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# DC ENERGY TRACEABILITY/EV CHARGING STATION ACCURACY TRACING



*The Voice of Ontario's Electricity Distributors*

*EDA Niagara  
Metering Exhibition and Workshop*

April 4, 2024, 9:00 – 9:45 AM

Perry Lawton, TESCO



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# TOPICS OVERVIEW

- DC Energy Traceability and ISO 17025 Accreditation
- EV Charging Station Accuracy Testing





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# DC ENERGY TRACEABILITY AND ISO 17025 ACCREDITATION



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# TESCO EVSE HISTORY

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- TESCO: Metering since 1904; energy measurement is what we do
- ~10 years ago we saw that EV chargers, since they would be selling energy, would need to be calibrated and tested similar to revenue grade utility meters
- 2015: TESCO's first patents for AC/DC calibration of EVSE



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# TESCO EVSE HISTORY: AC vs DC

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- Developed AC calibration capability first
  - Familiarity with AC measurement in shop and field test units for utility space was helpful here
- DC was not so easy....
  - First electric meter standards developed in 1910... a few years *after* DC meters were obsolete
  - There was never a recognized standard in NA for DC metering
  - TESCO worked to develop the methodology and process for DC metrology
  - Created equipment, took data, reviewed data, adjusted equipment, more data...
    - ***Fast-forward several years.. TESCO's lab received expansion of scope for ISO 17025:2017 accreditation to include DC Energy Measurement***

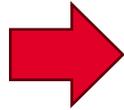


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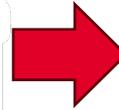
# EVSE TRACING



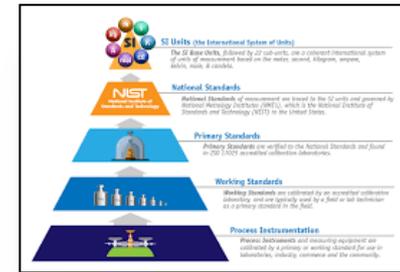
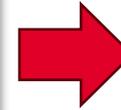
Level 1, 2, 3 EVSE Charger



TESCO Catalog #T4350



TESCO DCT



TESCO ISO 17025:2017 Accreditation



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# EVSE TRACING

## AC CALIBRATION



## DC CALIBRATION





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# ATTAINING DC ENERGY MEASUREMENT ACCREDITATION



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# DC ENERGY TRACEABILITY

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- TESCO Expansion of Scope of ISO17025 Accreditation for DC measurement (2022)
  - Standards: ANSI/ISO 9001: 2015, ISO/IEC 17025: 2017
    - Past and other standards
  - Testing
  - Known Process
  - Traceability
  - Uncertainty
  - Audit and Accreditation



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# STANDARDS

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- ISO9001: 2015 – Quality Management Systems
- “ISO 9001 Certified” means an organization has met the requirements in ISO 9001, which defines an ISO 9001 Quality Management System (QMS). ISO 9001 evaluates whether your Quality Management System is appropriate and effective, while forcing you to identify and implement improvements.
- QMS, QM
- Process based approach
- Continuous Improvement



- MIL-STD 45662(A)
  - US Military Standard
  - First Issued as a Mil-C in early 1960's
  - Requirements for establishing and running a Calibration "System"
  - Rescinded 1995, replaced by ANSI/NCSL Z540-1
- ANSI/NCSL z540-1
  - A U.S. National Standard
  - First Issued 1994
  - Requirements for operating a Calibration Laboratory
  - Compliance of suppliers to customers requirements
  - Withdrawn 2007, replaced by ISO/IEC 17025 and ANSI/NCSL Z540.3



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# STANDARDS

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- ISO/IEC 17025

- An Inter-national Standard
- First Issued 1999 (1990 as a guide)
- Requirements for the competence of a Testing or Calibration Laboratory
- Includes quality system requirements of ISO9001
- Current version is 2017
- Contained three main pillars in establishing competence-
  - **Metrological Traceability, specifically to the SI unit**
  - **Measurement Uncertainty, the “accuracy of a calibration”**
  - **Assuring the validity of results, all accredited labs must do proficiency testing, usually in the form of inter-laboratory testing to validate their processes**

- ANSI/NCSL z540.3

- A U.S. national standard
- First Issued 2006
- Requirements for establishing the technical requirements of a Calibration Lab
- Withdrawn as an active standard October 2020 and superseded by ISO/IEC 17025:2017



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# STANDARDS – TERMS

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- **TAR-TEST ACCURACY RATIO**

- MIL-STD-45562A, beginning of z540.1
- Required uncertainties to be “sufficiently small”
  - 4:1
  - If 4:1 not achieved, it must then be stated

- **TUR – TEST UNCERTAINTY RATIO**

- Latter part of z540.1, z540.3
- Thought of added error from calibration process
- 4:1



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# STANDARDS – TERMS

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- Mu – Measurement Uncertainty
  - ISO/IEC 17025
  - Shifted the focus from a test ratio to understanding a calibration process and the contributors to the uncertainty or inaccuracies of the calibration
  - Mu must be reported for each calibration test point
  - The concept was that by knowing the Mu the lab established more confidence in their measurements
  - Left the customer the responsibility to understand uncertainties and what it meant for their tests



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# ISO/IEC 17025: 2017

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- General requirements for the competence of testing and calibration laboratories
- Measurement Uncertainty
- ISO9001
- SI Traceability
- Inter-national
- Proficiency Testing
- Accreditation – Different than certification



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# ISO/IEC 17025: 2017

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- Certification - Certification is used for verifying that personnel have adequate credentials to practice certain disciplines, as well as for verifying that products meet certain requirements.
- Accreditation - Accreditation is used to verify that laboratories have an appropriate quality management system and can properly perform certain test methods (e.g., ANSI, ASTM, and ISO test methods) and calibration parameters according to their scopes of accreditation.



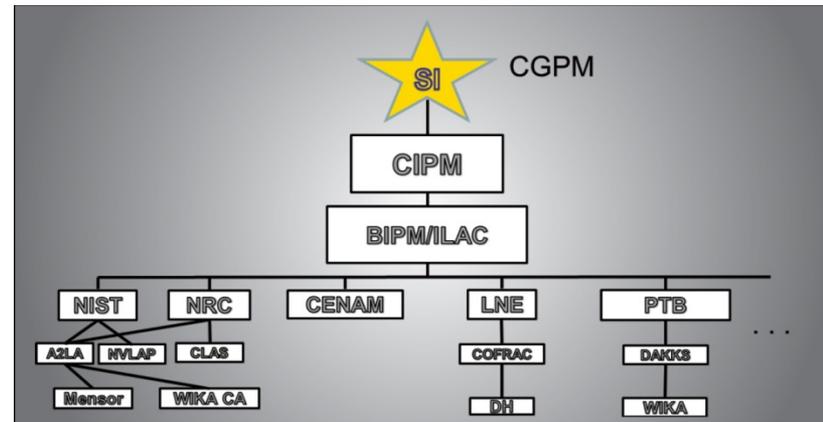
# TRACEABILITY

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- NRC/NIST Traceable?
- SI – BIPM
- Metre convention – Paris May 20 1875
- NMIs – NRC, NRC PTB
- Units Traceable?
  - NO
  - Measurements
- Unbroken Chain



- CIPM - The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue.
- ILAC – International Laboratory Accreditation Council
- ISO - International Organization for Standardization
- IAF - International Accreditation Forum
  - PJLA, A2LA





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# CALIBRATION AND TESTING

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- Calibrate DCT
- Rigorous Testing
- Repeatability
- Reproducibility
- Best Measurement, best measurement practices
- Ensure traceability with calibrated Measuring and Testing Equipment
  - What does it mean to calibrate?
  - What is the Specifications for calibration?
  - What determines calibration lifecycle?



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# KNOWN PROCESS

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- Document process
- ISO9001
- Repeatable process
- Work Instruction, SOP
- QMS
- Training
- Continuous Improvement



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# EV CHARGING STATION TRACING





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# EV CHARGING STATION TRACING

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- What are we doing?
- Why are we doing it?
- How are we doing it?



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# WHAT ARE WE DOING? EVSE TESTING CA

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- Testing Electric Vehicle Supply Equipment (EVSE) as per Scope identified in S-E-EVSE-01, issued under the authority of Section 12 of the Electricity and Gas Regulations
- Level 1+2 to start; Temporary dispensation for Level 3+ electric vehicle supply equipment (canada.ca)
  - Level 3 placed in service prior to July, 2024

Source: S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment (canada.ca)



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# WHAT ARE WE DOING? EVSE TESTING CA

- **B) Level 3+ EVSE put into service between July 1, 2024, and December 31, 2029**
  1. No later than December 31, 2029, eligible owners, or an authorized individual designated by the owner as acting on their behalf, wishing to take advantage of the dispensation shall:
    1. Meet all the requirements for Level 3+ EVSE in service prior to July 1, 2024, listed above in section (A);
    2. Supply electricity to the purchaser within an acceptable limit of error of  $\pm 3\%$ ;
    3. Provide evidence that the EVSE is dispensing electricity within the acceptable limit of error, either by submitting:
      4. test results for their meters, using a method and testing standard acceptable to Measurement Canada; or
      5. a letter, report or other similar document from the meter manufacturer, attesting to the accuracy of the EVSE, as established through the manufacturer's recognized evaluation program; and
  2. Ensure that every eligible EVSE identified in (A)(1)(b) is equipped with:
    1. a metering system capable of measuring the delivered energy; and
    2. a means to display the software and firmware version.

Source: [Temporary dispensation for Level 3+ electric vehicle supply equipment \(canada.ca\)](#)



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# WHAT ARE WE DOING? EVSE TESTING CA

- Testing of EVSE is done using the same transactional process as is used in the normal operation of the EVSE and consists of at least the following steps:
  1. Initiating a charging session using the standard handshake exchange between the EVSE and a vehicle. A vehicle may be replaced by a simulated vehicle, as long as it conforms to the standard protocols for handshake exchange.
  2. Charging at a specified power level for a specified quantity of energy (must be greater than the MMQ).
  3. Terminating the delivery of energy as would occur when terminating normal charging of an electric vehicle.
  4. Comparing the energy delivered as measured by the EVSE with that measured by the test equipment.
  5. Comparing the energy received (if applicable) as measured by the EVSE with that measured by the test equipment.
- Note: For DC EVSE the energy delivered should be sufficient so that the amount of energy delivered during ramp up and ramp down are less than 10 percent of the energy delivered at the test power.
- Note 2: The tests can be performed either with real load or with phantom load.

Source: [S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment \(canada.ca\)](#)



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# WHAT ARE WE DOING?

**Table 2: Maximum permissible errors**

Current range	Power factor	Maximum permissible error
$I_{st} \leq I < I_{min}$	>0.9	±15%
$I_{min} \leq I < I_{tr}$	>0.9	±1.5%
$I_{tr} \leq I \leq I_{max}$	>0.9	±1.0%

S-E-EVSE-01—Specifications for approval of type of electric vehicle supply equipment (canada.ca) Section 7.6 Table 2



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# HOW ARE WE DOING IT?

## Test Methods

- Simulation
  - Use of a load emulator, “Phantom Load”
- Man-in-the-middle (MITM)
  - Use of an electric vehicle, “Customer Load”



SIMULATION



MAN-IN-THE-MIDDLE



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# TS400 OVERVIEW: HARDWARE

## ISSUE SOLVED

With the growing demand for electric vehicles (EV), there needs to be a simple and accurate method to test EV charging systems.

Test the accuracy of AC and DC voltages and currents with **TESCO's Electric Vehicle Service Equipment (EVSE) Test System TS400**. The **TS400** is a valuable instrument with complete testing capabilities and caters to every possible EVSE charging protocol in the world (AC and DC).

## TS400 TEST LIMITS

### Simulation

- Tesla
- CHAdeMO
- CCS1
- Additional standards available upon request.
- Easy to use – select a site and press “test”
- Extremely fast, full accuracy is achieved in less than five seconds at any power level
- Field ready, and easily transportable
- Performs all accuracy and safety tests automatically without need for operator intervention.
- All information for sites, equipment, test procedures and test results are stored in internal database.
- Compatible with all current EV charging protocols.
- Software for exporting data and creating reports.



TS400 Test System includes the T4000 EVSE Tester and PL4000 Load Emulator to test all AC/DC charging standards.

CAT. TS400

**ELECTRIC VEHICLE SERVICE  
EQUIPMENT (EVSE) TEST SYSTEM**



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# TS400 OVERVIEW: HARDWARE

## T4000 SPECIFICATIONS

**AC:**  
 240V \* 80A -> ~19.2kW  
 208V \* 80A -> ~16.6kW

**DC:**  
 1000V \* 200A -> ~200kW

*Note: The charger is the limit. The T4000 can go to 650V AC, but CCS1\_AC is limited to 240V maximum*

**OPERATING TEMPERATURE:** -20°C to 50°C (-4°F to 122°F)

**STORAGE TEMPERATURE:** -22°C to 60°C (-22°F to 140°F)

**DIMENSIONS:** 21.2" x 16" x 10.6" (53.8 x 40.6 x 26.9 cm)



## T4000 FEATURES

- DISPLAY** 7", 1024 x 600, high brightness, daylight readable LCD
- ETHERNET** 100 BaseT with support for: Web Services, Remote Control, Database Access
- USB** 2X USB Type A with support for: Device, External Memory Storage, WiFi, Keyboard, Mouse; 1X USB Type B connection to computer
- GPS** Integrated GPS system provides location information for automatic determination of test site and data base access
- GFCI** Provision is provided to test the GFCI functionality of the EVSE (0-200ma)
- BATTERY** 99.6Whr Li-ion removable battery
- PL INTERFACE** Provides communications and power to any Programmable Load (PL Series)
- PC SIGNAL** Frequency +/- 1Hz, Duty Cycle +/- 0.5%, Wave form amplitude +/- 0.3%
- CASE** Watertight, crushproof, and dustproof Pelican™ Storm Case™

## PL4000 SPECIFICATIONS

**AC:**  
 240V \* 58A -> ~14kW  
 208V \* 50A -> ~10.4kW

**DC:**  
 240V \* 58A -> ~14kW  
 500V \* 28A -> ~14kW

*Note: The PL4000 is the limit. CCS1\_AC can go to 80A, but the PL is limited to 58A*

**OPERATING TEMPERATURE:** -20°C to 50°C (-4°F to 122°F)

**STORAGE TEMPERATURE:** -22°C to 60°C (-22°F to 140°F)

**DIMENSIONS:** 16.9" x 16.3" x 26" (42.9 x 41.4 x 66 cm)

**WEIGHT:** Approx. 46 lbs.



Ask about **TESCO's Cat. 1060 UtiliCart®** to easily transport and hold your equipment in the field.

*Charging Station not included.*

**CAT. TS400**

## ELECTRIC VEHICLE SERVICE EQUIPMENT (EVSE) TEST SYSTEM



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# T4350 vs T4000

- T4350 – what’s in a name?
  - “T”: Tester
  - “4”: 4<sup>th</sup> generation
  - “350”: rated for 350A continuous load
- What’s changed?
  - The T4350 is capable of higher power testing and supports the full spectrum of charger types across AC/DC

	T4000		T4350
Continuous Load	200A		350A
Max Load	400A		650A

**T4350**  
EVSE TEST SYSTEM







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# TESCO EVSE TESTING

## EV Charging Station Test Report



DEVICE MANAGER

### EVSE TESTER DEVICE INFO:

System Name: **T4000**  
Software Version: **1.3.4r**

Serial Number: **00046**  
Calibration Date: **Nov-22-2022 7:23 AM**

### EVSE Charger Info:

Establishment Name: **l'Esplanade**  
Customer: **Hydro Quebec**

Address:  
**8181 Av de l'Esplanade, Montreal  
ON, HGP 2R5**

### EVSE INFO:

Manufacturer: **Circuit Electrique**  
Serial Number: **CEA-10028**

Model: **smartTwo**  
GFCI rating: **0.02**

### PORTS INFO:

Port #1:  
Name: **Port1**

Connector Type: **CCS1 AC**



DEVICE MANAGER

### EvseSimulation TEST

AC-FAST : **CCS1 AC**  
PORT: **Port1**

Conducted by: **HYDRO QC**  
Conducted on: **Jun-07-2023 12:03 PM**

TEST INDEX	TEST NAME	DURATION	RESULT	ENERGY DELIVERED	ENERGY READING	% ERROR	COMPUTED SALES AMT	EVSE SALES AMT	TOLERANCE TYPE	TOLERANCE
1-1	FL	00:00:52	PASS	0.1003	0.1000	-0.30	0.100	0.000	Maintenance	2.00%
1-2	FL	00:00:52	PASS	0.1003	0.1000	-0.30	0.100	0.000	Maintenance	2.00%

Test Types: **NL** = No Load, **SL** = Startup Load, **LL** = Light Load, **FL** = Full Load, **GFCI** = Ground Fault Test, **DIODE** = CP Diode Test  
% Error = ((X-S)/S) \* 100





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# REVIEW OF KEY POINTS

- DC Energy Measurement is possible with certified, SI traceable equipment from TESCO's 17025:2017 accredited lab
- Canada has released guidance for type approval, field testing, and temporary dispensation for Level 1, 2, and 3+ EVSE
- Level 1, 2, 3+ EVSE can be tested using available, traceable equipment on the market today; TESCO offers several options of test equipment that are currently being used across the US and in Canada today





# QUESTIONS AND DISCUSSION



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This presentation can also be found under Meter Conferences and Schools on the TESCO website: [tescometering.com](http://tescometering.com)

**ISO 9001:2015 Certified Quality Company**  
**ISO 17025:2017 Accredited Laboratory**