Enetics

22 September 2015

Hon. Kathleen H. Burgess
Secretary to the Commission
New York State Public Service Commission
3 Empire State Plaza, 19th Floor
Albany, NY 12223-1350

Dear Honorable Burgess:

Enetics, Inc., a New York corporation, respectfully requests approval of our Non-Intrusive Appliance Load Monitoring ("NIALM") technology for use in the approved Statewide Residential Appliance Metering Study. The overall goal of the Statewide Residential Appliance Metering Study is to provide New York State a better understanding of premise level and major household appliance usage patterns among residential customers. These devices are designed to collect data from the premise which will be used to determine end-use consumption of individual appliances. The New York State Program Administrators[1] participating in the study, the vendor selected to administer the study, DNV GL, and DPS Staff have selected the Enetics device.

Enetics seeks commission approval for three of its products for use in this study:

1. LD-1110
2. LD-1120
3. LD-1203

Specific details about these devices and other supporting documents have been added as attachments to this petition to assist with the approval process:

Attachment A – Device Descriptions, Specifications, and Application Details
Attachment B – Prior clients
Attachment C – Test procedure/results of ANSI accuracy testing
Attachment D – Safety Information including UL ratings and jaw patents
Attachment E – Letter of Intent from National Grid

Our request for approval is based on the devices:

- ✓ Being safe to operate as shown by the UL ratings of AC connected components
- ✓ Causing no interference with the utility's revenue meter, which in all cases remains in use.

Please feel free to contact me with any questions you may have regarding the devices, or if you would like to visit our manufacturing facilities located in Victor, NY.

Sincerely,

William C. Bush

William Bush
President Enetics, Inc.

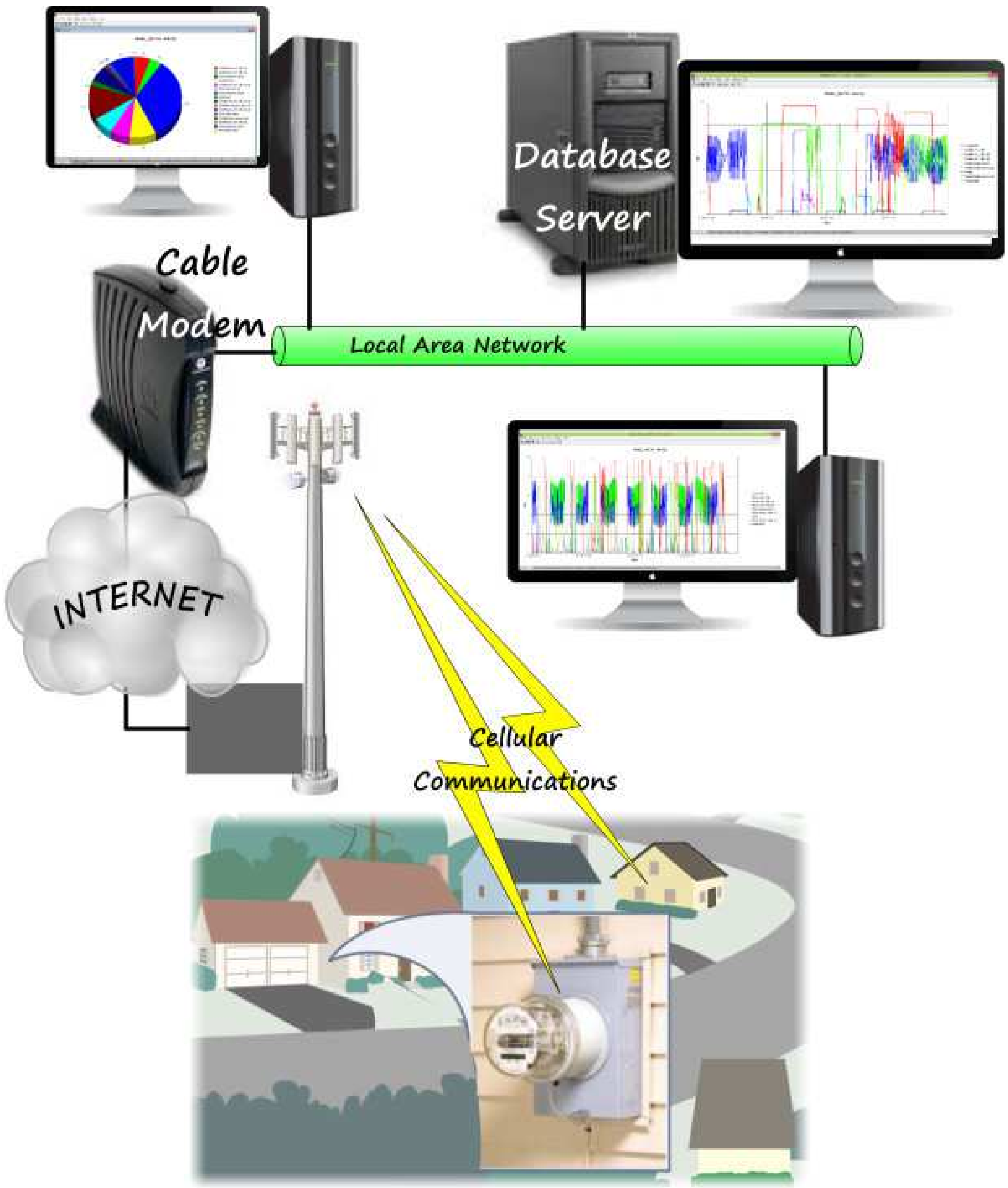
[1]Participating Program Administrators include: National Grid, Con Edison, Central Hudson, NYSEG/RG&E, NYSERDA and Orange& Rockland.

ATTACHMENT A – Device Descriptions, Specifications, and Application Details

Application and Function – Overview

Enetics, Inc. manufactures a line of products that fully characterizes the *specific use* of electric energy within a residence. By analyzing the profile of energy that flows through the home's electrical service entrance, Enetics' advanced technology devices extract information about the specific loads that are consuming energy within the monitored premises. The resulting load-use data is communicated via Wi-Fi or Cellular Modem to a central server located at Enetics' or the customer's data center where it is further reduced by Enetics' software to create interval data showing the consumption patterns of individual loads.

System Diagram



As shown in the diagram above, the Enetics NILMs System comprises a quantity of field devices each logging transitions that occur in the whole-house consumption as loads turn on and off. This transition or "edge" data is communicated automatically to a back-end host computer containing Enetics NILMs software and a supporting database. The software algorithms convert the edge data into consumption profiles for each end-use appliance and that interval data is stored in the central database which analysts can query for the exact premises and data range of interest.

Configurations

There are two types of data collection devices planned for use in the RAM project:

1. The LD-1110 and LD-1120 adapter devices which mechanically mount next to the utility's revenue meter in the meter base, and
2. The LD-1203 installs near the electric service entrance - typically at the breaker panel. The LD-1203 is suited for applications where either there is no utility meter socket available or where the residential service is supplied from 2 phases of a 3-phase system.

LD-1120

LD-1110

LD-1203

Each of the 3 configurations of Enetics' NILMs devices use very similar circuitry to perform identical functions of detecting variations that occur in the whole-house real and reactive consumption patterns as individual loads turn on and off.

For the few differences that exist, the following table summarizes the key configuration or functional capabilities of each of the product versions that will be used on the NY RAM project:

Item	LD-1110	LD-1120	LD-1203
Single Phase, 2 Leg Device for Residential Applications (180° Leg to Leg)	✓	✓	✗
Physically installs under a form 2S/12S utility meter	✓	✓	✗
Uses internal closed core toroidal CTs	✓	✓	✗
Three Phase Device for Residential Applications (120° Phase to Phase)	✗	✗	✓
Physically installs at the breaker panel	✗	✗	✓
Uses external split core CTs	✗	✗	✓
Measures voltage and current on each service leg at 32 samples/cycle	✓	✓	✓
Calculates and stores (logs) True RMS Real and Reactive Power for each service leg with 1 cycle resolution	✓	✓	✓
Logs transitions in real and reactive power. (aka "edges")	✓	✓	✓
Contains a Zigbee receiver to track the status of small plug loads equipped with a separate Zigbee power meter	✗	✓	✗
Has an option for an internal cellular data modem	✓	✓	✗
UL rating on all AC voltage connections and interfaces	✓	✓	✓

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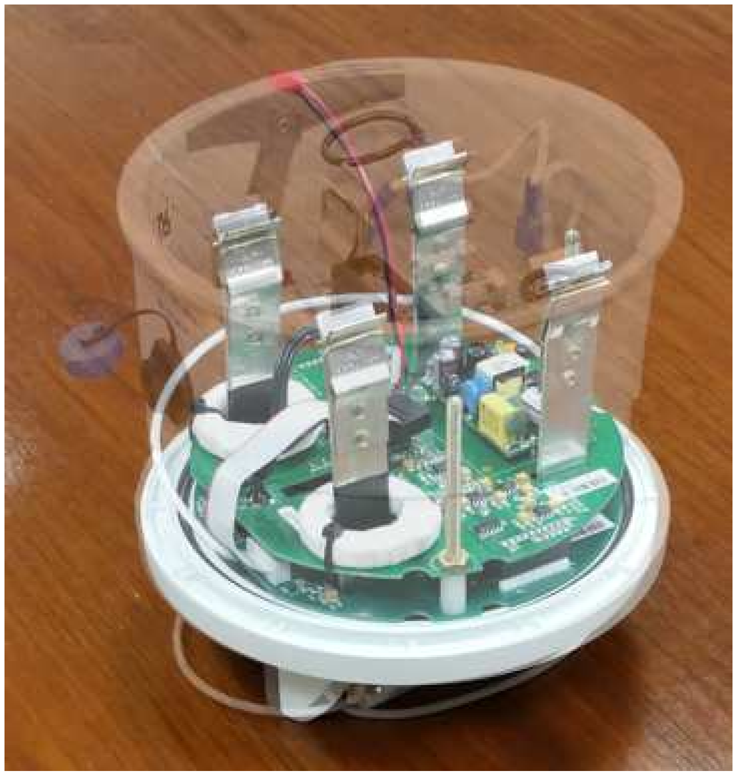
Build Information

LD-1110 and LD-1120
The LD-1110 and LD-1120 meter adapter recording devices are constructed with identical techniques shown with the aid of the following image with the ghosted enclosure:

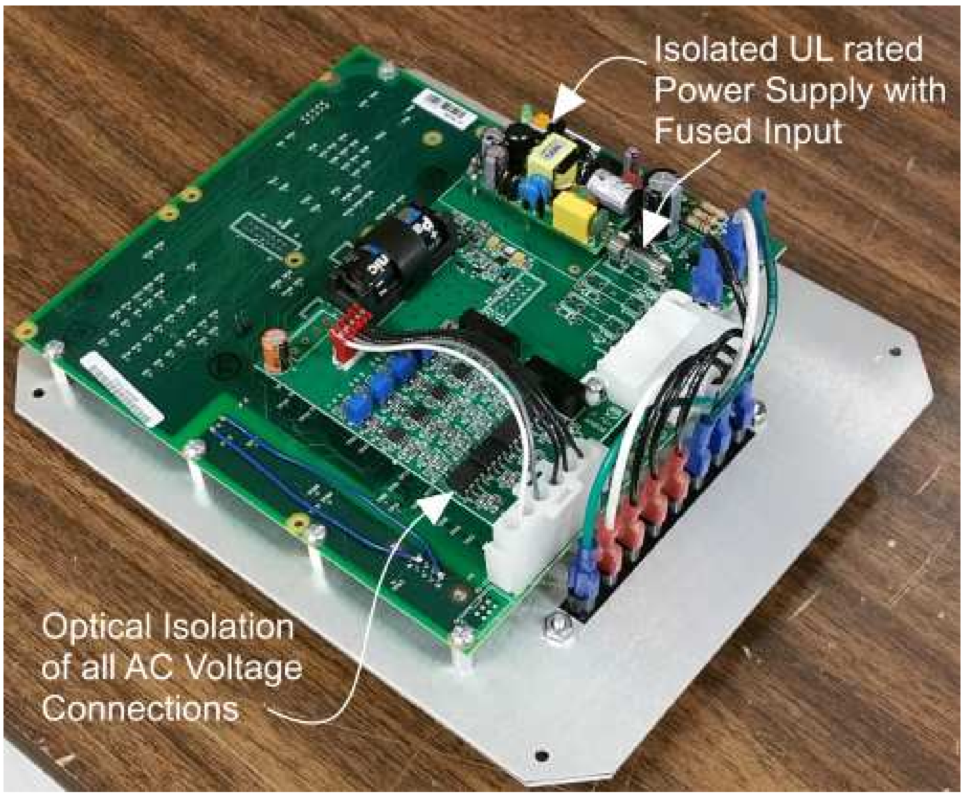


LD-1110 Internal Construction

- Tested to accuracy requirements of ANSI C12.1 2008 Para. 4.7.2 and subparagraphs
- Form 2S/12S, 200a Service Standard
- Internal cellular modem
- Non-volatile data storage
- Serial or USB local comms
- Solid steel bus bars with patented jaw design provide an uninterrupted connection from the original meter base to the utility's revenue meter.
- The LD-1110 makes direct measurements of the service voltage and load current only. All other values including real and reactive power are calculated from the voltage and current measurements.
- Solid core toroidal Current Transformers (CTs) go around the LD-1110's internal bus bars to measure the load current on each service leg independently and without any series shunt resistors.
- Voltage of each leg is measured relative to the service neutral though simple connection taps off of the bus bars. Each voltage input is fused to prevent unsafe fault currents.
- Circuit boards of the LD-1110 are mounted inside the enclosure. Openings are constructed in the circuit boards for the bus bars to pass through so that there is no diversion or interruption of the solid steel bus bars.

LD-1203

The LD-1203 is mounted in a UL rated NEMA 4X enclosure which installs downstream of the utility's electric meter usually at or very near the breaker panel. The software in the LD-1203 is capable of dealing with residential services that are supplied from 2 phases of a 3-phase service, (or in international applications such as the UK, Hong Kong, or Saudi Arabia, from a full 3-phase service) which mathematically is unlike a residential service supplied from 2 legs of a single phase service transformer. Key element of the build and construction of the LD-1203 include:



LD-1203 Internal Circuitry

- Device accuracy has been tested to ANSI C12.1 2008, paragraphs 4.7.2 and subparagraphs.
- AC voltages are immediately optically isolated through analog isolators. This means that:
  - ✓ AC voltages up to 600 vAC are reduced to small 5v levels immediately
  - ✓ There is no intermixing of AC voltages with low voltage circuitry
  - ✓ Isolation eliminates any galvanic continuity between AC voltages (the power grid) and the electronics of the device.
- The power supply the provides low voltage DC to the electronics of the device is fully isolated, UL rated, and fused to protect against faults.
- All conductive material such as the front mounting panel is earthed via a terminal block connection to system earth ground.

Specifications:

	LD-1110	LD-1203
Voltage Input Range:	0 - 260 Vrms L-L	0 - 600 Vrms L-L
Voltage Input Impedance:	2.0 MΩ	2.0 MΩ
Number of Channels:	4 - taken in 2 pairs for single-phase residential applications	8 - taken in 4 pairs for 3-phase C&I applications
Current Input Range:	0 – 200 amps	0 - 1.0 Vrms
Voltage Reading Accuracy:	+ 0.1% reading + 0.1% FS	+ 0.1% reading + 0.1% FS
Current Reading Accuracy:	+ 0.2% reading + 0.2% FS	+ 0.2% reading + 0.2% FS
Power Reading Accuracy:	+ 0.5% reading + 0.01% FS	+ 0.5% reading + 0.01% FS

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Attachment B – Prior clients

The following organizations and utilities have previously used or tested the Enetics NIALMs products:

EPRI
Commonwealth Edison
Consolidated Edison
Buckeye Coop
Dairyland Coop
Gainesville Regional Utility
Electric Generating Authority of Thailand
China Light and Power
National Association of Home Builders
Southern California Edison
Rochester Gas and Electric
Niagara Mohawk
East Kentucky Power Coop
Potomac Electric Power Co.
Public Service Electric & Gas Co
Oklahoma Gas and Electric
Ministerio de Electricidad y Energía Renovable
of Ecuador

Attachment C – Test procedure/results of ANSI accuracy testing

Enetics, Inc.

Enetics Test Procedure A72
5500, 5400 Series, and Derivatives

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Enetics Test Procedure A72 - 5500 and 5400 Series

1.0 Scope

Enetics, Inc. manufactures 8 different solid state recording electric meters all using the same circuit configurations but differing in physical packaging and operating firmware. Differences among the circuitry of these meters fall within the definition of "Minor Variations" as set forth in ANSI 12.1-2008; 4.2.5. Therefore, this Test Procedure applies to all 8 configurations of the meter and establishes their compliance with the intrinsic accuracy requirements of ANSI C12.1-2008 paragraph 4.7.2 and subparagraphs. Because of the physical and packaging differences between these meters, external influences described in 4.7.3 and subparagraphs are addressed in separate procedures where applicable. Note, in particular, the testing performed on the form 2S device is limited to circuit performance and accuracy.

2.0 Objective

The following matrix characterizes the functional and packaging variations in the devices covered by this test.

Meter Characteristics	PP-5510	LM-5510	LM-5515	LM-5520	LM-5410	LM-5415	LD-1110	LD-1203
Energy Meter	✓	✓			✓			
Energy plus Power Quality Meter			✓	✓		✓		
Permanent Mount Hoffman Case (Not intended for outdoor installation)	✓							
Permanent Mount NEMA (Intended for outdoor installation)		✓	✓	✓				
Portable Carry NEMA (Intended for outdoor installation)					✓	✓		
Form 2S NIALMS - Whole House Energy and Edge Transitions							✓	
NEMA 4X NIALMS - Whole House Energy and Edge Transitions								✓

Due to their common circuitry, all of these solid-state electronic meters share the following specifications:

Voltage Input Range:	0 - 600 Vrms L-L
Voltage Input Impedance:	2.0 MΩ
Number of Channels:	8 - taken in 4 pairs for 3-phase C&I applications
Current Input Range:	0 - 1.0 Vrms
Voltage Reading Accuracy:	+ 0.1% reading + 0.1% FS
Current Reading Accuracy:	+ 0.2% reading + 0.2% FS
Power Reading Accuracy:	+ 0.5% reading + 0.01% FS

Regarding the current input range, this family of electronic meters requires installation and use external current transformers (CTs) whose full-scale ratings can be of any value. For safety considerations all CTs used with these meters must be internally burdened and produce a nominal 1.0 Vrms at their full-scale rating. Current Transformers with full-scale output ratings less than 1.0 Vrms may also be used as long as a scaling factor of (1.0/FSO)x(FS Current Rating) is entered into the meter. (where FSO=Full Scale Output of the CT at the Full Scale Current Rating).

The objective of this procedure is to properly structure the accuracy testing called for by ANSI C12.1-2008 as applied electronic meters with low level analog-to-digital inputs and using external current transformers as described above.

3.0 Meter Classification

The ANSI standards define meter classifications based on current ratings of standard socket-type self-contained meters including utility revenue meters and state acceptable performance levels on the basis of these classes. Current classes covered in the standard include:

Current Class 10
Current Class 20
Current Class 100
Current Class 200
Current Class 320

Because the meters under test in this procedure use external CTs that can be rated anywhere from 5 amps up to 10,000 amps with *voltage* outputs that are analog to the current being measured, the meters are effectively of any and every class. Authors of the ANSI standard understood this and provided guidance. Paragraph 4.5.4 of the standard allows that:

"When devices of a class other than 10, 20, 100, 200, and 320 are tested for acceptance, the currents for all tests under the sections on performance requirements shall be those recommended by the manufacturer."

For the purposes of testing in this procedure, 500 amps will be high load current. Other load levels will be linearly pro-rated based on the requirements of the ANSI standard for Class 320 meters.

4.0 Test Setup

4.1 Unit under test

As prescribed by the ANSI standard tests will be conducted on quantity 3 each model PP-5510 meters. This is the meter model used most often in the NYISO Emergency Demand Response Program (EDRP) and the requirement for ±2% accuracy is explicitly cited in the EDRP manual.

4.2 Configuration

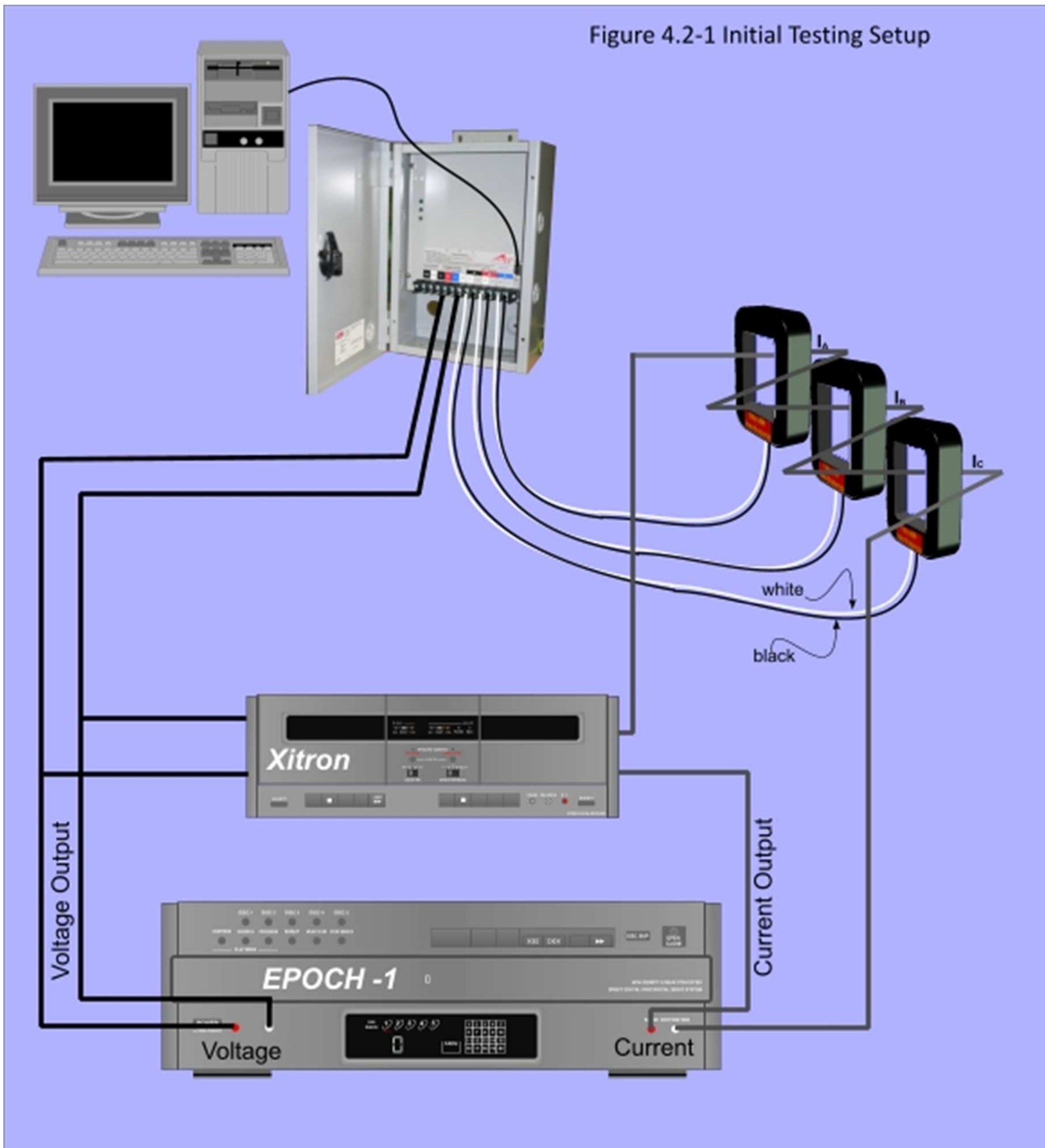

Figure 4.2-1 Initial Testing Setup

Figure 4.2-1 above shows the initial configuration of the unit under test along with the Xitron 2551 reference meter, the EPOCH-1 voltage and current generator and the current transducers.

Except for test 14, the setup shown in Figure 4.2-1 uses single phase instrumentation because ANSI C12.1-2008; Paragraph 4.7.1 states:

"Where the metering device has more than one voltage and current circuit, it shall be tested with the voltage circuits effectively in parallel and the appropriate current circuit(s) energized effectively in series, unless otherwise specified."

4.3 Specifications of the lab equipment:

EPOCH-I

The EPOCH-I is a stable AC Voltage and Current generator (50/60 Hz) where the relative V/I phase angles can be user selected.

Xitron 2551 -

For improved accuracy, the output readings from the EPOCH are not used as measurement data. All current and voltages used in the testing are futher confirmed by the NIST traceable Xitron 2551 meter.

Accuracy at line frequencies of 50/60 Hz:

- THD: 0.1%
- Harmonic: 0.05%
- Phase: 0.1º
- Power: 0.1%
- Resolution: 0.05% of range

4.4 Reference meters - NIST traceability

All reference meters used in the course of testing under this procedure have been recently calibrated by a certified laboratory (Caltronix Inc.) using calibration standards traceable to the National Institute of Standards and Technology (NIST). The calibration certification documentation they provide states:

"Caltronix certifies that this instrument has been calibrated using measurement standards that are traceable to the National Institute of Standards and Technology (NIST). Caltronix's calibration system meets or exceeds the requirements of MIL-STD-45662A, ANSI/NCSL Z540-1, ISO/IEC Guide 25 and ISO/IEC 17025."

5.0 Procedures

Procedures described below are taken exactly from the corresponding subparagraphs of ANSI C12.1-2008, section 4.7.2. Details have been added to account for the current class of the Enetics meter and the fact that the meters being tested are solid-state electronic meters. Current levels specified are shown in each test in accordance with Paragraph 4.5.4 of the ANSI standard which states:

"When devices of a class other than 10, 20, 100, 200, and 320 are tested for acceptance, the currents for all tests under the sections on performance requirements shall be those recommended by the manufacturer."

5.1 Test No. 1: No Load

5.1.1 Objective

This test confirms that the meter does not record any energy consumption when there is voltage applied to the voltage inputs but no load current flowing.

5.1.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1. with the CT ratio set to 1000:5 and the meter settings set to record voltage, current, and kW data with 1 min. intervals.
2. Set the EPOCH-I output voltage to 120 VAC and the current output to 0 amps.
3. At a convenient start time, enable both the voltage and current outputs on the EPOCH-I
4. Continue metering for 20 minutes and then turn off both voltage and current outputs on the EPOCH generator.
5. Fetch the stored data from the meter.

5.1.3 Results

Although the standard specifies results in terms of rotor revolutions which is applicable only for an electro-mechanical meter; the intent is that there should be no accumulated energy consumption (kWH) unless there is load current flowing.

Therefore, confirm results as shown in the table below:

	Required	Actual Observed
Real-Time Demand (watts)	<1 rotor revolution in 10 min.	0 W
Accumulated kWH	<2 rotor revolution in 20 min	0 kWH

Accumulated kWH can be read from the meter by fetching the data and looking at the stored .csv file.

5.2 Test No. 2: Starting Load

5.2.1 Objective

The starting load test confirms that the meter operates continuously (starts) with low voltage and low load currents. In our test setup, the meter is operating with 1000amp CTs so 1.5 amps is applied as a level equivalent to the starting currents specified in the standard.

5.2.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage to 10 VAC and the current output to 1.7 amps.
3. At a convenient start time, enable both the voltage and current outputs on the EPOCH-I.
4. View the real time readings reported by the meter.
5. Continue metering for at least 5 minutes and then turn off both voltage and current outputs on the EPOCH generator.

6. Fetch the stored data from the meter.

5.2.3 Results

	Required	Actual Observed
Real-Time Demand (watts)	Continuous operation without stopping. Readings>0	>0
Accumulated kWH	Continuous operation without stopping. Readings>0	>0

5.3 Test No. 3: Load Performance

5.3.1 Objective

The objective of the load performance test is to confirm that the meter's accuracy performance at various levels of load current shall not deviate more than a specified percentage from its accuracy at an initial reference level of load current.

5.3.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage to 120 VAC.
3. Set the EPOCH-I output current to the reference level shown in the table in 5.3.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Change the current drive from the EPOCH-I moving alternately above and below the reference current level as shown in the table of 5.3.3. and repeat steps 5. and 6. above for each new current level.
8. At each current level calculate the %Error = $\left|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}\right|$x100 and
   the % Deviation from the Reference Error = $|\ Error\ at\ Reference - Error\ at\ Drive\ Level|$

5.3.3 Results

Current Drive (amps)	Xitron Voltage Reading	Xitron Current Reading	Xitron kW x 100*	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
8	120.0	0.08	0.961	0.96	0.104	0.062	±2.0
16	120.0	0.16	1.917	1.92	0.156	0.198	±1.0
47	120.0	0.47	5.638	5.64	0.035	0.077	±1.0
80	120.0	0.8	9.604	9.60	0.042	Reference	Reference
120	120.0	1.2	14.396	14.40	0.028	0.069	±2.0
160	120.0	1.6	19.201	19.20	0.005	0.036	±1.5
230	120.0	2.3	27.604	27.60	0.014	0.027	±2.0
390	120.0	3.9	46.79	46.76	0.064	0.022	±2.0
470	120.0	4.7	56.48	56.46	0.035	0.006	±2.0
500	120.0	5.0	60.08	60.08	0.00	0.042	±2.5

*The test setup uses 100 turns of a wire coil as input to the meter under test so the Xitron current reading have to be multiplied 100

5.4 Test No. 4: Effect of variation of power factor

5.4.1 Objective

The objective of the power factor performance test is to confirm that the meter's accuracy performance at various power factors shall not deviate more than a specified percentage from its accuracy at unity power factor.

Each element of a multi-element metering device shall be tested as a single-element metering device, except that all voltage circuits shall be effectively in parallel.

5.4.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage to 120 VAC.
3. Set the EPOCH-I output current to the reference level and power factor shown in the table in 5.4.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Change the current drive and the power factor from the EPOCH-I as shown in the table of 5.4.3. and repeat steps 5. and 6. above for each new current level.
8. At each power factor calculate the %Error = $\left|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}\right|$x100 and

   the % Deviation from the Reference Error = $\left|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}\right|$x100

5.4.3 Results

Current Drive (amps)	Power Factor	Xitron Voltage Reading	Xitron Current Reading	Xitron kW x 100	(UUT kW)	% Error	% Dev. From Ref.	Spec. % Dev From Ref.
40	1	120	.40	4.802	4.808	0.129%	Ref.	Ref.
40	0.5 lag	120	.40	2.401	2.404	0.130%	0.805%	±2.0
250	1	120	2.49	29.994	30.052	0.195%	Ref.	Ref.
250	0.5 lag	120	2.49	14.997	15.026	0.196%	0.717%	±1.5
500	1	120	5.00	60.037	60.324	0.478%	Ref.	Ref.
500	0.5 lag	120	5.00	30.018	30.163	0.483%	0.912%	±2.0

The test setup uses 100 turns of a wire coil as input to the meter under test so the Xitron current reading have to be multiplied 100.

5.5 Test No. 5: Effect of variation of voltage

5.5.1 Objective

The objective of the voltage performance test is to confirm that the meter's accuracy performance at ±10% of calibrated voltage shall not deviate more than a specified percentage from its accuracy at the calibrated voltage.

5.5.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage as shown in table 5.5.3.
3. Set the EPOCH-I output current to the reference level shown in the table in 5.5.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Change the current drive from the EPOCH-I moving alternately above and below the reference current level as shown in the table of 5.3.3. and repeat steps 5. and 6. above for each new voltage level.
8. At each voltage level calculate the %Error = $\left|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}\right|$x100 and the % Deviation from the Reference Error = $\left|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}\right|$x100

5.5.3 Results

Current Drive (amps)	Xitron Voltage Reading	Xitron Current Reading	Xitron kW	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
10	120	10.01	1.201	1.202	0.117%	Reference	Reference
10	108	10.01	1.081	1.082	0.117%	0.08%	±1.0
10	132	10.01	1.321	1.322	0.117%	-0.06%	±1.0
80	120	80.03	9.603	9.617	0.148%	Reference	Reference
80	108	80.03	8.643	8.656	0.148%	0.39%	±1.0
80	132	80.03	10.563	10.579	0.149%	0.45%	±1.0

5.6 Test No. 6: Effect of variation of frequency

5.6.1 Objective

The objective of the frequency performance test is to confirm that the meter's accuracy performance at ±2% of rated frequency (60Hz) shall not deviate more than a specified percentage from its 60Hz accuracy. Due to limitations on features available on the EPOCH-I generator, the tests prescribed here will deviate by 10Hz (which is >> than 2%) down to 50Hz.

5.6.2 Sequence

1. The setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage as shown to 120 vAC.

3. Set the EPOCH-I output current to the reference level shown in the table in 5.6.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Change the current drive and system frequency from the EPOCH-I as shown in the table of 5.6.3. and repeat steps 5. and 6. above for each new condition.
8. At each voltage level calculate the %Error = $|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}|$x100 and
   the % Deviation from the Reference Error = $|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}|$x100

5.6.3 Results

Freq. (Hz.)	Current Drive (amps)	Xitron Voltage Reading	Xitron Current Reading	Xitron kW	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
60	10	120	10.01	1.201	1.202	0.12%	Reference	Reference
50	10	120	10.01	1.201	1.202	0.12%	-0.71%	±1.0
60	80	120	80.03	9.603	9.617	0.15%	Reference	Reference
50	80	120	80.03	9.603	9.617	0.15%	-0.07%	±1.0

5.7 Test No. 7: Equality of current circuits

5.7.1 Objective

The objective of the "equality of current circuits between elements" test is to confirm that the meter's accuracy performance with current applied to only one element shall not deviate more than a specified percentage from its accuracy when current is applied to all elements.

5.7.2 Sequence

1. The initial setup of test equipment shall be as shown in Figure 4.2-1. Then for conditions 2, 3, 4; and 6, 7, 8 the CTs shall be alternately removed from the drive conductor to energize only one current circuit at a time.
2. Set the EPOCH-I output voltage to 120 VAC.
3. Set the EPOCH-I output current to the reference level shown in the table in 5.7.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Change the CTs used to measure current as defined in the table of 5.7.3. and repeat steps 5. and 6. above for each new current channel configuration.
8. For each configuration calculate the %Error = $|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}|$x100 and
   the % Deviation from the Reference Error = $|\frac{UUT\ kW\ for\ ALL - UUT\ kW\ for\ single\ Chan}{UUT\ kW\ for\ ALL}|$x100

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5.7.3 Results

Phases Driven	Current Drive (amps)	Xitron Voltage Reading	Xitron Current Reading	Xitron kW	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
All	10	120	10.01	1.2012	3.6015	Reference	Reference	Reference
A only	30	120	30.02	3.6024	3.6085	0.17%	0.19%	±1.5
B only	30	120	30.02	3.6024	3.6095	0.20%	0.22%	±1.5
C only	30	120	30.02	3.6024	3.6075	0.14%	0.17%	±1.5
All	80	120	80.03	9.6036	28.7562	Reference	Reference	Reference
A only	240	120	2.415*	28.9800	28.8752	0.36%	0.41%	±1.5
B only	240	120	2.415*	28.9800	28.8762	0.36%	0.42%	±1.5
C only	240	120	2.415*	28.9800	28.8758	0.36%	0.42%	±1.5

*100-turn coil used for larger currents

5.8 Test No. 8: Meter losses

5.8.1 Objective

The objective of the meter loss test is to confirm that meter losses are less than a specified value. The ANSI standard allows 20 VA (but no more than 5 watts) for ***each*** voltage circuit plus 1.0 VA for each current circuit.

5.8.2 Sequence

Using the Xitron meter, measure the supply current, voltage and resulting power consumption to the Unit Under Test (UUT).

5.8.3 Results

The UUT power consumption shall be < 15 watts (which is 3 x 5 watts; we won't need the current circuit allocation allowed by the standard.)

Allowable Meter Loss	**Actual Meter Loss**
15 watts	1.64 watts

5.9 Test No. 9: Temperature rise

The purpose of the temperature rise test is to confirm that load currents passing through the meter device do not induce a temperature rise in excess of a specified amount. The premise being that hot conductors have a higher resistance which could, in turn, affect the performance and safety of the meter. The test is specifically intended for socketed, detachable metering devices where the actual load current passes through the meter. In the prescribed test, the standard requires that:

"The temperature-rise test shall be made by means of temperature detectors in intimate contact with the metal of the current circuit and located at its approximate center."

Because the Enetics Meter under test is an electronic meter using CTs where none of the load current passes through the meter, the temperature rise test does not apply to this type of meter. Accuracy performance from internal heating of the meter is tested in 5.11 below. Regarding the applicability of this test to the LD-1110, UL temperature rise testing done by the jaw manufacturer under patent filing 5,334,057 establishes performance in compliance with UL 414 and by reference therefore within the 55^{o}C limit required by ANSI C12.1.

5.10 Test No. 10: Effect of register friction

According to ANSI C12.1-2008 "This test may be omitted for solid state meters."

5.11 Test No. 11: Effect of internal heating

5.11.1 Objective

As with all of the tests of ANSI C12.1-2008, the internal heating test targets the concern for accuracy from heating in meters that are actually conducting the load current they are measuring. While internal heating in the Enetics meter under test does not arise from load current, (due to external CTs) the circuits and power supply in the meter do nevertheless cause internal heating to occur. This test will confirm that that internal heating over the period of the test does not induce inaccuracies that are greater than the amounts shown in the table of section 5.11.3.

5.11.2 Sequence

1. The initial setup of test equipment shall be as shown in Figure 4.2-1.
2. Set the EPOCH-I output voltage to 120 VAC.
3. Set the EPOCH-I output current to the current levels shown in the table in 5.11.3 below.
4. Enable the EPOCH-I voltage and current outputs.
5. Read the current, voltage, and kW values from the Xitron 2551 reference meter.
6. Record the Total kW reported by meter under test and divide by 3 for comparison to the Xitron readings.
7. Immediately after each condition specified in table of 5.11.3. below, change the current drive to that required for the next measurement, wait the number of minutes specified and repeat steps 5. and 6. above. After condition 8, turn the current drive off.
8. For each configuration calculate the %Error = $|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}|$x100 and

   the % Deviation from the Reference Error = $|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}|$x100

5.11.3 Results (reference levels are color coded for the tests to which they apply)

Con-dition	Test Condition - Minutes after On	Current Drive (amps)	Xitron Current Reading*	Xitron kW	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
Ref. for 1,2,7	1	500	5.01	60.120	60.52	0.67%	Reference	Reference
Ref. for 3,5	3	10	10.02	1.202	1.204	0.13%	Reference	Reference
Ref. for 4,6	5	80	8.01	9.612	9.654	0.44%	Reference	Reference
1	30	500	5.01	60.120	60.522	0.67%	0.50%	±1.0
2	60	500	5.01	60.120	60.521	0.67%	0.25%	±1.5
3	62	10	10.02	1.202	1.204	0.13%	0.00%	±1.5
4	65	80	8.01	9.612	9.654	0.44%	0.02%	±1.5
5	185	10	10.02	1.202	1.204	0.13%	0.63%	±1.5
6	187	80	8.01	9.612	9.6543	0.44%	0.71%	±1.0
7	189	500	5.01	60.120	60.523	0.67%	0.75%	±1.0

*Load current supplied through 100-turn or 10-turn coil

5.12 Test No. 12: Effect of tilt

According to ANSI C12.1-2008 "This test may be omitted for solid state meters."

5.13 Test No. 13: Stability of performance

5.13.1 Objective

The stability test confirms accuracy stability of the meter over a 2-week time period.

5.13.2 Sequence

1. Set the EPOCH-I output to 120 vAC, 60 Hz, 50 amps and enable the outputs.
2. Measure the kW accuracy of the meter at 50 amp load current (10%) at the start of the test.
3. At the same time of day for each of the next 10 days, measure accuracy under the same conditions (voltage, current, phase angle, frequency) as shown in table 5.13.3 below.
4. For each day calculate the %Error = $\left|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}\right|$x100 and

   the % Deviation from the Reference Error = $\left|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}\right|$x100

5.13.3 Results

Day Number	Xitron kW (drive set to level)	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
0	6.002	6.024	0.37%	Reference	Reference
1	6.002	6.024	0.37%	0.45%	±1.0
2	6.002	6.024	0.37%	0.36%	±1.0
3	6.002	6.024	0.37%	0.91%	±1.0
4	6.002	6.024	0.37%	0.09%	±1.0
5	6.002	6.024	0.37%	0.26%	±1.0
6	6.002	6.024	0.37%	0.34%	±1.0
7	6.002	6.024	0.37%	0.40%	±1.0
8	6.002	6.024	0.37%	0.32%	±1.0
9	6.002	6.024	0.37%	0.27%	±1.0
10	6.002	6.024	0.37%	0.25%	±1.0

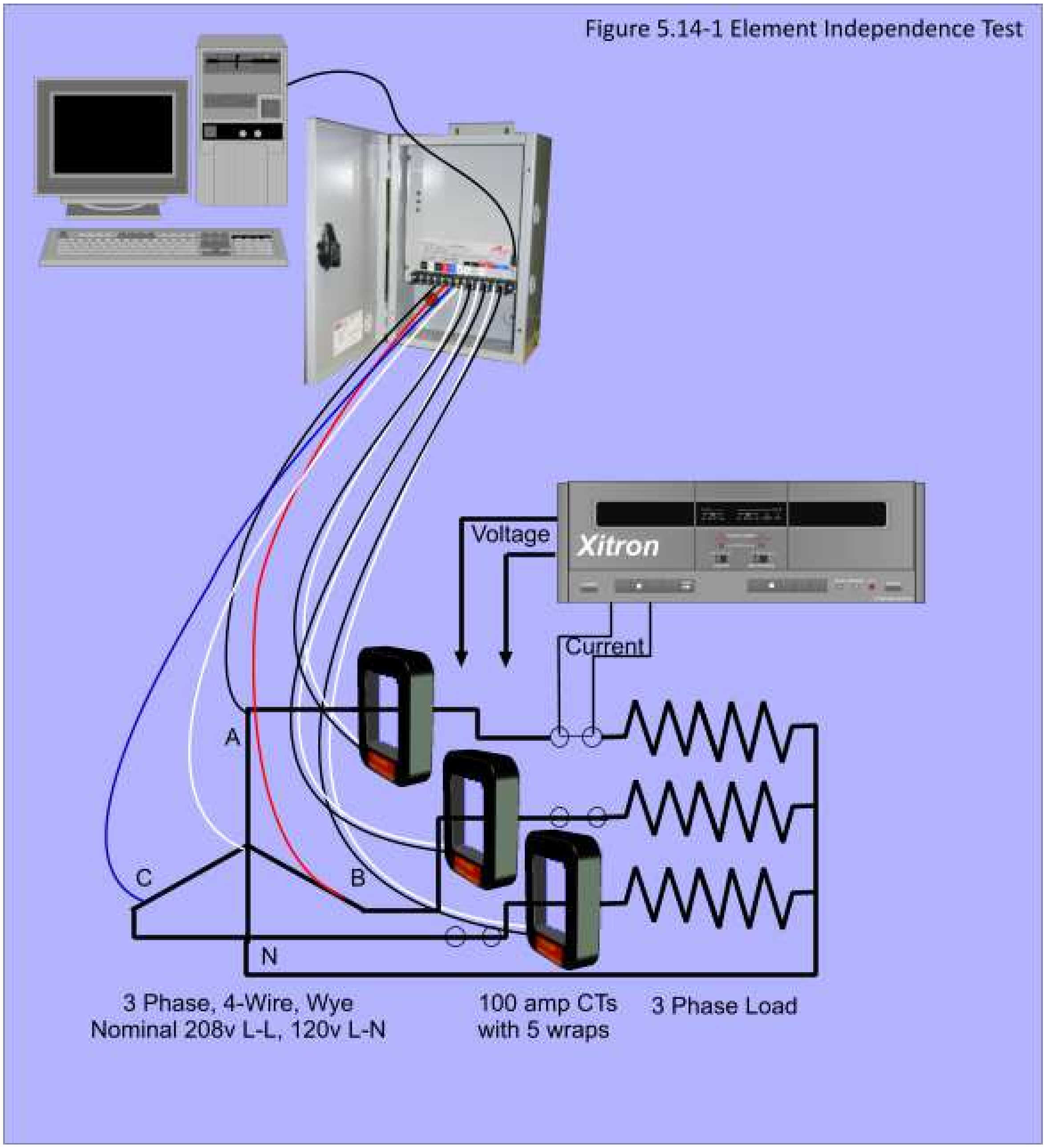
5.14 Test No. 14: Independence of elements

5.14.1 Objective

The independence of elements test confirms that intermixing of circuit phases (both voltages and voltages with currents together) on the various meter elements does not affect the accuracy performance of the meter, using test conditions of Table 20 of the ANSI standard.

5.14.2 Setup

The test setup will be as shown in Figure 5.14-1 below. This test requires operation on a 3-phase, 4-wire, Wye source circuit. Our test setup will use the actual grid driving a resistive load.



Because the grid voltages can be expected to vary by more than the accuracy tolerance allowed by the specification, all measurements for this test shall be normalized to the actual grid voltage at the time of the power reading. By "normalized" we mean that the power readings will be adjusted up or down by the ratio $\frac{Grid\ voltage\ at\ instant\ of\ test\ reading}{Grid\ voltage\ at\ instant\ of\ reference\ reading}$.

Also because of the inherent 20 amp per phase circuit limitation, the CTs used for this test will be changed to 100amp CTs with the load wire *wrapped 5 times* around the CT. The "test circuit" is defined as the grid together with its 3-phase load as shown in Figure 5.14-1.

There are 12 different configurations that have to be measured: 4 for reference measurements and 8 for various configurations of voltage and current. These are delineated in the test sequence section below.

5.14.3 Sequence

1. The general test setup shall be as shown in Figure 5.14-1. This general configuration shall be tailored for each test condition to meet the requirements of the specification as described in the following numbered items.
2. To obtain the reference accuracy for test conditions (1) through (4) connect all meter *voltage* phase inputs to phase A of the test circuit. Also connect the meter phase A CT to the phase A load in the test circuit. Phase B and phase C CTs are terminated and not mounted or measuring any circuit.
3. Record the reference performance for conditions (1) and (3) as shown in the table in section 5.14.3.
4. Record the reference performance for conditions (2) and (4) as shown in the table in section 5.14.3.
5. For each condition including the reference cases calculate the %Error = $|\frac{Xitron\ kW - UUT\ kW}{Xitron\ kW}|$x100 and the % Deviation from the Reference Error = $|\frac{Error\ at\ Reference - Error\ at\ Drive\ Level}{Error\ at\ Reference}|$x100
6. Change the connections to the test setup for conditions (1) and (2). To do this, connect the phase B meter voltage input to the phase B voltage of the test circuit, and the phase C meter voltage input to the phase C voltage of the test circuit. Leave the phase B and C CTs off (disconnected from) any load circuits.
7. Carry out tests for current conditions (1) and (2) as shown in table in section 5.14.4 below.
8. Change the connections to the test setup for conditions (3) and (4). To do this, connect the phase B meter voltage input to the phase C voltage of the test circuit, and the phase C meter voltage input to the phase B voltage of the test circuit. Leave the phase B and C CTs off (disconnected from) any load circuits.
9. Carry out tests for current conditions (3) and (4) as shown in the table in section 5.14.4 below.
10. Change the connections to the test setup for recording the reference accuracies for conditions (5) through (8). To do this connect all meter voltage and current inputs to Phase A of the test circuit.
11. Record the reference performance for conditions (5) and (6) as shown in the table in section 5.14.4.
12. Record the reference performance for conditions (7) and (8) as shown in the table in section 5.14.4.
13. Change the connections to the test setup for conditions (5) and (6). To do this, connect the phase B meter voltage and current input to the phase B voltage and phase B load current of the test circuit, and the phase C meter voltage and current input to the phase C voltage and phase C current input of the test circuit.
14. Carry out tests for current conditions (5) and (6) as shown in table in section 5.14.4 below.
15. Change the connections to the test setup for conditions (7) and (8). To do this, connect the phase B meter voltage and current input to the phase C voltage and phase C load current of the test circuit, and the phase C meter voltage and current input to the phase B voltage and phase B current input of the test circuit.
16. Carry out tests for current conditions (6) and (7) as shown in table in section 5.14.4 below.

Enetics

5.14.4 Results

Record the results of the test measurements in the table below. Take note of 5.14.2 above for normalizing voltage readings before calculating kW values.

Condition	Measured Current	Xitron kW	(UUT kW)	% Error	% Dev. From Reference	Specified % Dev. From Ref.
Ref 1, 3	15	1.800	1.808	0.44%	Reference	Reference
Ref 2, 4	90	10.800	10.835	0.32%	Reference	Reference
1	15	1.800	1.808	0.44%	0.00%	±1.0
2	90	10.800	10.835	0.33%	0.57%	±1.0
3	15	1.800	1.808	0.44%	0.00%	±1.0
4	90	10.800	10.835	0.32%	0.29%	±1.0
Ref 5, 7	8	2.880	2.891	0.38%	Reference	Reference
Ref 6, 8	40	14.400	14.438	0.26%	Reference	Reference
5	8	2.880	2.891	0.38%	0.64%	±1.0
6	40	14.400	14.438	0.26%	0.24%	±1.0
7	8	2.880	2.891	0.38%	0.55%	±1.0
8	40	14.400	14.438	0.26%	0.29%	±1.0

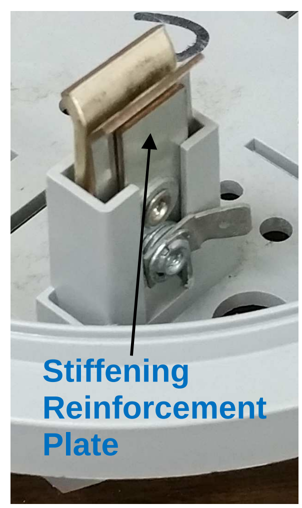
ATTACHMENT D – Safety Considerations

1. All Interfaces to Alternating Current (AC) Voltages are UL Rated and fused:

- Enclosure
- Jaws
- Power Supply

2. LD-1110/1120 Patented Jaw Designs

"In use, the jaw-type receptacle of this invention, owing to the biasing force provided by the spring member, applies an insertion force to the meter blade contact that results in a maximum heat rise well within certification limits of **UL 414** while also passing insertion force tests. The surprising result is that the receptacle of this invention is able to pass such heat rise and insertion force tests after rigorous test procedures involving **repetitive removal and reinsertion** of the blade-like contacts in the receptacle of this invention."



LD-1203

- AC voltages are immediately optically isolated through analog isolators. This means that:
    - ✓ AC voltages up to 600 vAC are reduced to small 5v levels immediately
    - ✓ There is no intermixing of AC voltages with low voltage circuitry
    - ✓ Isolation eliminates any galvanic continuity between AC voltages (the power grid) and the electronics of the device.
- The power supply the provides low voltage DC to the electronics of the device is fully isolated, UL rated, and fused to protect against faults.
- All conductive material such as the front mounting panel is earthed via a terminal block connection to system earth ground.
- CTs used on LD-1203 installations have been independently tested by MET labs (a National Registered Testing Lab (NRTL)) and are UL rated:

NRTL LISTED MET® C US

UL 61010-1
CSA C22.2 No. 61010-1
E113183

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Enetics

ATTACHMENT E – Letter of Intent from National Grid

nationalgrid

300 Erie Blvd West
Syracuse, NY 13202
www.nationalgrid.com

September 14, 2015

Hon. Kathleen H. Burgess
Secretary to the Commission
New York State Public Service Commission
Empire State Plaza
Agency Building 3
Albany, NY 12223-1350

Dear Honorable Burgess:

In accordance with the requirements of the Rules and Regulations of the Public Service Commission of the State of New York, 16 NYCRR, Part 93 – Approval of New Types of Electricity Meters, Instrument Transformers and Auxiliary Devices, National Grid is submitting this letter in support of the approval process for the following Enetics NILM Recorders;

Model
LD-1110 Speed Recorder
LD-1120 Speed Recorder
LD-1203 Speed Recorder

It is our understanding that Enetics is submitting a formal approval request for these devices and this letter is to confirm our intention to utilize these devices in series with our existing solid state metering, if approved.

Sincerely,

Nicholas R. Ritts

Nicholas R. Ritts
Lead Engineer - Electric Meter Standards
National Grid
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