



# Capabilities and Activities on Electricity and Magnetism Field at National Institute of Standards (NIS), Egypt

Prepared by

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# Overview About NIS



## NIS Mission

- Maintaining the national standards and disseminate them through measurement and calibration services.
- Providing training and consultation services.
- Research and development of new standards and measurement procedures.





# NIS Timeline

The Royal Egyptian Cubit



2700 BC

Metrology Existed in Egypt

Egypt signed The Meter Convention

1962



1963

NIS is Founded

NIS moved to current premises in Haram, Giza

1992



2000

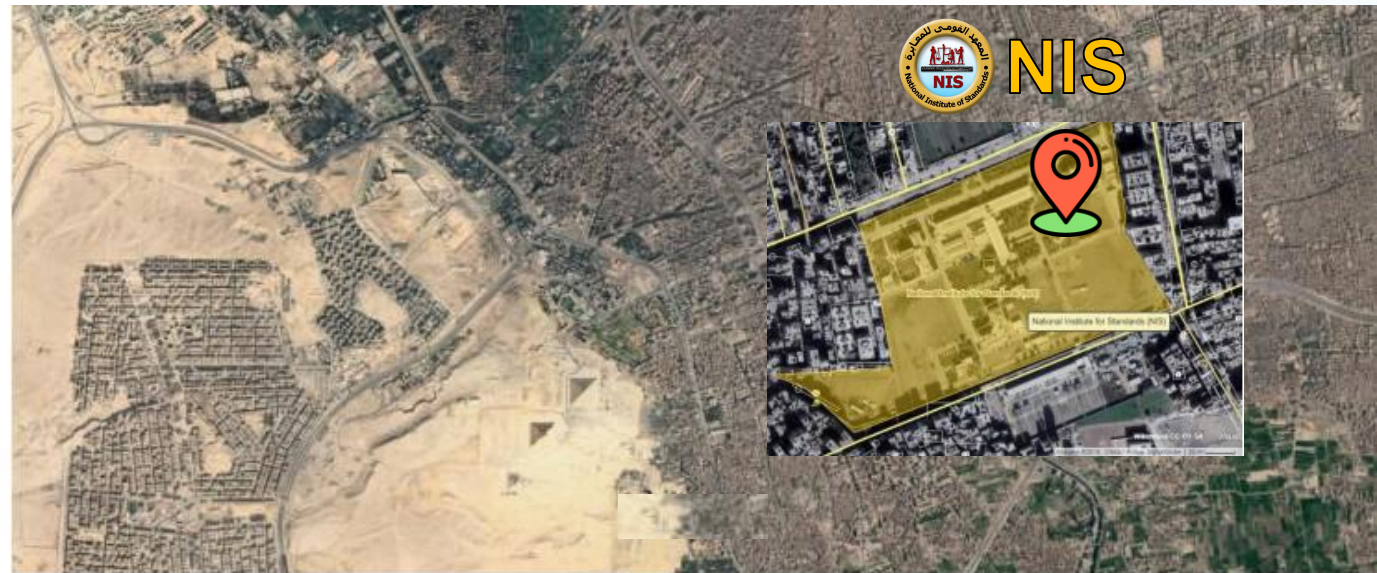
NIS Signed CIPM MRA



# NIS Location



NIS Area ~ 150,000 m<sup>2</sup>



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## NIS Organization Chart

Ministry of Scientific Research and Higher Education

NIS BOARD OF DIRECTORS

NIS President

NIS Secretary General

Vice President for Technical affairs

Vice President For Research affairs

Office of International Affairs

Supporting Departments

Human Resources Department

Technical Office for Calibration

National Proficiency Testing Laboratory (NPTL)

Technical Supervisor

Quality Supervisor

ISO17034 TC

Quality Supporting Team

SCIENTIFIC DIVISIONS

Length and Precision Engineering Division

Mass and Force Metrology Division

Thermometry and Ionizing Radiation Division

Electrical Metrology Division

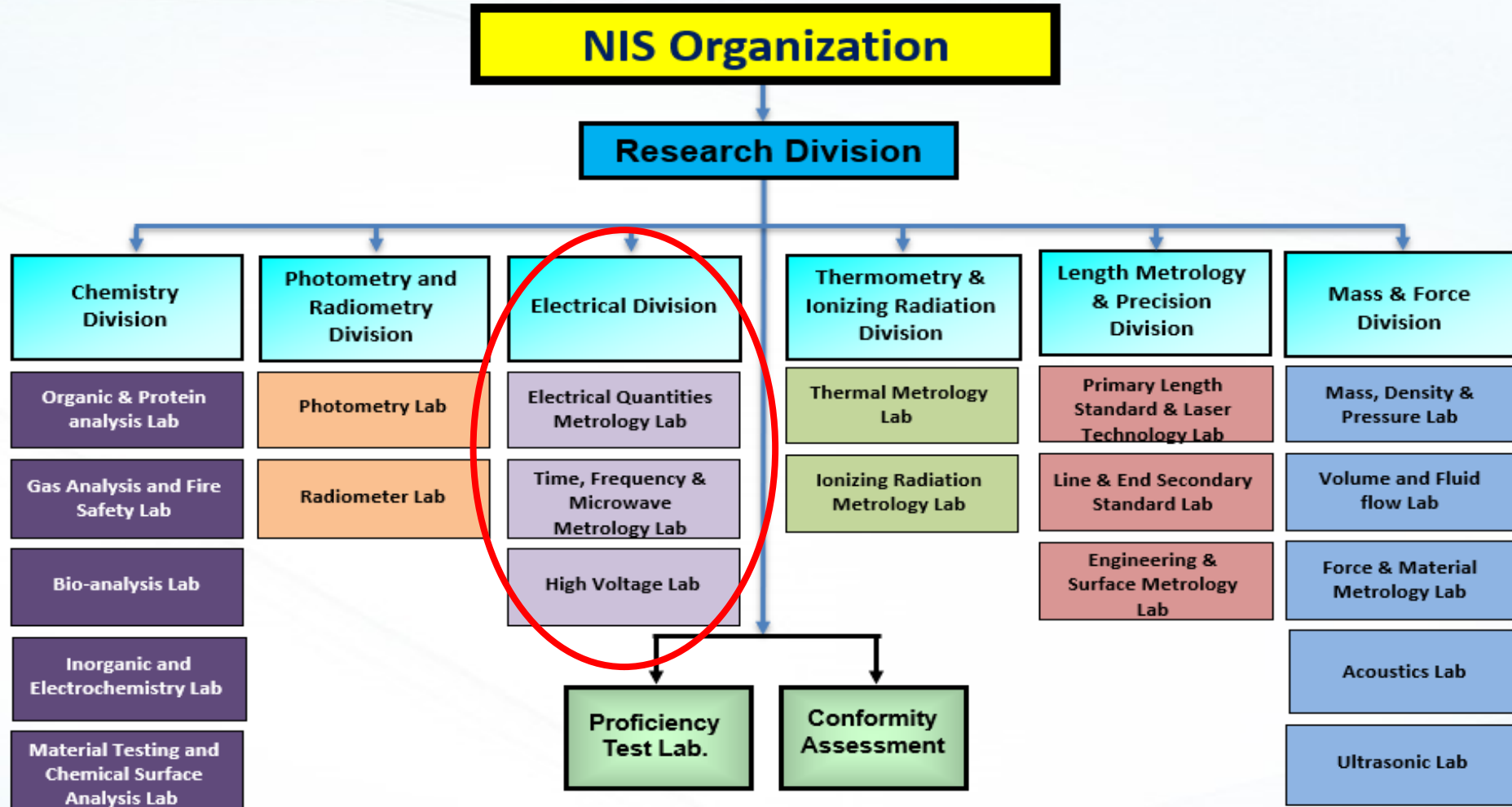
Chemical Metrology Division

Photometry and Radiometry Metrology Division



# NIS Structure

NIS contains 21 laboratories in 6 divisions.





# NIS Published CMC

- NIS has 99 CMCs published in the BIPM-KCDB website in different metrology areas.
- These CMCs include some fields such as:
  - *Length, Mass, Pressure, Viscosity.*
  - *Time and Frequency.*
  - *Current, Resistance, Voltage, Capacitance.*
  - *Radiofrequency.*
  - *Power and Energy.*
  - *Force, Torque, Hardness.*
  - *Chemistry, Flow, Ionizing Radiation and Acoustics.*

The screenshot shows the KCDB (Key Comparison Database) website. The header includes the KCDB logo and a statement: "All data listed in the KCDB have been reviewed and approved within the CIPM Mutual Recognition Arrangement". The navigation menu includes Home, CMCS, COMPARISONS, NEWS, and STATISTICS. The search results page shows "Results for: NIS, Egypt" with a search bar containing "NIS, Egypt" and a magnifying glass icon. The number of results, "99 results", is circled in red. Below the search bar, there are filters for "CMC Area" with checkboxes for "Chemistry and Biology (2)" and "General physics (94)". A pagination bar shows "1 2 3 4 5". A note explains the notation  $Q[a, b]$  for uncertainty statements: "In the CMCs uncertainty statements, the notation  $Q[a, b]$  stands for the root-sum-square of the terms between brackets:  $Q[a, b] = [a^2 + b^2]^{1/2}$ . Unless otherwise stated the expanded uncertainties given below correspond to  $k = 2$  (at a 95 % level of confidence)". The search results list "Egypt, NIS (National Institute for Standards)".





# NIS Capabilities in Electrical Metrology Division





# EM Division Structure

## Electrical Metrology Division

Electrical  
Quantities  
Metrology  
Laboratory

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

High  
Voltage  
Metrology  
Laboratory

Division Staff: 21 researchers, 8 assistant researchers, 5 specialists and 6 technicians



# EM Division Structure

## Electrical Metrology Division

### 1. Electrical Quantities Metrology Laboratory

#### **Head: Prof. Dr. Nadia Nassif**

1. DC Voltage and Current Calibrations.
2. Electrical DC Resistance Calibrations.
3. Electrical Impedance Calibrations.
4. AC/DC Transfer Standards Calibrations.

# 1. DC Voltage and Current Calibrations

## 1. Electrical Quantities Metrology Laboratory



Since 2009, the laboratory had Primary Standard of DC Voltage, Josephson Array Voltage Standard.

- Range: -10 V to +10 V
- Uncertainty:  $\leq 0.2$  ppm



The unit of voltage is also maintained via a bank of 8 Zener diode reference standards as secondary standards with 1.018 V, and 10 V outputs.

- Uncertainties: 0.03 ppm to 0.2 ppm

# 1. DC Voltage and Current Calibrations

Electrical  
Quantities  
Metrology  
Laboratory



- The laboratory has capabilities in calibrating the different DC instruments for sourcing and measuring:

- DC voltage up to 1000 V,  
Expanded uncertainty: 0.13  $\mu$ V to 44 mV.

- DC current up to 20 A,  
Expanded uncertainty: 2 nA to 7.9 mA.

Using Calibrators and Digital Multimeters

- The laboratory has several CMCs published in BIPM-KCDB website for some of these scopes.

## 2. Electrical DC Resistance Calibrations

Electrical  
Quantities  
Metrology  
Laboratory

- The unit of resistance is maintained at NIS by the mean of five "One Ohm" Thomas type standard resistors.
- The laboratory also has:
  - Two 10 k $\Omega$  ESI standard resistors,
  - Two 100  $\Omega$  IET standard resistors,
  - Hamon transfer standards from 1  $\Omega$ /step to 10 M $\Omega$ /step, and
  - Fluke standard resistors from 1  $\Omega$  to 100 M $\Omega$ .



## 2. Electrical DC Resistance Calibrations

Electrical  
Quantities  
Metrology  
Laboratory



- The laboratory has highly accurate automatic resistance bridge (MI model 6010C) with range extender and DC power supply for resistors from 1 m $\Omega$  to 10 k $\Omega$ .
- For resistance standards higher than 10 k $\Omega$  to 100 M $\Omega$ , a potentiometric bridge has been established at the laboratory.
- The dc resistance standards calibrations capabilities: 1 m $\Omega$  to 100 M $\Omega$ .
  - Expanded uncertainty: 0.3 ppm to 761 ppm.



# 3. Electrical Impedance Calibrations

Electrical  
Quantities  
Metrology  
Laboratory

The unit of capacitance is maintained by some types of capacitance standards, such as:

- Two sets of AH Fused Silica capacitance standards,
- General radio and IET air capacitance standards.



Highly accurate capacitance calibrations are carried out using:

- Ultra precision capacitance bridge with (option E) which is the first copy of this version in the world.





## 3. Electrical Impedance Calibrations

Electrical  
Quantities  
Metrology  
Laboratory



- The unit of inductance is maintained by different types of inductance standards.
- The laboratory also has:
  - Precise automatic LCR meter,
  - Two General Radio bridges for capacitance and inductance measurements, and
  - New impedance analyzer-120 MHz model E4990A.



## 3. Electrical Impedance Calibrations

1. Electrical  
Quantities  
Metrology  
Laboratory



Discipline	Range	Expanded Uncertainty (k=2)
<b>AH Fused Silica capacitance standards</b>	1 pF, 10 pF, 100 pF	≤ 0.7 ppm
<b>General Radio capacitance standards</b>	1 nF - 10 μF	3 ppm – 100 ppm
<b>Inductance Standards</b>	10 μH – 10 H	3 nH - 8 mH
<b>Highly accurate capacitance measurement</b>	0.8 aF – 1.5 μF	> 5 ppm
<b>Accurate capacitance measurement</b>	1 pF - 10 μF	1 pF - 10 μF
<b>Accurate inductance measurement</b>	10 μH – 10 H	3.2 nH - 5.6 mH

## 4. AC/DC Voltage and Current Calibrations

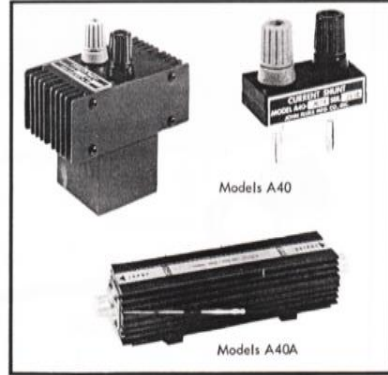
Electrical  
Quantities  
Metrology  
Laboratory



- AC voltage and current are maintained in the laboratory by multi-junction and single-junction thermal converters connected with multipliers or current shunt resistors to cover the AC voltage up to 1000 V and AC current up to 20 A.
- The laboratory is capable to calibrate AC sources and AC/DC transfer standards using:
  - Thermal voltage converters (TVCs): 0.3 V to 1000 V at frequencies from 10 Hz to 1 MHz in addition to,

# 4. AC/DC Voltage and Current Calibrations

Electrical  
Quantities  
Metrology  
Laboratory



- Micro- potentiometers ( $\mu$ pots): 2 mV to 200 mV at frequency range from 10 Hz to 100 kHz,
  - Expanded uncertainty: 3 ppm to 150 ppm.
- Thermal current converters (TCCs) up to 20 A at 10 Hz to 10 kHz,
  - Expanded uncertainty: 3 ppm to 25 ppm.
- Other AC instruments for sourcing and measuring AC voltage are calibrated from 1 mV to 1000 V at 10 Hz to 1 MHz,
  - Expanded uncertainty: 3.7  $\mu$ V to 590 mV, and AC current from 100  $\mu$ A to 20 A at 10 Hz to 10 kHz,
  - Expanded uncertainty: 10 nA to 10 mA.



# EM Division Structure

## Electrical Metrology Division

2. Time,  
Frequency,  
Microwave  
Metrology  
Laboratory  
(Microwave  
Activity)

**Head: Dr. Eng. Mohamed El-Hawary**

1. Scattering Parameters Measurement (Frequency: 10 MHz to 40 GHz).
2. RF Power Measurements (Frequency: DC to 40 GHz).
3. Power Sensors Frequency Calibration.
4. Power Meters Frequency Calibration.
5. Spectrum Harmonics Measurement (Frequency: 9 kHz to 30 GHz).
6. Transponder Tester Calibration.
7. Electric and Magnetic Fields Strength Measurements.

# Microwave Activity

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



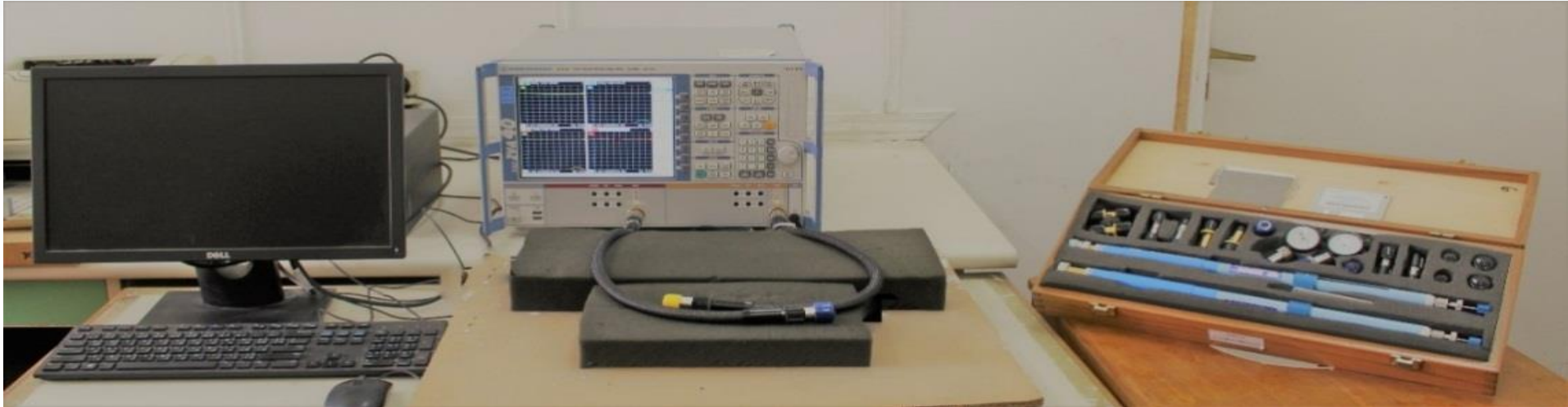
- The laboratory in the microwave activity is realizing and maintaining the national primary standard of high frequency power using Microcalorimeter in the frequency range from 10 MHz to 18 GHz.
- Expanded uncertainty:  $3.2 \times 10^{-03}$  to  $6.1 \times 10^{-03}$  (dimensionless).

# 1. Scattering Parameters Measurement

(Frequency: 10 MHz to 40 GHz)

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



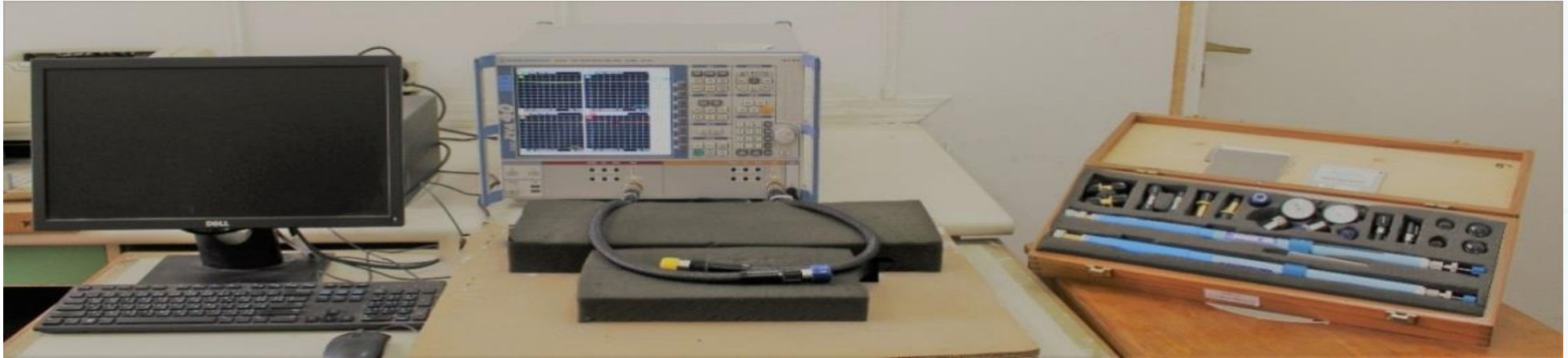
The laboratory calibrates the commercial RF attenuators (N-Type, K-type, BNC, SMA connectors), adaptors, isolators, directional coupler, directional bridges, pulse limiters, cables, RF filters, power splitters, antennas, and site master calibrators using Vector Network Analyzer (VNA) and N-Type calibration kit.

# 1. Scattering Parameters Measurement

(Frequency: 10 MHz to 40 GHz)

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



- The calibrated parameters are voltage standing wave ratio (VSWR), Reflection coefficient (S11), and Transmission coefficient (S21, S12).
- Expanded uncertainty of transmission coefficient:  $7.4 \times 10^{-02}$  to 0.15 dB at 60 dB.
- Expanded uncertainty of reflection coefficient magnitude (0 to 1):  $6.0 \times 10^{-03}$  to  $2.8 \times 10^{-02}$  (dimensionless).



## 2. RF Power Measurements

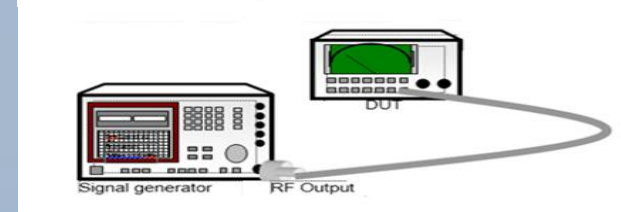
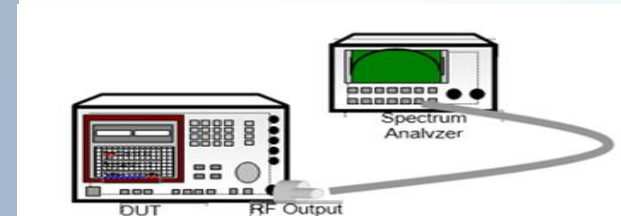
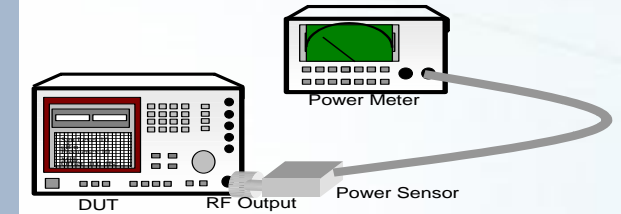
(DC to 40 GHz)

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity

The laboratory calibration capabilities:

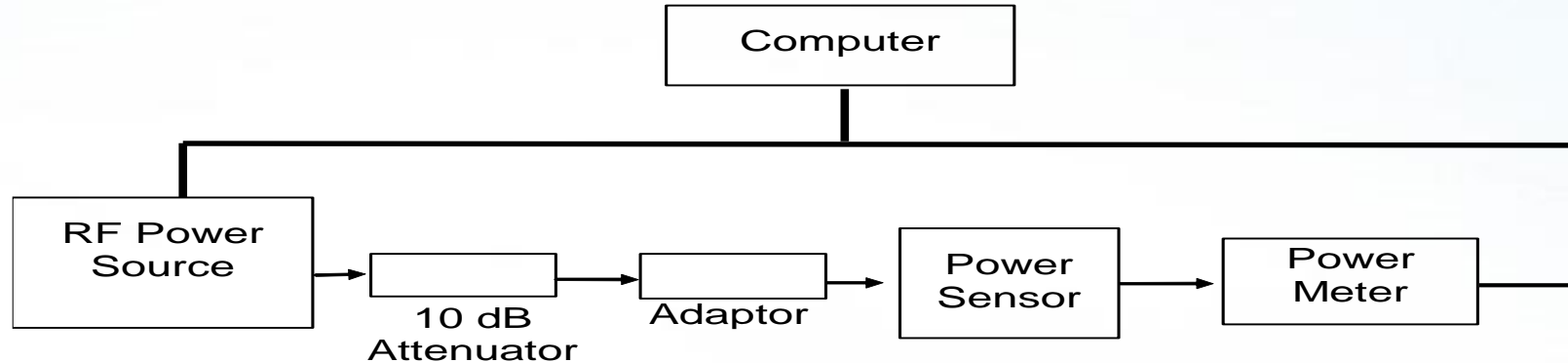
- Signal generators using power meter that covers:
  - Power range from 1  $\mu$ W to 100 mW (-30 dBm to +20 dBm).
  - Expanded uncertainty from  $5.9 \times 10^{-03}$  to  $7.4 \times 10^{-02}$  dBm.
- RF sources by using spectrum analyzer that covers:
  - Frequency range from 9 kHz to 30 GHz, and
  - Power range up to 1000 mW (+30 dBm).
  - Expanded uncertainty up to  $1.9 \times 10^{-02}$  dBm.
- RF receivers (like: Spectrum analyzer, TV receivers, power meter) using signal generator that covers:
  - Frequency range from 100 kHz to 40 GHz, and
  - power range up to 501 mW (+27 dBm)
  - Expanded uncertainty up to  $2.2 \times 10^{-02}$  dBm.



## 3. Power Sensors Frequency Calibrations

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



- The laboratory has the capabilities to calibrate the power sensors to obtain the Calibration Factor (CF) from 0.8000 to 1.0000
  - Frequency range: 10 MHz to 18 GHz, and
  - Power range from 0.1 mW to 10 mW (-10 dBm to 10 dBm).
  - Expanded uncertainty:  $6.2 \times 10^{-03}$  to  $8.6 \times 10^{-03}$  (dimensionless).

## 4. Power Meters Frequency Calibration

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



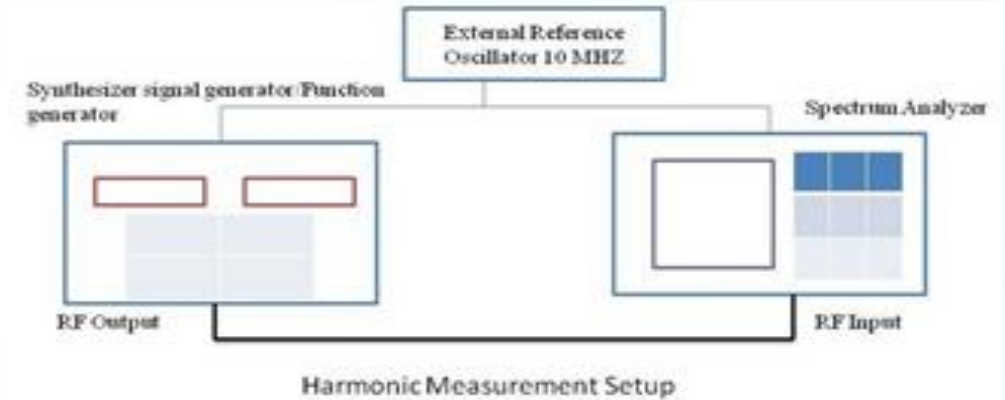
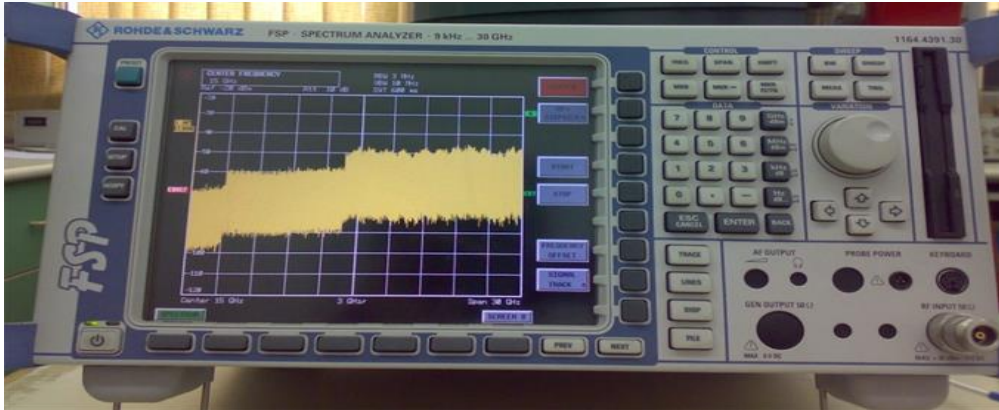
- The laboratory calibrates power meters to obtain their power level using a signal generator.
  - Frequency range: 100 kHz to 40 GHz, and
  - Power range up to 501 mW (+27 dBm).
  - Expanded uncertainty: up to  $2.2 \times 10^{-02}$  dBm.

# 5. Spectrum Harmonics Measurement

(Frequency: 9 kHz to 30 GHz)

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity



- The laboratory measures phases for harmonic and distortion measurement processes for many devices such as atomic time and frequency standard, quartz frequency standard, and synthesized signal generators using spectrum analyzer.
- The measured parameter: 0.00 dBc to - 90 dBc that covers:
  - Frequency range: 9 kHz to 30 GHz, and
  - Power range up to 1000 mW (+30 dBm).
  - Expanded uncertainty  $7.1 \times 10^{-01}$  dBc.

## 6. Transponder Tester Calibration

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity

The laboratory has the capabilities to calibrate the transponder testers using:

- Spectrum analyzer to measure the frequency range from 9 kHz to 30 GHz,
- Vector network analyzer (VNA) with N-Type calibration kit to measure VSWR on antenna port and on RF I/O port at frequency range from 10 MHz to 40 GHz with expanded uncertainty:  $6.0 \times 10^{-03}$  to  $2.8 \times 10^{-02}$  (dimensionless)



## 7. Electric and Magnetic Fields Strength Measurements

Time,  
Frequency,  
Microwave  
Metrology  
Laboratory

Microwave  
Activity

- The laboratory measures the electric and magnetic fields from any electrical instruments that radiate electromagnetic waves such as antennas, mobile stations using a broadband field strength meter that cover a frequency range from DC to 40 GHz using the probes.
- The laboratory has 3 probes differs in frequency and electromagnetic strength ranges as following:
  - Probe 1: Frequency range (1 Hz – 400 kHz), measurement range E-field: 1 V/m to 100 kV/m, H-field: 50 nT to 10 mT.
  - Probe 2: Frequency range (100 kHz - 3 GHz), measurement range E-field: 0.2 V/m to 20 V/m (RMS).
  - Probe 3: Frequency range (1 MHz - 40 GHz), measurement range E-field: 1 V/m to 55 V/m (RMS).





# EM Division Structure

## Electrical Metrology Division

### 3. High Voltage Metrology Laboratory

Head: Prof. Dr. Eng. Mamdouh Halawa

1. High Voltage and Current Calibrations.
2. Power and Energy Calibrations.
3. Electrical Safety Testers Calibration.
4. EMC Testing.
5. Other Testing such as Performing approval type test on electricity energy meters for all types and accuracy.

# 1. High Voltage Calibrations

High  
Voltage  
Metrology  
Lab.



- The laboratory performs several calibrations in high voltage activity such as calibration of:
  - AC/DC HV sources for AC voltage ranges up to 400 kV at 50 Hz, and DC voltage ranges up to 200 kV,
  - Calibration of AC/DC HV meters in AC & DC voltages up to 200 kV.
    - Expanded uncertainty ranges:
      - 1.3% to 1.5% in AC voltage calibrations.
      - 0.7% to 1.2% in DC voltage calibrations.
- These calibrations are done according to IEC 60060-1/2:2010.
- The laboratory is ILAC accredited up to 100 kV in AC at 50 Hz and DC voltage calibrations.





# 1. High Voltage Calibrations

High  
Voltage  
Metrology  
Lab.

- Calibration of voltage transformers turns ratio up to 400 kV at 50 Hz,
  - Expanded uncertainty: 0.03%.
- Calibration of partial discharge calibrators up to 2000 pC,
  - Expanded uncertainty: 3%.
- Oil testers calibration up to 100 kV at 50 Hz,
  - Expanded uncertainty: 0.15%.
- Calibration of HV impulse generators up to 500 kV peak,
  - Expanded uncertainty: 0.65%.
- Calibration of HV insulation testers up to 611 GΩ at 5000 V,
  - Expanded uncertainty: 0.1%.



## 2. High Current Calibrations

High  
Voltage  
Metrology  
Lab.

- The laboratory performs several calibrations in high current activity such as AC current sources and meters calibrations up to 5 kA at 50 Hz and DC currents up to 2 kA.
- Other High Current calibrations: Current Transformers up to 5 kA at 50Hz, clamp meters, primary and secondary injection current units, load bank current, and DC battery current.
- Expanded uncertainty: 0.3 % in AC and DC high current calibrations.



### 3. Power and Energy Calibrations

High Voltage Metrology Lab.



The laboratory performs power and energy calibrations and measurements using its reference standard.

- Accuracy: 30 ppm in voltage and 90 ppm in current and 85 ppm in power and energy.
- Power and energy instruments can be calibrated up to 300 V and 100/1000/5000 A at any power factor.
- The laboratory performs calibrations of power meters and analyzers, energy standard meters, power factor meters, and power sources.
- Some of these calibrations are done according to ES 1021:2010.
- Expanded uncertainty: up to 0.02%.



## 4. Electrical Safety Testers Calibration

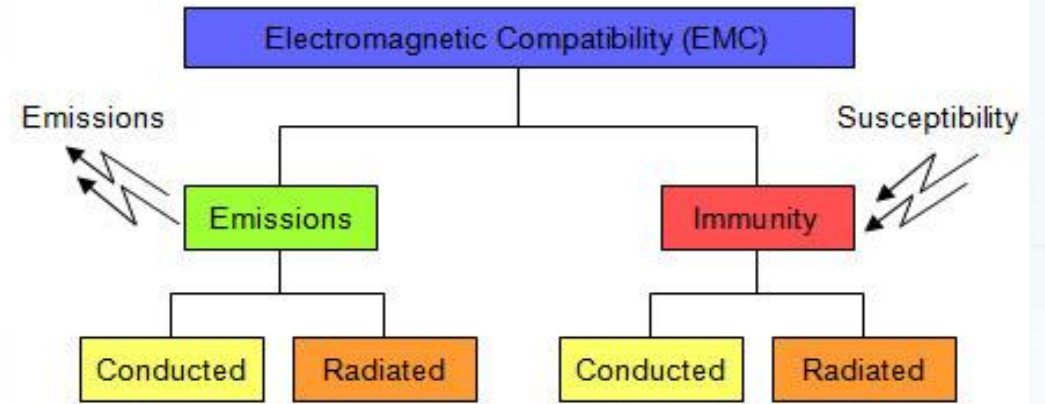
High  
Voltage  
Metrology  
Lab.



- The laboratory calibrates electrical safety testers that used for testing of household appliances.
- The calibration of AC voltage, insulation resistance, earth resistance, AC power, and leakage current measurements are performed with the laboratory capabilities in these quantities.

# 5. EMC Testing

High Voltage Metrology Lab.



It is the branch of electrical engineering concerned with the unplanned generation, propagation and reception of electromagnetic energy which may cause unwanted effects such as electromagnetic interference (EMI) or even physical damage in operational equipment.

## 5. EMC Testing

High  
Voltage  
Metrology  
Lab.



The laboratory performs some tests such as:

- Surge immunity test,
- Conducted emission test,
- Conducted immunity test,
- Radiated emission test, and
- Radiated immunity test.

## 6. Other Testing

High  
Voltage  
Metrology  
Lab.



- The laboratory performs other testing such as the electrical approval type tests on electricity energy meters for all types and accuracy. Testing of electrical meters is carried out according to international standards such as:
  - IEC 62052-11, 2020
  - IEC 62053-21, 2020
  - IEC 62053-22, 2020
  - IEC 62053-23, 2020
  - IEC 62053-24, 2020
  - EN 50470-1, 2006 and EN 50470-3, 2006.
- Some of these tests are ILAC accredited.





# Research Activities

Electrical Metrology Division





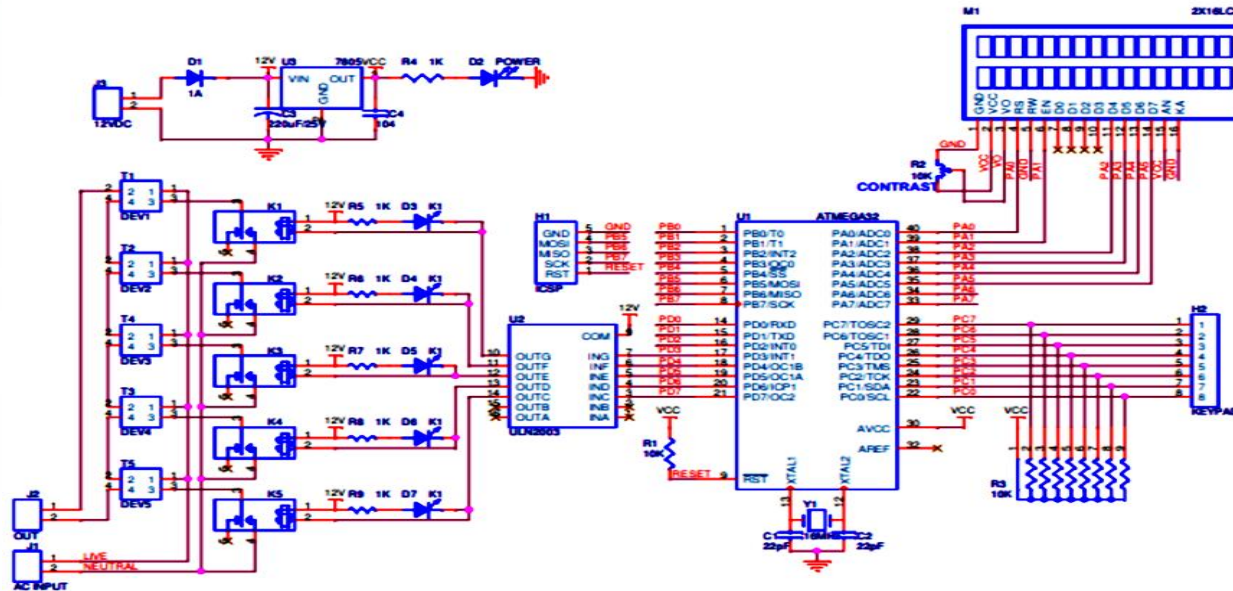
# Research Activities

## Electrical Metrology Division

In the field of electricity and magnetism, NIS has published more than 74 publications in scientific journals indexed in SCOPUS during the period from 2005 to 2022 and around 35 publications from 2017 to 2022.

# Research Activities

## 1. Establishment of New Automated Multi Range Thermal Current Converter



Publication

Nahed Abdelmonaem, Rasha S. M. Ali, and Hamdy Shatla, "International Journal of Power Electronics and Drive Systems (IJPEDS)", Vol. 14, No. 2, June 2023, ISSN: 2088-8694, DOI: 10.11591/ijped.s.v14.i2.



# Research Activities

## 1. Establishment of New Automated Multi Range Thermal Current Converter

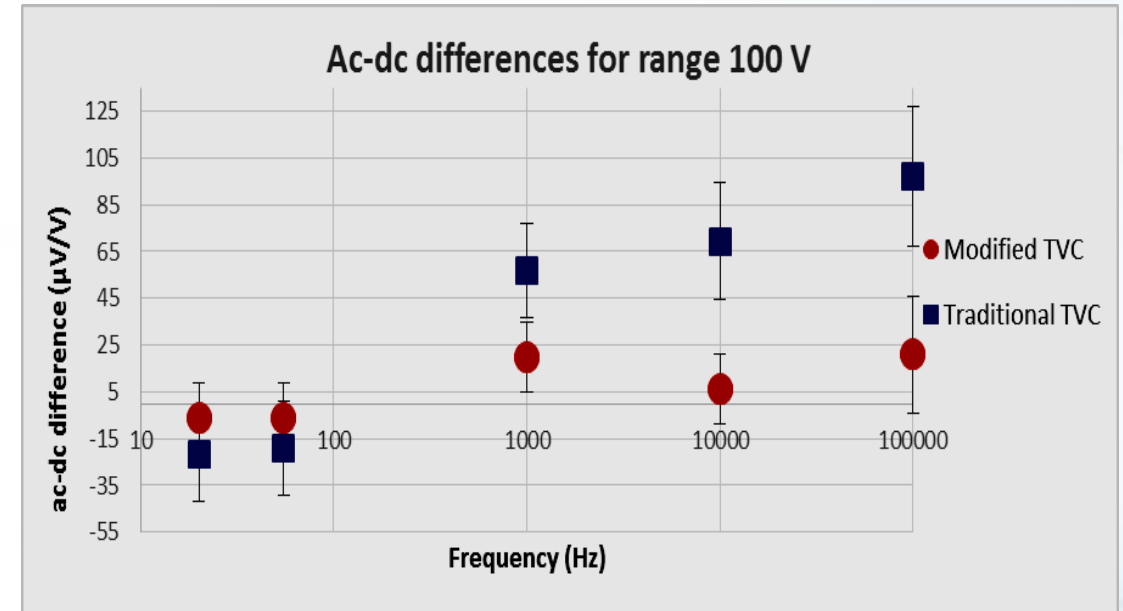
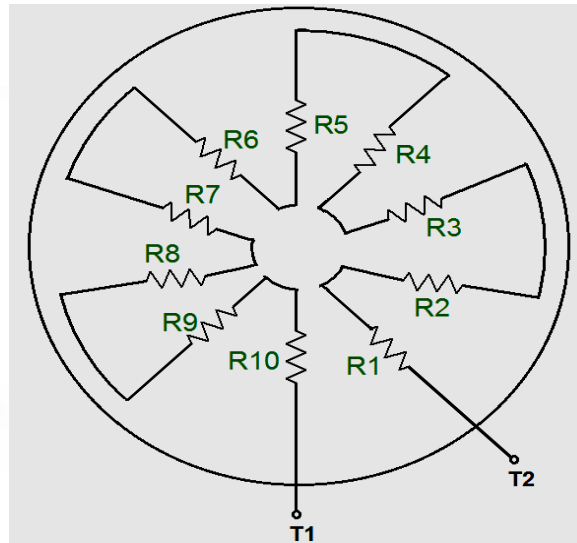
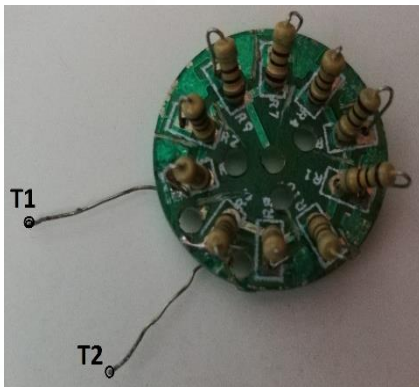
- A new automated multirange thermal current converter (TCC) has been designed and implemented at the National Institute of Standards (NIS), Egypt.
- Five single junction thermal elements, rating of each is 1 A, have been connected in parallel on PCB with an LCD, keypad and a microcontroller to control a five fast switching relays.
- This TCC has been designed to cover the ac current ranges from 500 mA to 6 A at frequencies from 40 Hz up to 10 kHz.
- MATLAB-designed software is specially established to solve manual calibration issues.
- Estimated ac-dc disparities for all ranges at varied frequencies with enlarged uncertainty.
- The new TCC improves AC current accuracy and reduce the uncertainty by eliminating the drawbacks of the shunt resistor used with the conventional TCC.

### Publication

Nahed Abdelmonaem, Rasha S. M. Ali, and Hamdy Shatla, "International Journal of Power Electronics and Drive Systems (IJPEDS)", Vol. 14, No. 2, June 2023, ISSN: 2088-8694, DOI: 10.11591/ijpeds.v14.i2.

# Research Activities

## 2. Modified Multipliers Resistors for Measurement of AC Voltages



### Publication

- 1) Rasha S. M. Ali, "Modified Construction for Thermal Voltage Converter Multipliers Resistors", Conference on Precision Electromagnetic Measurements (CPEM), Paris-France, July 2018.
- 2) Rasha S. M. Ali, "*Measurement Journal*", Vol. 126, PP. 378-381, October 2018.



# Research Activities

## 2. Modified Multipliers Resistors for Measurement of AC Voltages

- This modified multiplier consists of ten metal-film resistors with small power rating connected in series in a radial structure to have a minimal inductance.
- This high values resistors are mounted in PCB board with high insulation to prevent leakage currents, stray and parasitic capacitances, and dielectric loss particularly at high voltages and frequencies.
- 10 k $\Omega$ , 20 k $\Omega$ , and 40 k $\Omega$  Modified Multipliers Resistors (MMRs) are fabricated to cover 50 V, 100 V, and 200 V ac voltages calibration.
- It is found that this modified TVCs are more precise and accurate than the traditional TVCs because the series MMRs eliminate some errors that appear in the traditional multipliers such as skin effect, and heating effect due to distributing the high concentrated power dissipation.

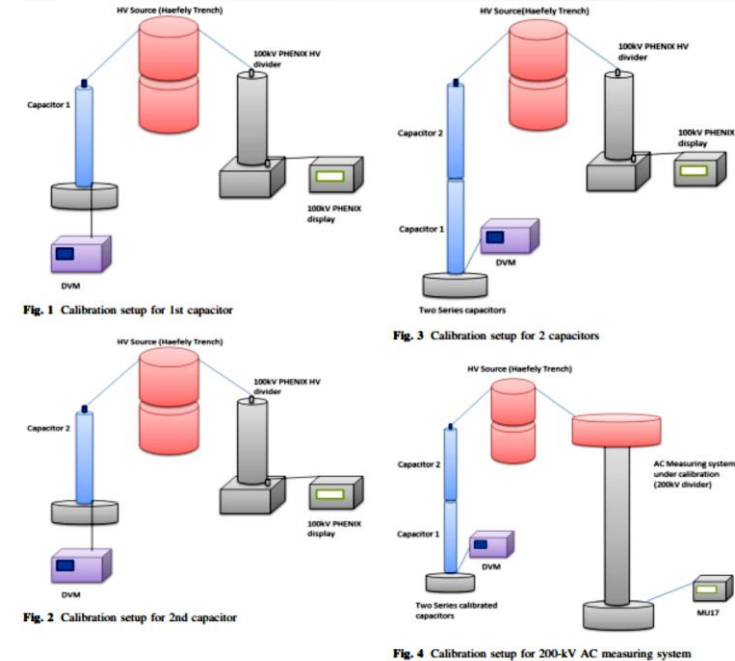
### Publication

- 1) Rasha S. M. Ali, "Modified Construction for Thermal Voltage Converter Multipliers Resistors", Conference on Precision Electromagnetic Measurements (CPEM), Paris-France, July 2018.
- 2) Rasha S. M. Ali, "*Measurement Journal*", Vol. 126, PP. 378-381, October 2018.

# Research Activities

## 3. Adapted Technique for Calibrating Voltage Dividers of AC High Voltage Measuring Systems

- Two identical capacitors have been used as two similar AC high-voltage capacitive dividers.
- The ratios of two capacitors have been achieved by calibrating each capacitor via a traceable reference standard AC high-voltage divider up to 100 kV.
- Both capacitors were connected in series to perform as one 200 kV AC voltage divider.
- Their dividing ratios from 100 kV to 200 kV are calculated by mathematical derivation.
- These calibrated two series capacitors have been used to calibrate a voltage divider of a 200 kV AC HV measuring system.
- Enhanced uncertainties have been acquired which are 0.06%–0.11%.

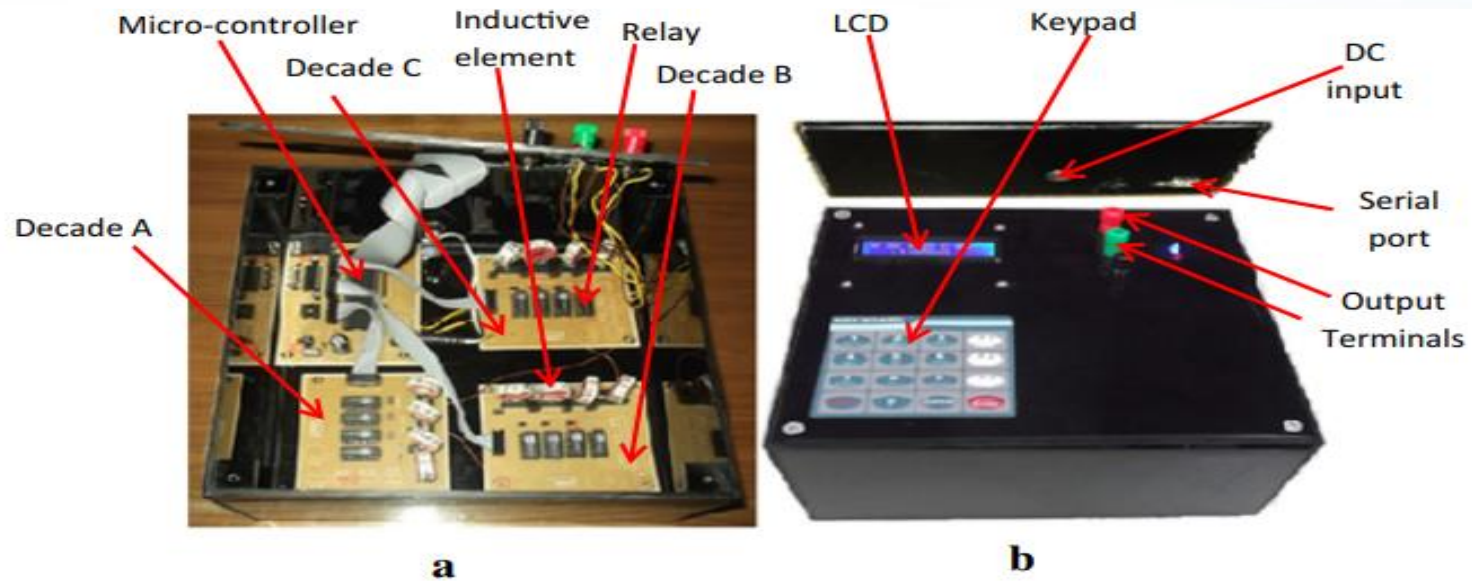


Publication

H. M. Abdel Mageed, and R. S. Salah Eldeen, "MAPAN-Journal of Metrology Society of India", Vol. 35, No. 1, pp. 11–17, 2020.

# Research Activities

## 4. Fully Automated Inductance Measuring System Using New Fabricated Inductance Box



Publication

M. Helmy A. Raouf, A. Eliwa Gad, El-Sayed Soliman A. Said, and M. A. Elwany, "MAPAN-Journal of Metrology Society of India", Vol. 32, No. 3, PP. 199-205, Sept. 2017- doi:10.1007/s12647-017-0210-z



# Research Activities

## 4. Fully Automated Inductance Measuring System Using New Fabricated Inductance Box

- The main aim is constructing a new inductance box providing a huge number of automated inductance steps, which are used in the laboratories to perform full automatic calibration of inductance meters.
- Therefore, a new inductance box has been introduced that mainly consists of three decades, that each decade can generate 15 different inductance values.
- 1666 different inductance values can be obtained from this inductance box, while 4096 inductance values can be obtained by the possible combinations of its three decades steps.
- The relative deviation of output inductance steps from their rated values is in the range from  $\pm 5E-4$  to  $\pm 5E-3$ , while the maximum relative uncertainty due to the summation effect is less than 60 ppm.
- Practically proved that the new inductance box has better electrical performance than the ordinary old one due to its higher accuracy and lower summation effect uncertainties.

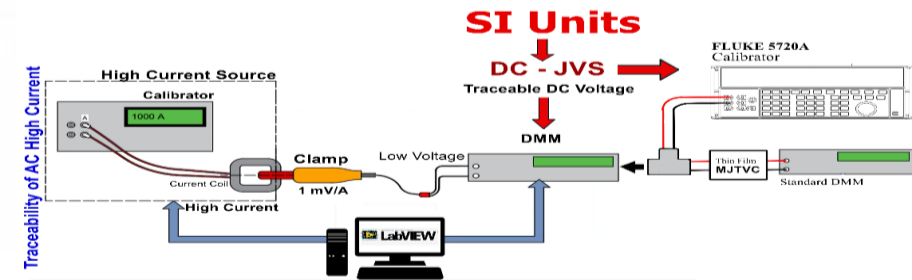
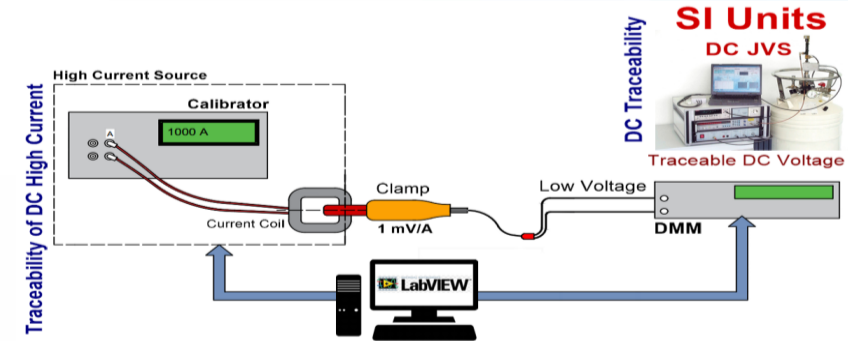
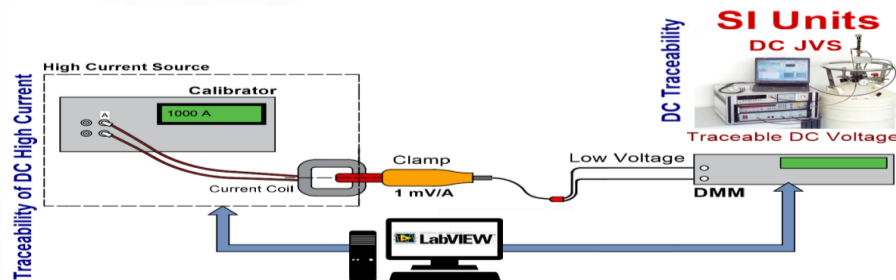
### Publication

M. Helmy A. Raouf, A. Eliwa Gad, El-Sayed Soliman A. Said, and M. A. Elwany, "MAPAN-Journal of Metrology Society of India", Vol. 32, No. 3, PP. 199-205, Sept. 2017- doi:10.1007/s12647-017-0210-z



# Research Activities

## 5. A Traceable System for Automatic Calibration of DC and AC High Current Sources with Current Coils at NIS



### Publications

- 1- Omar M. Aladdin, Rasha S. M. Ali, Hala M. A. Mageed, and M. A. Elmenyawi, "MAPAN-Journal of Metrology Society of India", Vol. 36, No. 3, PP. 579-587, Sept. 2021.
- 2- Omar M. Aladdin, H.M.A. Mageed, Rasha S. M. Ali, M.A. Elmenyawi, "A New Technique for High Current Calibrations Using Low Voltage Reference Standards", IEEE Instrumentation and Measurement Magazine, Vol. 25 (3), pp. 30-36, 2022.



# Research Activities

## 5. A Traceable System for Automatic Calibration of DC and AC High Current Sources with Current Coils at NIS

- This paper describes the establishment of traceability of high current DC and AC source up to 1000 A without using current transformer; hence it can be useful for many calibration laboratories.
- The DC high current calibration setup has been demonstrated to realize the traceability of high DC currents to the DC JVS.
- Two setups have been proposed to calibrate the AC high currents using 1 V-MJTVC: thermal converter directly connected to clamp probe.
- Limitation of AC current calibration setup using 1 V-MJTVC is overcome by using calibrated DMM traceable to 1 V-MJTVC to complete ranges of AC current calibration up to 1000 A.
- Results show a good agreement between the obtained high current results compared to the reference values based on calibration certificates of the source under test which prove that our new calibration systems are reliable and associated uncertainties were acceptable.

### Publications

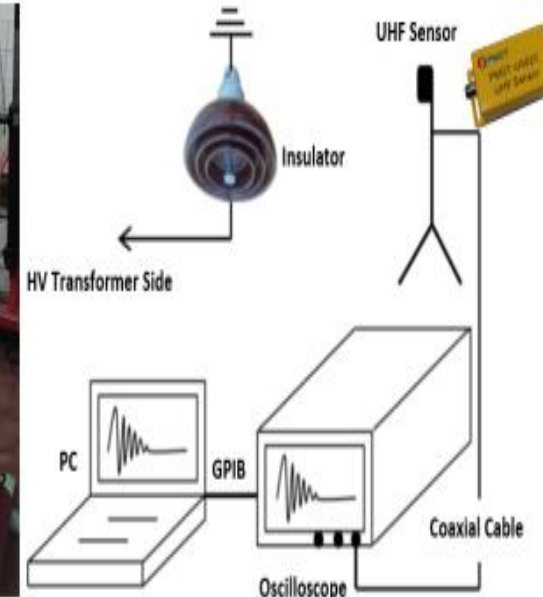
1- Omar M. Aladdin, Rasha S. M. Ali, Hala M. A. Mageed, and M. A. Elmenyawy, "MAPAN-Journal of Metrology Society of India", Vol. 36, No. 3, PP. 579-587, Sept. 2021.

2- Omar M. Aladdin, H.M.A. Mageed, Rasha S. M. Ali, M.A. Elmenyawy, "A New Technique for High Current Calibrations Using Low Voltage Reference Standards", IEEE Instrumentation and Measurement Magazine, Vol. 25 (3), pp. 30-36, 2022.

# Research Activities

## 6. Remote detection of partial discharge in high voltage insulators based on RF signature

- Defective discs of ceramic insulators essentially contain partial discharge (PD) activities.
- The detection of radio frequency (RF) waves emitted from the PD activities is an emerging technique to monitor the insulator's condition during its operation.
- RF signatures are captured using a high frequency sensor under the normal operating voltage.
- Signal processing techniques are introduced to the captured RF signatures for further analysis.
- An Artificial Neural Network (ANN) is used for training of an intelligent classifier that is used for identifying the type of the insulator defect.



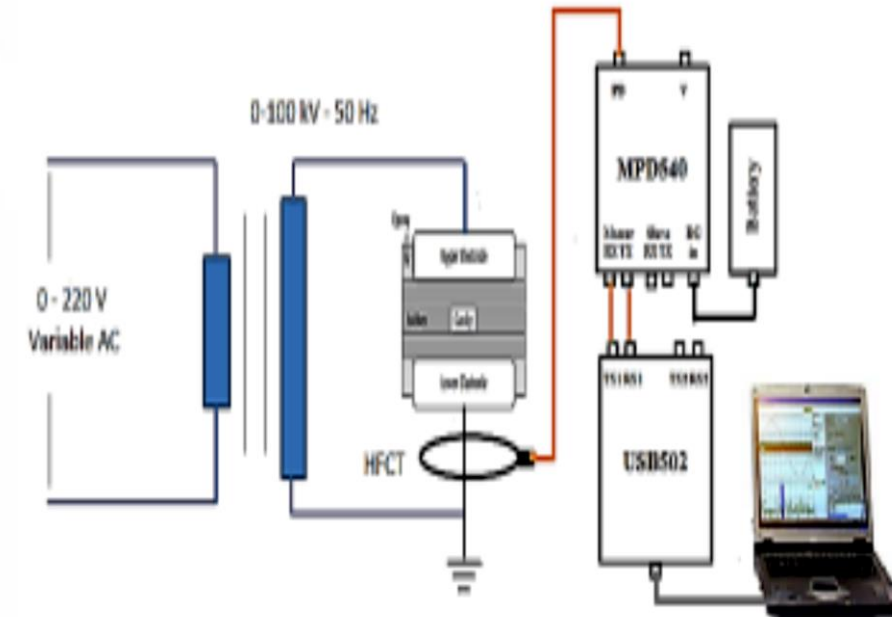
Publication

Ahmed S. Haiba, Ahmed Gad, Soliman M. El-Debeikey, Mamdouh M. Halawa, "IEEE Electrical Insulation Conference (EIC)", Calgary, Alberta, Canada, pp. 432-335, 16-19 June 2019.

# Research Activities

## 6. Remote detection of partial discharge in high voltage insulators based on RF signature

- PD measurement was performed on a rubber sample with an artificial variable cavity diameter to discuss the influence of cavity diameter on the behaviour of PD activities.
- This measurement was carried out by using HFCT technique indicating that the PD magnitude is strongly depending on the spatial geometry of the cavity inside the insulating material as well as increasing the cavity diameter increases the PD magnitude depending on the applied voltage.
- The results obtained from experimental study has a maximum error of 8.20 % based on the maximum PD magnitudes at 30 kV and 50 Hz.



Publication

Ahmed S. Haiba, Adel A. El-Faraskoury, Ahmed D. El-Koshairy, Mamdouh M. Halawa, "TELKOMNIKA Telecommunication, Computing, Electronics and Control", Vol. 19, No. 6, pp. 2000-2008, December 2021.

# Research Activities

## 7. Modified Climatic Chamber for solar radiation testing of the outdoor electricity meters

- The solar simulator was constructed by inserting quartz tungsten halogen lamps (QTH) inside the climatic chamber (MKF-240) that controls ambient temperature to be able to simulate the sunlight.
- The output irradiance of the simulator was adjusted after many experimental tests to be suitable for testing the electricity meters.
- Solar testing has been done on two electricity meters with different accuracy classes.
- The accuracy of the electricity meters was measured during exposure to solar radiation at the operating condition and various electrical loads to know the effect of radiation on electricity meters accuracy.



### Publication

Eman M. Hosney, Hala M. Abdel Mageed, and Adel S. Nada, "IEEE Instrumentation and Measurement Magazine", Vol. 25, No. 3, pp. 52– 57, 2022



# Calibrations & Measuring Capabilities

Published CMCs

Submitted CMCs



# Calibrations & Measuring Capabilities



Results for: Electricity and Magnetism > "NIS, Egypt Electricity"  
21 results

SELECT ALL

EXPORT XLS

In the CMC uncertainty statements,  $Q(a,b) = [a^2 + b^2]^{1/2}$

Unless otherwise stated the expanded uncertainties given below correspond to  $k=2$  (at a 95 % level of confidence)

	GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY	IN A S
<input type="checkbox"/>		Egypt NIS	21.3.1		DC voltage, current, and resistance	DC voltage (up to 1100 V)	DC voltage sources: single values	DC ste
<input type="checkbox"/>		Egypt NIS	21.2.1		Impedance up to the MHz range	Impedance (up to the MHz range)	Capacitance: low-loss capacitors	Fu
<input type="checkbox"/>	<a href="#">S</a>	Egypt NIS	<a href="#">21.6.2</a>		DC voltage, current, and resistance	DC current (up to 100 A)	DC current meters: intermediate values	Di
<input type="checkbox"/>	<a href="#">S</a>	Egypt NIS	<a href="#">21.4.3</a>		AC voltage, current, and power	AC voltage (up to the MHz range)	AC/DC transfer difference at medium voltage	AC Sta
<input type="checkbox"/>		Egypt NIS	21.4.1		AC voltage, current, and power	AC current	AC/DC current transfer difference	AC ste
<input type="checkbox"/>	<a href="#">S</a>	Egypt NIS	<a href="#">21.3.4</a>		DC voltage, current, and resistance	DC current (up to 100 A)	DC Current: Intermediate Values	Mt Ca

## Published CMCs

There are 21 CMCs published on the BIPM-KCDB website in the different activities such as:

- DC voltage sources and meters,
- DC current sources and meters,
- Ultra-low values DC current sources,
- Resistance standards and meters,
- AC voltage meters, AC current meters,
- AC/DC voltage transfer difference,
- AC/DC Current transfer difference,
- Radiofrequency(Scattering parameters), and
- AC power and energy.

# Calibrations & Measuring Capabilities

Submitted CMCs

There are another 2 CMCs under evaluation in the DC resistance activity.

KCDB

CMC IDENTIFIER	METROLOGY AREA	SERVICE CODE	BRANCH	QUANTITY	INSTRUMENT	SUBMITTING RMO
<a href="#">AFRIMETS-EM-EG-00000NXT-1</a>	EM	DC resistance	DC voltage, current, and resistance	DC Resistance (Intermediate values from 10 ohm up to 10 kohm)	Fixed standard resistors (10 ohm to 10 kohm)	AFRIMETS
<a href="#">AFRIMETS-EM-EG-00000NXU-1</a>	EM	DC resistance	DC voltage, current, and resistance	DC Resistance (Low values equal to 1 ohm)	1 $\Omega$ fixed standard resistor	AFRIMETS





# International Comparisons

Completed  
&  
Approved

Ongoing

Planned





# International Comparisons

Completed  
&  
Approved

Ongoing

Planned

No.	Comparison Identifier	Comparison Title	Status
1	<u>EURAMET.EM-S24</u>	Ultra-Low DC Current Sources	Supplementary Comparison, 2005-2009
2	<u>EURAMET.EM-K2.1</u>	Resistance Standards	Key Comparison, 2010-2011
3	<u>SIM.EM-K12</u>	AC/DC Current Transfer Standards	Key Comparison, 2010-2012
4	<u>APMP.EM-S8</u>	Digital Multimeter	Supplementary Comparison, 2011-2013
5	<u>EURAMET.EM-K12</u>	AC/DC Current Transfer Standards	Key Comparison, 2012-2014
6	<u>BIPM.EM-K11</u>	DC Voltage, Zener Diode	Key Comparison, 2014
7	<u>BIPM.EM-K14.a</u>	Capacitors	Key Comparison, 2016
8	<u>BIPM.EM-K14.b</u>	Capacitors	Key Comparison, 2016
9	<u>AFRIMETS.EM-S1</u>	DC Resistance	Supplementary Comparison, 2015-2018
10	<u>GULFMET.EM-S3</u>	AC/DC Voltage Transfer Standards	Supplementary Comparison, 2017
11	<u>COOMET.EM-K5</u>	AC Power At 50/60 Hz	Key Comparison, 2016-2018
12	<u>AFRIMETS.EM.RF-S1</u>	Attenuation And Reflection for Coaxial	Supplementary Comparison, 2017-2018
13	<u>SIM.EM-S14</u>	AC Energy	Supplementary Comparison, 2018

# International Comparisons

Completed  
&  
Approved

Ongoing

Planned

Year	Identifier	Description	Participants	Pilot	Status
2020	AFRIMETS.EM-S2	<p>ACV: 100 mV, 100 V, 1000 V @40 Hz 1 kHz. ACI: 10 mA, 1 A, 10 A @40 Hz and 1 kHz. DCI : 10 mA, 1 A, 10 A. DCV : 100 mV, 10 V, 1000 V DC Resistance: 100 kΩ, 1 MΩ, 100 MΩ Artifact: 6 ½ DMM</p>	NMISA, LPEE-LNM, DEF-NAT, KEBS, NIS, UNBS, NMIE, SIRDC- NMI	NIS (DEF-NAT provided artifact)	Draft A is in progress
2018	EURAMET Project 1512	<p>It is aimed to check results of primary level effective efficiency for Type-N thermistor power sensors in the frequency range 10 MHz to 18 GHz. The measurement frequencies for this comparison are 50 MHz, 500 MHz, 1 GHz, 2 GHz, 4 GHz, 6 GHz, 8 GHz, 10 GHz, 12 GHz, 14 GHz, 16 GHz and 18 GHz.</p>	UME, NPL, NIS, PTB, NMISA	UME	Draft A report has been prepared and shared with the participants. Participant's feedback is collected for modifications and corrections.



# International Comparisons

Completed & Approved

Ongoing

Planned

Year	Identifier	Description	Participants	Pilot	Status
2022	AFRIMETS.EM-S4	DC & AC High Voltage DC: 5 kV, 10 kV, 20 kV AC @50Hz: 5 kV, 10 kV, 20 kV Artifact: to be identified	NIS, LPEE-LNM, DEF-NAT, TBS	NIS (LPEE-LNM will provide artifact)	Planned (Technical protocol will be prepared by NIS before end of this year)
2023	AFRIMETS.EM-S5	AC Power and energy 50V to 300V 5 mA to 120A 10W to 36000W, VAR PF 0 - 1, Frequency 45 Hz to 65 Hz Artifact: Power and Energy meter	NMISA, LPEE-LNM, KEBS, NIS, TBS, SIRDC-NMI	NMISA (NIS will provide artifact)	Planned (Technical protocol will be prepared by NMISA before end of this year)
2024	AFRIMETS.EM-S6	AC-DC transfer in Voltage: 2 V @ 10 Hz, 1 kHz, 20 kHz, 100 kHz, 1 MHz 200 V @ 10 Hz, 1 kHz, 10 kHz, 20 kHz, 50 kHz, 100 kHz Optional: 1000 V @ 10 Hz, 1 kHz, 10 kHz, 20 kHz, 50 kHz, 100 kHz Artifact: to be identified	NMISA, DEF-NAT, NIS, NMIE, KEBS, TBS, SIRDC-NMI, UNBS	NMISA (will provide artifact)	Planned



# International Comparisons

Completed  
&  
Approved

Ongoing

Planned

Year	Identifier	Description	Participants	Pilot	Status
2025	AFRIMETS. EM. RF-S2	Radio Frequency power At frequencies 10 MHz, 100 MHz, 1GHz and 18 GHz Power sensors at 1 MW Artifact: power sensor	NMISA, NIS, DEF-NAT,	(NMISA could provide artefact and NIS/DEFANT could write protocol and analyze data)	Planned
2026	AFRIMETS. EM. RF-S3	S-parameters Reflection coefficient $S_{ii}$ (-1, 1) At frequencies: 50 MHz, 1GHz, and 18 GHz Reflection coefficient $S_{ij}$ (magnitude) 0 dB, 40 dB and 80 dB At frequencies: 50 MHz, 1GHz, and 18 GHz $S_{ij}$ (phase) (-180° to 180°) At frequencies: 50 MHz, 1GHz, and 18 GHz Artifact: Attenuators	NMISA, NIS, DEF-NAT	(?? will provide artefact)	Planned
2026	AFRIMETS.EM-K?	Electrical capacitance 1 pF to 1 $\mu$ F at 1 kHz	NMISA, NIS, DEF-NAT, SIRDC-NMI, NMIE, KEBS	(?? will provide artefact)	Planned

# International Comparisons

Completed  
&  
Approved

Ongoing

Planned

Year	Identifier	Description	Participants	Pilot	Status
2026	AFRIMETS.EM-S7	High DC Resistance 1 G $\Omega$ to 1 T $\Omega$	NMISA, NIS, DEF-NAT	(?? will provide artefact)	Planned
2026	AFRIMETS.EM-K?	Electrical Inductance 100 mH at 1 kHz Current: 1 mA	NMISA, NIS, DEF-NAT, SIRDC-NMI, NMIE, KEBS	(?? will provide artefact)	Planned



# NIS Role in AFRIMETS





# NIS Role in AFRIMETS



NIS has an important role in AFRIMETS-RMO and participated in many activities in the field of electricity and magnetism such as:

1. **Reviewing CMCs by 4 staff members as one of CIPM-MRA activities.**
2. **Reviewing of the quality systems for some NMIs.**
3. **Providing training and consultation to NEWMET members (Sudan-Ghana).**
4. **Participating in some comparisons as pilot NMI and in other comparisons as a member.**
5. **Hosting some AFRIMETS meetings such as TC-EM in 2017, and 2019 and will also host the next meeting in August 2023.**





# Projects



There are 2 projects from 2008 up to 2022 that the electrical metrology division at NIS participated in them in the field of electricity and magnetism



# Project 1

## “Fabrication and Characterization of Precise System for Generating Low-Level AC Voltage Signals”

This project was in the framework of the executive programme of scientific and technological cooperation between Italy and Egypt for the years 2008 to 2011.

Through this project, the following achievements were executed:

- Extending our capabilities to cover all the low ac voltage calibrations. So, several micro-potentiometers were developed from 200 mV to 2 mV.
- The Istituto Nazionale di Ricerca metrological (I.N.Ri.M) Torino, Italy, had been visited by two researchers.
- An inter-laboratory comparison was performed between the NIS micro-potentiometers and the I.N.Ri.M standard and system for generating low voltages.

### Publications:

- Rasha S.M. Ali, Hala A. Mageed, and N.N. Tadros, “Automated Multi-Meter Method for the scaling of Low AC Voltage from 200 mV to 2 mV”, Energy and Power Engineering (EPE), Vol. 5, PP. 129-134, March 2013.
- Hala A. Mageed, Rasha S.M. Ali, N. N. Tadros, Mamdouh Halawa, Marco Lanzillotti, “Interlaboratory Comparison in Measuring Low Levels of AC Voltage between Italy and Egypt”, MAPAN-Journal of Metrology Society of India, Vol. 29, PP. 175 – 181, 2014.



# Project 2

## Development of RF and Microwave Metrology Capability (15RPT01)

This project was arranged under the umbrella of EURAMET that was funded by European Union with the participation of 10 NMIs. The project runtime was from 1 June 2016 to 31 May 2019. Final report of the project has been issued and published on the EURAMET site, in June 2019.

the following achievements were executed:

- The collaborators have been trained to use the VNA metrology software VNA Tools to perform VNA measurements.
- Software supports data taking, VNA calibration and error correction and the evaluation of measurement uncertainties in accordance with relevant standards.
- Concluding activity named "software capabilities for measurement uncertainty evaluation" is a measurement comparison in Type-N 50 Ohm up to 18 GHz as a EURAMET project.



# Project 2

## Development of RF and Microwave Metrology Capability (15RPT01)

- Final report of the comparison of Type N Reflection coefficient (S-parameter comparison) had been finished and published on the EURAMET site in May, 2019.
- Final report of the comparison (1426 EURAMET Project) of calibration factor of power sensors and thermistor had been finished and published on the EURAMET site in May, 2019.
- Final report of the comparison of Voltage reflection coefficient (VRC) of an RF source had been finished and published on the EURAMET site.



# Patents

Approved

Under Evaluation

# Patents

Approved

Under  
Evaluation

There are 6 patents were approved (No. 26576, 26040, 26493, 24567, 24446, and 24447) in designing new resistance, capacitance, and inductance decades.

# Patents

Approved

Under  
Evaluation

## Patent 1:

Automatic  
Inductive Voltage  
Divider with least  
number of  
elements.

Request No.: 2105/2018

## Patent 2:

Modified Climatic  
Chamber for solar  
radiation testing of  
the outdoor  
electricity meters.

Request No.: 618/2021



# Thank You



Prof. Dr. Rasha Sayed Attiya Mohammed