV) up to 800 A or 2000 A with the **Current Booster**, 5 kVA output power
g) Polarity check with a **Polarity Checker** up to 800 A or 2 kV AC, 5 kVA output power
h) Testing of the entire protection chain by primary fault current injection and live CB tripping

4.6. Software and Hardware Requirements

4.6.1. Software Requirements

4.6.1.1. The portable multifunctional test system shall be fully automated and software driven. The software shall be able to capture, analyze and manage data. It shall be supplied complete with the software.

4.6.1.2. The software shall eliminate human error with an automated setup and testing. The user shall simply select the test mode and test voltage to conduct one or more tests, and the test set performs the measurements and reports the results in an easy-to-read format.

4.6.1.3. The configuration software shall be compatible with at least one Microsoft Windows Operating System less than 2 years old and another that is between 2 and 5 years old". Software is regarded as an integral part of the portable multifunctional test system and shall therefore be included as part of the package at no additional cost.

4.6.1.4. It shall be possible to perform future firmware upgrades via the configuration port. Software and firmware updates shall be fully backward compatible with all units less than 15 years old. Firmware upgrades involving EPROM replacement is not acceptable.

4.6.1.5. Software and firmware updates shall be made available to KPLC at no additional cost for a minimum of 5 years after the delivery of the unit.

4.6.1.6. The software shall have a Data Management system that establishes a library of every apparatus' test result that the users collect. The Data Manager System shall allow users to retrieve copy and organize existing data records, as well as create new records and shall provide easy-to-use functionality comparable to Windows Explorer.

4.6.1.7. The software shall also have a Standardized Test Form system for different equipment (transformers, current transformers, surge arresters, etc.). The Standardized Test Forms shall make testing and storing of data easy to manage.

4.6.1.8. The test forms shall resemble one another; however, each one shall be customized for the appropriate test procedures for that type of apparatus.

4.6.1.9. Test results shall be automatically stored after each test, eliminating the need to reenter nameplate information when testing the same apparatus in the future. Should two or more data files exist for a particular apparatus, the software shall have the functionality to merge them into one record.

4.6.1.10. To improve the efficiency of testing and evaluation of results, each equipment nameplate and test history is located in one record.

4.6.1.11. The software shall have On Screen Help that will reduce inconsistency in test results and provide direction for performing tests correctly and consistently. The standardized test procedures shall provide consistency for identical tests that can be performed with the same methodology each time.

4.6.1.12. The software shall have automated temperature compensation by applying a temperature correction factor for accurate comparison of periodic test results.

4.6.1.13. The electrical characteristics of most insulating materials vary depending on temperature. In order to accurately compare results of periodic tests on the same apparatus, it is necessary to minimize the variation that is due to different temperatures. This can be accomplished by applying a temperature correction factor to the Power Factor calculation. A number of factors determine the

appropriate correction factor: ambient temperature, apparatus temperature, apparatus type, manufacturer, and voltage class.

4.6.1.14. The software shall have an expert system that is able to analyze each line of data, taking into consideration the type of equipment, nameplate information, previous test results (if available), and reference tables. Further it shall also give a rating with an explanation as to how the rating was acquired. When unacceptable readings are obtained, the software shall provide the test technician with a list of recommended investigative procedures that can be followed.

4.6.1.15. All records are presented in a format that is easy to read, save and print. The software shall have the ability to diagnose and identify problems with the instrument.

NOTE: ***To ensure that the tenderer complies with the software requirement a copy of the software shall be supplied with the tender document or shall be demonstrated at the time of tender evaluation.***

4.6.2. Hardware Requirements

4.6.2.1. Laptop (optional, unless specified in the tender)

The laptop shall be designed and manufactured as per the requirements of IEC 60950 with minim requirements as per Table 5.

Table 5: Technical design data for a Laptop

Item	Minimum Specification
Brand	Specify
Model	Specify
Year of manufacture	Specify
Processor	Intel® Core™ i5-920 Processor or higher
Clock speed	2.2 GHz or higher
Chipset	Compatible – (specify)
Motherboard	Compatible – (specify)
Memory (maximum)	2GB DDR3, 1333MHz (Upgradable upto 6 GB)
Cache memory	3MB L2 or higher
Graphics	256MB Dedicated DDR3 Memory
Hard disk controller	Serial ATA
Hard disk	250 GB or higher 5400RPM SATA Hard Drive
Shock resistant	Anti-shock mounting design to protect screen and hard disk drive from damage and data loss

Keyboard	Spill resistant keyboard
Mouse	2 or 3 button with scroll wheel optical PC Mouse with pad – USB 3.0
Touch pad	Intelligent Touch with configurable vertical and horizontal scroll functions
Power supply	Input – 220V – 250V Auto-sensing, 50 Hz
Battery life	4 hours or higher
Optical drive	Dual Layer DVD +/-RW
Card slots	Secured Digital Card Reader
Display	14" or smaller WXGA with 1280 x 800 or higher resolution
Integrated Web Camera	2 Mega Pixels or higher
Network/Wireless Interfaces	Integrated 10/100/1000Mbps Ethernet LAN, Integrated 802.11 a/b/g/n WLAN, Bluetooth
Security	Booting/HDD User password Protection and Fingerprint Recognition
I/O Inputs	Minimum 3 x USB 3.0 Hi-Speed, 1 x RJ45, 1 VGA
Operating system	MS Windows 7 Professional OEM Version with original Media kit, & manuals (firewall enabled and all security updates and patches and fixes up-to-date) or equivalent higher version.
Productivity software	Latest versions of, Open Office AND Genuine Microsoft Office 2007 Standard or better, OEM, Full or Suitable licensing scheme * Please quote the price for one unit of computer with and without Microsoft Office 2007
	Adobe Acrobat reader - the latest version
Anti-virus	Anti-Virus software should be installed with licenses (Specify) * Please quote the price for one unit of computer with and without Anti-Virus software
Carrying bag	Include with the same brand of the notebook.
Manufacturer Authorization and warranty	Attach Authorization letter and 2 years comprehensive on-site manufacturer authorized warranty (parts).

4.6.2.2. Cable Accessories *(mandatory)*

No	Particulars	Accessories
1	Generator Combination cable	To carry all ac test quantities (at least 8 banana ended leads)
2	Flexible Test Leads ($2.5mm^2$, 3m long)	At least 12 banana ended leads
3	Insulated Crocodile clips ($4mm^2$)	At least 8 pieces
4	Flexible jumpers ($2.5mm^2$, 50mm long)	at least 4 banana ended leads

5	PC to Test Set Communication cable	Parallel port or Ethernet or USB, or Optical Ethernet, Optical , IEC61850
6	Network communication cable	Parallel port or Ethernet or USB, or Optical Ethernet, Optical , IEC61850
7	Carrying Bag for accessories	.Should be able to carry all the accessories, should be water proof
8	Others if any	Specify

4.7. Quality Management System

4.7.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the portable multifunctional test system set and accessories physical properties, tests and documentations, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.

4.7.2. The Manufacturer's Declaration of Conformity to applicable standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.

4.7.3. The bidder shall indicate the delivery time of the items, manufacturer's monthly & annual production capacity and experience in the production of the type and size of items being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar type of the portable multifunctional test system and its accessories sold in the last five years as well as reference letters from at least four of the customers shall be submitted with the tender for evaluation.

5.0. TESTS AND INSPECTION

5.1. The portable multifunctional test system set and accessories shall be inspected and tested in accordance with the requirements of IEC 61010-1, IEC 60950,IEC 60664- 1 & 3, IEC 61326, IEC 60112 and IEC 60529 standards. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works.

5.2. Copies of previous Type Tests Reports issued by a third party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the tender for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third party testing laboratory used shall also be submitted with the tender document (all in English Language)

5.3. Copies of type test reports to be submitted with the tender (by bidder) for evaluation shall be as stated below:

5.3.1. Type Tests for Equipment Performance

- Electromagnetic compatibility (EMC) tests.
- Switching tests on the equipment.
- Impulse overvoltage tests on the equipment -Clearances
- Dielectric voltage withstand tests on the equipment - Controlled overvoltage.
- Functional tests on the equipment

5.3.2. Type Tests for Printed Circuit Board Coating Performance

- Environmental, humidity and thermal conditioning tests
- Dielectric voltage withstand tests
- Comparative tracking index (CTI)
- Resistance to soldering heat
- Flammability
- Coating adhesion
- Insulation resistance between conductors

5.4. Routine and sample test reports for the instruments and meters to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers will witness tests at the factory before shipment.

5.5. On receipt of the goods KPLC will perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC the portable multifunctional test system, which upon examination, test or use; fail to meet any of the requirements in the specification.

5.6. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with IEC 61010-1, IEC 60664- 1 & 3, IEC 61326, IEC 60112 and IEC 60529 standards and this specification and shall include the following:

- Insulation Resistance of the equipment
- Leakage Current of the equipment
- Ground Continuity of the equipment
- Ground Bond of the equipment
- Polarization Test of the equipment
- Recurring Peak Voltage Determination
- Dielectric Voltage Withstand Tests - Measuring clearances
- Functional tests

6.0. MARKING AND PACKING

6.1. The portable multifunctional test system and its accessories shall be packed in separate standard rugged heavy duty robust case with cushion grip handles and rubberized gripping surface for outdoor use (protection category IP X5) in such a manner to avoid damage during transportation.

6.2. The housing shall be complete with a gasket to seal the lids when closed so as to protect the instrument against water and dirt while the instrument is carried through rainstorms or other hazardous conditions. The lid shall be secured by two latches and a handle for portability. A compartment shall also be provided for storage of test cables and line cord.

6.3. The portable multifunctional test system and its accessories shall be marked in a permanent manner with the following information (in English Language):

a) Standard to which the portable multifunctional test system set complies,
b) Name of manufacturer,
c) Type of portable multifunctional test system (description of type, number and overall size of sections),
d) Year and month of manufacture and serial number,
e) Maximum permissible measurement limits,
f) The words "**Property of Kenya Power & Lighting Co**" shall be engraved, permanently on each portable multifunctional test system or its accessories while the other parameters shall be marked on a permanent label.
g) The overvoltage protection category and duty rating e.g. category IV-field
h) The portable multifunctional test system shall be provided with a separate permanent label displaying advice to the user.
i) In addition, they shall be marked with the necessary labels that conform to IEC 61010-1, clause 5.1.2 to 5. In case of laptop, the markings shall also be as per IEC 60950, clause 1.7.

7. DOCUMENTATION, WARRANY AND TAINING

7.1. Documentation

7.1.1. The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

a) Guaranteed Technical Particulars signed by the manufacturer;

b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records for the last five years and at least four customer reference letters;
d) Details of manufacturing capacity and the manufacturer's experience;
e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
g) Manufacturers letter of authorization, ISO 9001:2008 certificate and other technical documents required in the tender.

7.1.2. The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

a) Guaranteed Technical Particulars signed by the manufacturer;
b) Design Drawings with details of portable multifunctional test system set and the recommended accessories to be manufactured for KPLC.
c) Quality assurance plan (QAP) that will be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008
d) Detailed test program to be used during factory testing;
e) All documentation necessary for safety of the equipment as specified in IEC 61010-1 clause 5.4 shall be provided with the equipment.
f) Manufacturer's undertaking to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the portable multifunctional test system for The Kenya Power & Lighting Company;
g) Packaging details (including packaging materials).

7.1.3. The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the testers to KPLC stores

7.2. Warranty and Training

7.2.1. The portable multifunctional test system set or its accessories shall be backed by a minimum 12-months factory warranty.

7.2.2. If the test set is new to KPLC, then a two day Training on the equipment shall be carried out by the Supplier's engineer on a KPLC agreed site. The supplier shall meet the cost of this training.

7.2.3. After tender award, factory inspection and certification by two KPLC's engineers or third party shall be carried out before shipment of the Equipment.

7.2.4. Technical support and software, where applicable upgrades shall be provided free of charge to KPLC for a period of not less than 36 months.

7.2.5. The Bidder shall submit a clause by clause statement of compliance with the specifications together with copies of the manufacturer's catalogues, brochures, technical data and proven test reports clearly marked to support each clause, all in English for evaluation. The manufacturer's type reference/designation of the item offered shall be indicated.

7.2.6. In the case of tender award, technical details for the portable multifunctional test system or its accessories shall be submitted to the procuring entity for approval before manufacture commences.

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ANNEX A: *Guaranteed Technical Particulars (to be filled and signed by the supplier and submitted together with copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records and copies of test certificates for tender evaluation)*

Tender No ..... Bidder's Name & Address .....

No.	Parameter	KPLC Requirement	Bidders Offer
1	Name of the manufacturer and country of origin		Specify
	Type Reference Number or Model Number		Specify
2	**Applicable Standards**		Specify
3	**Terms and Definitions**		Specify
4	**Requirements**		
4.1	Service conditions		Specify
4.2	Design and construction		Specify
	4.2.1 – 4.2.3		
	4.2.4	Control Unit	Specify
		4.2.4.1 - 4.2.4.4	
	4.2.5	Power electronic unit	Specify
		4.2.5.1 - 4.2.5.4	
	4.2.6	Measurement unit	Specify
		4.2.6.1 - 4.2.6.5	
	4.2.7	Interface module	Specify
		4.2.7.1 - 4.2.7.6	
4.3	**Ratings**		
	4.3.1	**Generator outputs**	Specify

	Range	Amplitude	Vmax	Power
Current Outputs	800 A AC	0 --- 800 A	6.0 V	4800 VA
		0 --- 400 A	6.4 V	2560 VA
		0 --- 200 A	6.5 V	1300 VA
	6 A AC	0 --- 6 A	55 V	330 VA
	3 A AC	0 --- 3 A	110 V	330 VA
	400 A DC	0 --- 400 A	6.5 V	2600 VA
		0 --- 300 A	6.5 V	1950 VA
		0 --- 200 A	6.5 V	1300 VA
	6 A DC	0 --- 6 A	60 V	360 VA
2000 A AC[3] shall be achieved with an interface to a **Current Booster**				

	Range	Amplitude	Imax	Power
Voltage Outputs	2 kV AC	0 -- 2 kV	1.25 A	2500 VA
		0 -- 2 kV	0.5 A	1000 VA
	1 kV AC	0 -- 1 kV	2.5 A	2500 VA

			0 -- 1 kV	1.0 A	1000 VA	Specify
		500 V AC	0 – 500 V	5.0 A	2500 VA	
			0 – 500 V	2.0 A	1000 VA	
		130 V AC	0 – 130 V	3.0 A	390 VA	
	Internal measurement of outputs (Accuracy)	Output	Range	Amplitude FSE	Phase FSE	Specify
		800 A AC	-	<0.10 %	$<0.10^0$	
		400 A DC	-	<0.05 %	-	
		2 kV AC	2000 V	<0.05 %	$<0.10^0$	
			1000 V	<0.05 %	$<0.15^0$	
			500 V	<0.05 %	$<0.20^0$	
			5 A	<0.05 %	$<0.10^0$	
			500 mA	<0.05 %	$<0.10^0$	

4.3.2 Generator inputs

	Measuring inputs (Accuracy)	Input	Impedance	Range	Amp. FSE	Ph.FSE	Specify
		I AC/ DC	<0.1 Ω	10 A AC	<0.05 %	$<0.10^0$	
				1 A AC	<0.05 %	$<0.15^0$	
				10 A DC	<0.08 %	-	
				1 A DC	<0.08 %	-	
		V1 AC	500 kΩ	300 V	<0.05 %	$<0.10^0$	
				30 V	<0.05 %	$<0.10^0$	
				3 V	<0.05 %	$<0.10^0$	
				300 mV	<0.05 %	$<0.10^0$	
		V2 AC	10 MΩ	3 V	<0.08 %	$<0.10^0$	
				300 mV	<0.08 %	$<0.10^0$	
				30 mV	<0.25 %	$<0.15^0$	
		V DC		10 V	<0.08 %	-	
				1 V	<0.08 %	-	
				100 mV	<0.10 %	-	
	4-wire resistance measurement with 400 A DC output and 10 V input	Current	Resistance	Voltage	Accuracy(full scale)		Specify
		400 A	10 μΩ	4 mV	Error < 0.70 %		
		400 A	100 μΩ	40 mV	Error < 0.55 %		
		400 A	1 mΩ	400 mV	Error < 0.50 %		
		400 A	10 mΩ	4 V	Error < 0.50 %		
	4-wire resistance measurement with 6 A DC output and 10 V input	6 A	100 mΩ	0.6 V	Error < 0.35 %		
		6 A	1 Ω	6 V	Error < 0.35 %		
		1 A	10 Ω	10 V	Error < 0.25 %		
	2-wire resistance measurement with 10 V VDC	>5 mA	100 Ω		Error < 0.60%		
		>5 mA	1 kΩ		Error < 0.51 %		

input					

Output to input synchronization	Particulars	Test cards Quick Sequencer, Ramping	Amplifier test card	Specify
	Frequency range	48 Hz – 62 Hz	48 Hz – 62 Hz	
	Synchronization Inputs	V1 AC	V1 AC, V2 AC, I AC	
	Input magnitude	10 % of output range full scale		
	Output magnitude	5 % of output range full scale		
	Settling time	100 ms after 5 % of output range full scale is reached	1000 ms after 5 % of output range full scale is reached	
	Signal changes	All quantities must be ramped within 20 signal periods	No changes of frequency and phase. Magnitude changes without limitation. Output follows within 250 ms.	
	Phase tolerance	0.5^0 within the limits as specified above		

4.3.3 Power Supply and Mechanical Data

Description		KPLC Requirement	Bidders Offer
Power Supply	Single-phase, nominal	220 V AC ... 250 V AC, 16 A	
	Single-phase, permissible	215 V AC ... 264 V AC (L-N or L-L)	
	Frequency, nominal	50 Hz	
	Power consumption	<3500 VA (<7000 VA for short time < 10 sec)	
	Connection	C22 conforming to IEC 60320	
Environmental conditions	Operating temperature	-1 ... +40 °C (+14 ... +131 °F)	
	Storage temperature	-20 ... +70 °C (-4 ... +158 °F)	
	Humidity range - Rel. humidity	< 95 %, non-condensing	
	Shock (operating)	15 g / 11 ms half sine as per IEC 60068-2-27	
	Vibration (operating)	Frequency range from 10 Hz to 150 Hz, continuous acceleration 2 g (20 m/s^2), 10 cycles per axis as per IEC 60068-2-6	
EMC immunity	Performance criteria of the equipment	IEC 61326-1 Class A,	
	Rated Impulse Voltage for	6000 V as per IEC 60664-1,	

	Safety	equipment -1.2/50µs	table 1	Specify
		Overvoltage category	Class IV as per IEC 61010-1	
		Pollution category	Class 2 as per IEC 61010-1	
		Insulation material group	Group II - 400≤CTI<600 (PLC=1) as per IEC 60112	
		Minimum clearances for equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	5.5 mm as per IEC 60664-1	
		Creepage distance for equipment subject to long term stresses, min	1.8 mm as per IEC 60664-1	
		Minimum acceptable creepage distances on printed circuit boards	1.0 mm as per IEC 60664-1	
		Maximum recurring peak voltage related to creepage distance on printed wiring boards	913 V as per IEC 60664-1	
		Width of grooves by pollution degree on printed circuit boards	0.4 mm as per IEC 61010-1	
		Partial discharge requirements	< 5pC as per IEC 60664-1 Annex C	
		Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3	
	4.3.4 – 4.3.6	**Additional features**		Specify

4.4	**Multifunctional Test System Accessories (*Optional*)**					Specify
	4.4.1	**Tan delta unit**				
		4.4.1.1 – 4.4.1.5				
	High Voltage Output	V	I	t_{max}	At f (Hz)	
		0 --- 12 kV AC	300 mA	>2 min	15 ---- 400	
			100 mA	>60 min		
	Voltage / Current measurement	Range	Resolution	Accuracy		
		1200 V AC	1 V	error < 0.3 % reading + 1 V		
		5 A AC	5 digits	error < 0.5 % reading		
		8 mA AC	5 digits	error < 0.3 % reading + 100 nA		
	Capacitance Cp (equivalent parallel circuit)	Range	Resolution	Accuracy	Conditions	
		1 pF --- 3 µF	6 digits	error < 0.5 % reading + 0.1 pF	< 8 mA	
				error < 0.2 % reading	> 8 mA	
	Dissipation	0 --- 10 % (capacitive)	5 digits	error < 0.1 % reading + 0.005 %	15 --- 70 Hz	

	factor DF (tan δ)	0 --- 100 (0 --- 10000 %)	5 digits	error < 0.5 % reading + 0.002 %	< 8 mA	Specify
	Power factor cos φ	0 --- 10 % (capacitive)	5 digits	error < 0.1 % reading + 0.005 %	15 --- 70 Hz	
		0 --- 100 %	5 digits	error < 0.5 % reading + 0.002 %	< 8 mA	

4.4.2 Coupling Unit

Current Output Ranges	Current range		Compliance voltage	Specify
	0 --- 10 A rms		500 V rms	
	0 --- 20 A rms		250 V rms	
	0 --- 50 A rms		100 V rms	
	0 --- 100 A rms		50 V rms	
Measuring Transformers	VT	600 V : 30 V	class 0.1	
	CT	100 A : 2.5 A	class 0.1	
Mechanical data	Protection		IP 20	
	Approx. dimensions		450 x 220 x 220 mm	
	Approx. weight		28.5 kg	

4.4.3 Grounding Box

Electrical data	Nominal ac spark-over voltage		< 1000 V rms	Specify
	Short circuit proof		Up to 30 kA for 100 ms	
	Output power (MTS)		5 kVA at cos φ < 1.0 for 8 s	
Accuracy	Measured value	Typical accuracy	Current range	
	0.05 – 0.2 Ω	1.0 – 0.5 %	100 A	
	0.2 – 2 Ω	0.5 – 0.3 %	100 A	
	2 – 5 Ω	0.3 %	50 A	
	5 – 25 Ω	0.3 %	20 A	
	25 – 300 Ω	0.3 – 1.0 %	10 A	
Mechanical data	Approx. dimensions (Φ x h)		200 x 190 mm	
	Approx. weight including ground cable		6.8 kg	
	Accessories to be provided			

4.4.4 12kV Oil Test Cell

4.4.4.1 – 4.4.4.4

Technical Data	Cell Type:	Three-terminal, guarded	Specify
	Cell Gap Spacing:	11 mm, nominal	
	Sample Volume:	1.2 liters (min) to 2 liters (max)	
	Cell Capacitance:	65 pF nominal (in air)	
	Maximum Test Voltage:	12 kV rms	
	Voltage Operating Range:	2.5 to 12 kV for a stress of 200 to 1100 V/mm	
	Connectors:	6 mm sockets for high voltage cable 4 mm sockets for measuring cables – class C22 as per IEC 60320	

		Approx. dimensions:	22 x 25 cm [diameter x height]				
		Approx. weight:	6 kg				
4.4.5	**Current Booster**						Specify
	4.4.5.1 – 4.4.5.2						
Current outputs	Range	Amplitude	V_{max}	$Power_{max}$			
	1000 A AC	0 -- 1000 A	4.90 V	4900 VA			
		0 – 500 A	5.00 V	2500 VA			
		0 – 2000 A	2.45 V	4900 VA			
Internal measurement of outputs	Output	Guaranteed accuracy		Typical accuracy			
		Amplitude	Phase	Amplitude	Phase		
	2000 A AC	0.25 %	0.50^0	0.13 %	0.25^0		
	1000 A AC	0.25 %	0.50^0	0.13 %	0.25^0		
4.4.6	**Polarity Checker**						Specify
	4.4.6.1 – 4.4.6.3						
4.4.7	**Switch Box**						
Technical Data (with grounding cable)	Nominal ac spark overvoltage	< 1000 V_{rms}					Specify
	Impulse spark overvoltage	< 2000 V_{rms}					
	Short circuit proof with16 mm cylindrical or 20 mm ball studs	26.5 kA (< 100 ms) / 67 kA_{peak}					
	Short circuit proof with16 25 mm or 1 mm ball studs	30 kA (< 100 ms) / 75 kA_{peak}					
	Torsional moment for changing arrestors	> 15 Nm					
	Approx. dimensions	200 x 190 mm					
4.4.7	**FFT Voltmeter with adapter**						Specify
	4.4.8.1 – 4.4.8.4						
Frequency	Range	10 Hz to 20 kHz					
	Resolution	4-figure					
	Accuracy	± 1 %					
	Zoom FFT: Resolution	0.73 Hz to 187.5 Hz					
Effective value, level	Units	U_{eff} (dBµ, dBV)					
	Resolution	4-figure (for display in %) or 3-figure (for display in dB)					
	Accuracy	± 1 %					
	Bandwidth	20Hz to 20kHz					
	Effective input signal level (upper limit for measurement	3.8 V_{eff} (asymmetric); The 1:10 adaptor setting must be used for >3.8 V_{eff} (asymmetric);					
Mechanical data	Connections	XLR input and RCA output					
	Power supply	3 x 1.5 V batteries (AA/LR6 alkaline type)					

		Approx. dimensions (W x H x D)	86 x 205 x 42 mm	
		Weight	0.45 kg	
4.5	**Measurement applications**			
	4.5.1	Current Transformer Testing		Specify
		4.5.1.1 - 4.5.1.4		
	4.5.2	Voltage Transformer Testing		Specify
		4.5.2.1 - 4.5.2.3		
	4.5.3	Power Transformer Testing		Specify
		4.5.3.1 - 4.5.3.7		
	4.5.4	HV cable and power line testing		Specify
		4.5.4.1 - 4.5.4.4		
	4.5.5	Substation grounding analysis		Specify
		4.5.5.1 - 4.5.5.3		
	4.5.6	Switchgear and circuit breaker testing		Specify
		4.5.6.1 - 4.5.6.4		
	4.5.7	Commissioning and trouble shooting of Protection Systems		Specify
		4.5.7.1 - 4.5.7.2		
4.6	**Software and Hardware**			
	4.6.1	Software requirements		Specify
		4.6.1.1 - 4.6.1.5		
	4.6.2	Hardware requirements		Specify
		4.6.2.1 Laptop requirements		
	Brand		Specify	
	Model		Specify	
	Year of manufacture		Specify	
	Processor		Intel® Core™ i5-920 Processor or higher	
	Clock speed		2.2 GHz or higher	
	Chipset		Compatible – (specify)	
	Motherboard		Compatible – (specify)	
	Memory (maximum)		2GB DDR3, 1333MHz (Upgradable upto 6 GB)	
	Cache memory		3MB L2 or higher	
	Graphics		256MB Dedicated DDR3 Memory	
	Hard disk controller		Serial ATA	
	Hard disk		250 GB or higher 5400RPM SATA Hard Drive	
	Shock resistant		Anti-shock mounting design to protect screen and hard disk drive from damage and data loss	
	Keyboard		Spill resistant keyboard	
	Mouse		2 or 3 button with scroll wheel optical PC Mouse with pad – USB 3.0	
	Touch pad		Intelligent Touch with configurable vertical and horizontal scroll functions	

	Power supply	Input – 220V – 250V Auto-sensing, 50 Hz	Specify
	Battery life	4 hours or higher	
	Optical drive	Dual Layer DVD +/-RW	
	Card slots	Secured Digital Card Reader	
	Display	14" or smaller WXGA with 1280 x 800 or higher resolution	
	Integrated Web Camera	2 Mega Pixels or higher	
	Network/Wireless Interfaces	Integrated 10/100/1000Mbps Ethernet LAN, Integrated 802.11 a/b/g/n WLAN, Bluetooth	
	Security	Booting/HDD User password Protection and Fingerprint Recognition	
	I/O Inputs	Minimum 3 x USB 3.0 Hi-Speed, 1 x RJ45, 1 VGA	
	Operating system	MS Windows 7 Professional OEM Version with original Media kit, & manuals (firewall enabled and all security updates and patches and fixes up-to-date) or equivalent higher version.	
	Productivity software	Latest versions of, Open Office AND Genuine Microsoft Office 2007 Standard or better, OEM, Full or Suitable licensing scheme * Please quote the price for one unit of computer with and without Microsoft Office 2007	
		Adobe Acrobat reader - the latest version	
	Anti-virus	Anti-Virus software should be installed with licenses (Specify) * Please quote the price for one unit of computer with and without Anti-Virus software	
	Carrying bag	Include with the same brand of the notebook.	
	Manufacturer Authorization and warranty	Attach Authorization letter and 2 years comprehensive on-site manufacturer authorized warranty (parts).	
	4.6.2.1 **Cable accessories**		Specify
	Generator Combination cable	To carry all ac test quantities (at least 8 banana ended leads)	
	Flexible Test Leads ($2.5mm^2$, 3m long)	At least 12 banana ended leads	
	Insulated Crocodile clips ($4mm^2$)	At least 8 pieces	
	Flexible jumpers ($2.5mm^2$, 50mm long)	at least 4 banana ended leads	
4.7	**Quality Management Systems**		Specify

	4.7.1 – 4.7.3	Specify
5.0	**Tests and Inspection**	Specify
	5.1 – 5.6	
6.0	**Marking and packing**	Specify
	6.1 – 6.3	
7.0	**Documentation, Warranty and Training**	
	7.1 Documentation	Specify
	7.1.1 – 7.1.3	
	7.2 Warranty and Training	Specify
	7.2.1 – 7.2.6	
8	Manufacturer's Guarantee and Warranty	Specify
9	List catalogues, brochures, technical data and drawings submitted to support the offer.	Specify
10	List customer sales records submitted to support the offer.	Specify
11	List Test Certificates submitted with tender	Specify
12	List test & calibration reports to be submitted to KPLC for approval before shipment	Specify
13	Statement of compliance to specification (indicate deviations if any & supporting documents)	Specify

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Manufacturer's Name, Signature, Stamp and Date