APPLICATION Petition FOR APPROVAL:

S4x Solid-State Meter Family with Gridstream Series 5 RF Mesh IP radio

Matter Number 16-01754

Manufactured by:
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General Information

Applicant

We are proud that we have been in business for over 100 years. The foundation we stand on is strong and the values of Thomas Duncan still pulse through the company.

Our beginnings were set in motion in 1892 when Thomas Duncan developed the first induction watt-hour meter to use a single disk for both the driving and braking element. He followed that invention with the development of a watt-hour meter for the Fort Wayne Electric Corporation (Indiana, U.S.A.) in 1898.

Thomas Duncan settled in Lafayette, Indiana, in 1901 and established Duncan Electric Manufacturing Company, shipping the first meters in 1902.

In 1976 Landis & Gyr AG of Switzerland bought Duncan Electric Company and continued operations in Lafayette, Indiana. Siemens of Germany bought Landis & Gyr's metering division in 1998 and renamed it Siemens PT&D.

After the change in ownership from Siemens AG to KKR & Co. effective September 26, 2002, we became Landis+Gyr again.

We carry on Duncan's style for innovation and development, and the commitment to quality and service that began so long ago.

Centered on the metering needs of our customers and an emphasis on customer satisfaction, Landis+Gyr is concerned with providing the best metering solution in terms of capability, technology and affordability. By uniting our experience and technology with that of our strategic allies and development partners, we provided metering solutions that cover the range of utilities metering needs from residential to Grid applications.

Everyone in our organization is focused on developing and improving processes to meet the highest customer standards for on time delivery of defect free products and metering solutions.

We are up to the challenge of exceeding your expectations…beyond Measure.

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Product Overview

S4x with Gridstream Series 5 radio

The S4x with Gridstream Series 5 Radio advanced function AMI meter provides the utility industry with a reliable, quality, solid-state meter platform with two way Gridstream RF mesh smart grid communication technology. This best-in-class innovative product offers open AMI communications, Demand, TOU, Load Profile, enabling you to manage energy better. The S4x Gridstream enabled endpoint provides reliable and accurate billing data, along with voltage information, alarms, events and power quality information.

Technology

Forms 1s, 2s, 2Se, 3s, 4s, 45s, 36s, 9s, 12s, 12Se, 25s, 25Se, 16/15/14s, 16/15/14Se, and 29s, utilize a single circuit board design mounted at the front of the meter. This allows room for modular Gridstream Series RF Mesh IP AMI communications on all meter forms with the same connection header. Fewer parts and connectors throughout these designs increase reliability and contribute to better overall endpoint performance. Highly accurate load performance and the use of a field-proven Digital Multiplication Measurement Technique ensure reliability and dependability during the entire life of the S4x Gridstream RF meter.

Capabilities

Meter reconfiguration can be accomplished optically through the configuration port located on the front cover or Over the Air utilizing the Gridstream RF Network.

- Select from displayable positive, negative, net and added (security) metrics
- Change the displayed information, order or digits
- Flash Meter Firmware
- Flash Radio DCW
- Preset or reset kWh, KVRH, KVAH
- 6 digit LCD and 3 Alpha ID
- Tilt, Tamper and Temperature alarms

AMI Meter Data

S4x provides direct register interface to Industry Standard ANSI Tables. This allows for direct register reads for energy, demand, including time of use data.

Register Types

–	+kWh	Energy delivered to the load
–	-kWh	Energy received from the load
–	NET kWh	The net energy consumed by the load, or negative kWh subtracted from positive kWh
–	ADDED kWh	Negative kWh added to positive kWh, also referred to as *security* mode
–	Reactive	Both KVRH or KVAH along with KVAR and KVA

Type Designation

S-Base:
- Transformer rated: Class 20, 3S, 4S, 45s, 36s, 9s, and 29s
- Self-contained: Class 200, 1S, 2S, 12S/25S (Network), and 16/15/14S
- Self-contained: Class 320, 2SE, 12/25SE, 16/15/14SE

K-base:
- Self-contained: Class 480, 12K, 16/15/14K, and 27K

Advanced Features

- Active energy kWh/kW/TOU meter
- Reactive Energy KVARH/KVAR, KVAH/KVA
- +kWh, -kWh, Net kWh and added kWh (security)
- Digital multiplication measurement technique
- Non-volatile memory
- Optional KYZ (2 or 4) outputs, and (2) Inputs with AMI
- Designed for 20+ year life
- Certified and tested to the following ANSI standards for performance:
    - ANSI C12.1 - Electricity metering
    - ANSI C12.10 - watt-hour meters
    - ANSI C12.18 – Protocol Specification for Type 2 Optical Port
    - ANSI C12.19 – Protocol Specification for Utility Industry End Device Tables
    - ANSI C12.20 – Electricity Meters – 0.2 and 0.5 Accuracy Classes
    - ANSI C12.21 – Protocol Specification for Telephone Modem Communication
    - CAN3-C17-M84 Canadian specifications for approval of type of electricity meters
    - CAN3-Z234.4-79 Canadian specifications for all-numeric dates and times
    - IEC 687 - Electrical Specifications
    - FCC Class B Emissions
- Utilizes ANSI protocol (between meter and AMI device)
- 9-digit LCD
- 4 x 1, 4 x 10, 5 x 1, 5 x 10, 6 x 1 or 6 x 10 metric display format
- Display scroll sequence programmable (factory or end user)
- Configuration port (cover does not have to be removed)

– Power consumption indicator (DRI, DPI)
– Custom meter configuration

Cover Options for the S4x Advanced Function Meter

DIGIT 6	DIGITS: "00", "01", "AA", "AB", "AC" & "AD" S4x HWV2 -0PAC RELEASE FOR THE FOLLOWING 7TH & 8TH AMR/AMI DIGITS: "AE", "AF", "AG", "AH", "DA" & "EA" **COVER TYPE for S4x Hardware Version 2, (S, A & K-Base)** **NOT INTERCHANGEABLE w S4x Hardware Version 1**	
Smoke, Translucent Polycarbonate Cover with Clear Window		
H **–Default**	Smoke Translucent (not opaque), Optical Port, Reset SEE RELEASE LIMITATIONS ABOVE	72515-9
J	Smoke Translucent (not opaque), No Optical Port, No Reset SEE RELEASE LIMITATIONS ABOVE	72515-10
K	Smoke Translucent (not opaque), Optical Port, Only SEE RELEASE LIMITATIONS ABOVE	72515-11
L	Smoke Translucent (not opaque), Optical Port, Keylock Reset SEE RELEASE LIMITATIONS ABOVE	72515-12

Technical Specifications

Self-Contained Meter Forms

Form	Class	Test Amps	Volts	Wire	Kh
1S	200	15	120-480	2	3.6
2S	200	30	240-480	3	7.2
2SE	320	50	240-480	3	12
12S	200	30	120-480	3	14.4
12SE	320	50	120-480	3	14.4
25S	200	30	120-480	3	14.4
25SE	320	50	120-480	3	14.4
16/15/15S	200	30	120-480	4	21.6
16/15/15SE	320	50	120-480	4	21.6

Transformer Rated Meter Forms

Form	Class	Test Amps	Volts	Wire	Kh
3S	20	2.5	120-480	2	.6
4S	20	2.5	120-480	3	.6
45S	20	2.5	120-480	3	1.2
36S	20	2.5	120-480	4	1.8
9S	20	2.5	120-480	4	18
29s	20	2.5	120-480	4	1.8

Product Measurements

	Net	Single Pack	Single Pack	Four Pack	Four Pack
Form	**lbs.**	**Weight**	**Dimensions**	**Weight**	**Dimensions**
1S	2.2	3.14 lbs.	9 ¾" x 8 ¾" x 9 ¼"	10.7 lbs.	16.5 x 15 x 7 ½
2S(E)	2.3	3.18 lbs.	9 ¾" x 8 ¾" x 9 ¼"	10.8 lbs.	16.5 x 15 x 7 ½
12K	3.8	5.90 lbs.	14" x 13" x 9"	N/A	N/A
45S	2.3	3.23 lbs.	9 ¾" x 8 ¾" x 9 ¼"	10.8 lbs.	16 x 15 x 7 ½
16/15/14S	2.5	3.28 lbs.	9 ¾" x 8 ¾" x 9 ¼"	11.2 lbs.	16 x 15 x 7 ½

LCD Display

The S4x display shows the digital power indicator, nominal service voltage and kWh digits. Instantaneous voltage and meter error codes can also be displayed. The LCD has a high contrast that allows visibility from 6-foot and from a 150-degree right-to-left angle. The LCD accommodates a 6-digit format, including decimal points between digits, along with a three-digit alphanumeric indicator, available through programming.

The following display enunciations are available:

- Meter/AMI Module/optical communications indicator
- DPI (Digital Power Indicator)
- Alternate and test mode indicator
- Current TOU rate indicator
- EOI (End-of-Interval) indicator
- Service Voltage (120V, 240V, 277V, 480V)

The active digital power indicator (DPI or "caterpillar") segment check illuminates all LCD billing digit segments without affecting the DPI segments. This permits a user to use the DPI for timing when a segment check is being displayed during a scroll sequence.

A two character programmable alphanumeric label can be associated with each display except the active DPI segment check, which has all segments in the alphanumeric field, illuminated. This two-character field is used to identify the energy displayed. It can be left blank if desired.

Configuring the Meter

The ability to configure the meter is provided through a secure meter configuration port. A cover mounted optical configuration port accommodates meter configuration by the user. The configuration port is designed to be used in a meter shop ambient environment, requiring that

it function in a room temperature environment under room ambient lighting conditions. The configuration port interface supports a read/write security function.

OTA (Over the Air Configuration) can be accomplished utilizing the Landis +Gyr Command Center Head end AMI system. Meters are able to partially or fully re-programmed and allow for optional retention or register reads or resetting to zero. Additionally, OTA functionality allows for firmware and DCW changes to done without impact to the billing registers. The S4x meter provides memory to store the new firmware/DCW and options to implement immediately or at a future date. These features ensure customers assets are future ready for many years to come.

Initial Power-up and Operation
S4x meters can be factory programmed or programmed by the customer utilizing Landis+Gyr 1132 software.

Display Multiplier
The user has the ability to program a display multiplier. KWh values contained in the energy registers are multiplied by the display multiplier prior to being displayed in the LCD. The display multiplier does not affect the contents of the internal energy registers. If direct reading is desired on transformer rated installations, it can be accommodated via this programmable multiplier.

The display multiplier multiplies the displayed energy value(s) by N for $1<N<240$. N is an integer value.

AMI Technology for the S4x Family of Meters

Gridstream Series 5 RF mesh IP

Landis + Gyr Gridstream Networks creates the critical networking infrastructure for the Smart Grid, known as a Smart Energy Network. Based on the Internet Protocol (IP) suite, it addresses the challenges of running multiple applications and devices on a common networking infrastructure using multiple transport technologies, dramatically improving efficiency, lowering costs and ensuring the reliable delivery of services. This smarter, more efficient grid could cut the growth rate of worldwide energy consumption by more than half over the next 15 years and drastically reduce carbon emissions.

The Gridstream RF Mesh Network Solution

The Landis+Gyr Gridstream RF Mesh solution is industry leading and field proven. More than 30 million Gridstream RF Mesh two-way endpoints have been contracted and/or deployed at Tokyo Electric Power, Light, and Ameren Illinois. The Landis+Gyr Gridstream RF Mesh solution is standards-based and interoperable. It features end-to-end security, incorporating industry standards and best practices. This combination of experience and technical capabilities assures that Landis+Gyr and the Gridstream solution will meet or exceed all foreseen Smart Grid Requirements.

- Two-way AMI metering solution with our advanced S4x meter platform featuring
- Disconnect/reconnect capability for residential metering applications.

- A powerful yet simple RF mesh network design with complete "plug-and-play".

- Network management capabilities are streamlined through an interface for network alarm and event management and for broadcast capability.
- A powerful, robust, feature-rich Command Center AMI head end application for secure meter data.
- Diagnostic data acquisition and network management. Browser and standards based option to utilize the most economical and available IT server platforms available.
- Open standards platform with vision for future Smart Grid requirements.
- Standard NIST based and optional advanced security features

Landis+Gyr Inc. Calibration Test Procedures

Calibration Verification and Testing

Calibration of voltage, current and phase angle of the S4x watthour meter is accomplished through calibration constants stored in non-volatile memory. These constants cannot be changed, except by recalibration at the factory.

Verification of Watt Calibration

FOCUS calibration may be verified using standard testing procedures via the calibration LED output. The watt calibration LED is the left LED located inside the optical configuration port on the face of the meter. The calibration test probe for detecting the output pulse is attached to or held against the cover in front of the optical port. The infrared output pulses from the LED can be changed via the 1132 PROG/COM programming software. The optical LED output pulse rate can be selected to be either 1 pulse per complete DPI transition on the LCD (standard), 6 pulses per a complete DPI transition or 12 pulses per transition.

Calibration LED

The FOCUS has an infrared light emitting diode (LED) that emits energy pulses. The calibration LED is deactivated 24 hours after the meter powers up. Once reactivated, the calibration LED remains active for 24 hours.

The calibration LED is accessible from the front of the meter cover. The user can fix an LED pickup device to the front of the meter.

The calibration LED produces stable pulses in no more than five seconds following meter power up.

The calibration LED produces pulses in response to energy whether it is delivered to the load or received from the load.

Registration verification testing requires no less than 30 seconds at full load.

The calibration LED is visible in meter shop lighting and room temperature conditions.

Test Times

The minimum test time required to obtain accurate verification of FOCUS calibration for the Watthour metric at Test Amps is at least 40 seconds @ unity Power Factor. This test time holds for all PF and TA values.

When testing calibration, the test board being used should have a 12 second settling time programmed. This will allow 12 seconds for the calibration pulse output to stabilize after the current has been applied.

Field Testing

This can be performed by one of two standard methods, depending upon the degree of accuracy required. A stopwatch may be used to time DPI transitions (as historically performed on the rotating disk in electromechanical meters) while under a known load. Calibration testing may also be performed with more accuracy by removing the meter from service, applying a known load, and testing pulse outputs against a watthour standard as is performed in the meter shop.

Pass/Fail Calibration Limits*

SFL +/-0.15
SPF +/-0.30 relative to SFL
SLL +/-0.2 relative to SFL

*Please note, these limits are currently applied to all FOCUS forms.

Frequently Asked Questions

1. What is your procedure for testing and calibrating electronic meters?

Landis+Gyr tests and calibrates all solid-state meters at 120V, at test amps (TA), 60 degree lagging power factor at TA and at 10% of TA.

For a self-contained 200 amp rated polyphase meter this would be:
- 120V, 30A unity power factor
- 120V, 30A 60 degree lagging power factor
- 120V, 3A unity power factor

2. **Upon what reference standard(s) do you base your calibration practices?**

Landis+Gyr uses WECO test racks for all solid-state meters. WECO test racks contain Radian RM-10 standards for performing watt-hour comparisons. Landis+Gyr has found Radian standards to be the most stable and accurate standards available.

3. **What is your procedure in determining the measurement uncertainty of your testing and calibration practices?**

   Landis+Gyr tests the factory calibration racks monthly. The calibration racks accuracy is verified using RM-11 transfer standards. The WECO racks are yearly certified for accuracy

4. **What is the total measurement uncertainty of Landis+Gyr's laboratory?**

   The RM-11 transfer standards used by Landis+Gyr have a manufacturer's maximum error specification of 0.02% error. The manufacturer's specified typical error is below 0.005%. We have found their error to be within the typical 0.005% for our internal accuracy transfers between test rack and master reference.

   The RS-703 master reference standard has a manufacturer's maximum error of 0.005% unity, 0.01% power factor traceable to NIST. Its typical error specified by the manufacturer is 0.0005% (5 ppm). The RS-703 is calibrated annually by the manufacturer who is traceable to NIST.

5. **How does Landis+Gyr ensure a high standard of accuracy in meters?**

   All meters are 100% calibrated and tested. The test results from our automatic calibration/test racks are recorded on our company database server. Our shipping department is tied into the same database. Our company wide software does not allow a meter to ship that has not been tested and found to pass all testing.

6. **What is Landis+Gyr's optimal calibration tolerance before deciding that the meters are ready for delivery?**

   Calibration is performed under computer control on our WECO calibration racks. No human interaction is involved for calibrating a solid-state meter.

   Landis+Gyr requires the accuracy of a solid-state meter to be within +/- .15% on our calibration racks. Meters outside of this limit are rejected. However, the majority of our meters are well within +/- 0.05% limits.

Landis+Gyr Quality Practices

Landis+Gyr Meter Quality Control Process

In-Process Verification

As part of the normal manufacturing process of the meter, each operator is required to perform a visual verification process. This process checks for Critical to Quality Features (CTQ's) based on the operation(s) performed on the meter just prior to the operation being performed. This assures that two sets of eyes have performed the visual inspection, one during the assembly operation and one in the subsequent operation. This also assures that any defects are detected as early in the process as possible.

Calibration

The following steps are performed during the calibration operation:

1. If a customer program is required, it is loaded to the meter optically.
2. Three-phase calibration is performed on the meter. Series Full Load (SFL), Series Power Factor (SPF), Series Light Load (SLL) and single element Full Load and Power Factor calibration results are written to the meter.
3. Functional Testing is performed on options such as KYZ and Modems. In the case where the meter requires additional RAM, the calibration rack tests for presence and proper size of the ram with respect to the catalog number scanned at the beginning of the calibration operation.

First Piece Quality Check

Please note, a first piece audit is performed on all meters requiring a specific customer program.

The first piece quality check is basically the same process performed at audit. However, special attention is focused on peculiar customer options and programs. This is the point where a printout is made of the data from the customer program and compared with the master customer program book.

Upon the completion of this process, manufacturing is notified with the results and the first piece audit is documented on the first piece log maintained at the audit station.

Meter Audit

The following steps are performed as part of the meter audit process. Presently, meters are audited 100%.

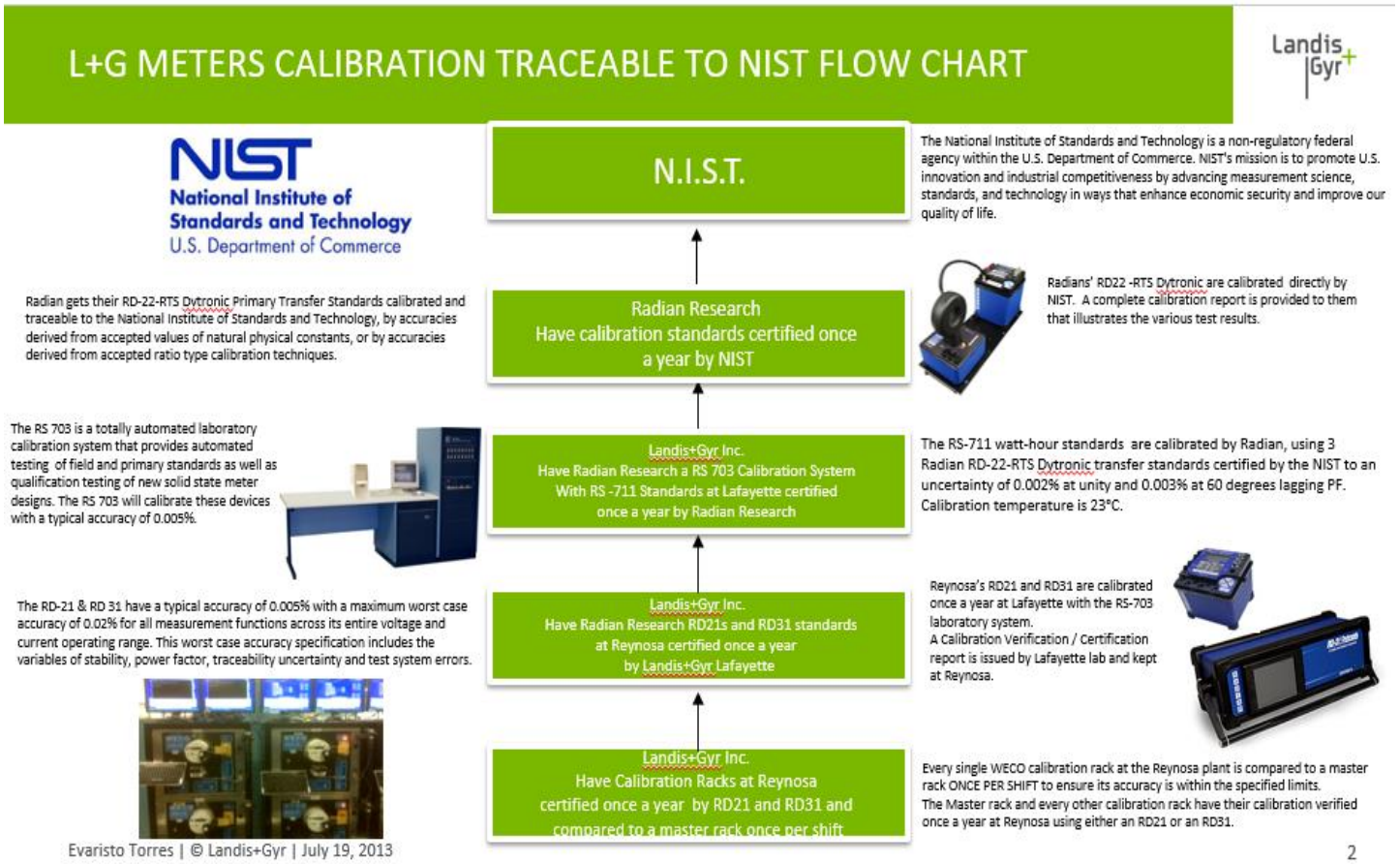
1. Verify that the nameplate information is correct
2. Verify that all the special customer requirements are met by comparing meter configuration with that of the Bill of Materials (B.O.M.) and the Catalog Document.
3. Read out meter program information and compare with that of the First Piece Audit printout.

4. Verify correct factory data such as Class, Form and Firmware Revision.
5. Verify meter configuration by comparing Program ID with Master Program Book and assuring program data as well as display configuration is correct.
6. Check 3 Phase calibration data written to the meter from the calibration operation. Compare to calibration limits table found in applicable audit work instruction.
7. Perform Single Phase Full Load Calibration check and compare results to tolerances identified in applicable audit work instruction.
8. Test options as applicable
9. Reset Kwh to zero.

Applicant Test Procedure

The S4x solid-state, electricity meter has been thoroughly tested and meets ANSI standards. Please note the following:

- All ANSI testing has been conducted by personnel with thorough practical and theoretical knowledge of the meters and adequate training in making precision measurements.
- The test equipment employed in these tests conforms to the applicable requirements specified within Standards and Standardizing Equipment, of the latest version of ANSI C12.
- The accuracy of the test equipment has been established by comparison with standards whose accuracy is traceable to the National Institute of Standards and Technology. The following Process is utilized by Landis + Gyr.



ANSI Test Documentation

The following ANSI C12 tests were passed by S4x:

- No Load
- Starting Load
- Load Performance
- Effect of Variation of Power Factor
- Effect of Variation of Voltage
- Effect of Variation of Frequency
- Equality of Current Circuits
- Effect of Internal Heating
- Effect of Variation of Ambient Temperature
- Effect of Relative Humidity
- Effect of Operating Temperature
- Effect of Temporary Overloads—Accuracy
- Effect of Temporary Overloads—Mechanical Structure and Insulation
- Effect of Current Surge in Ground Conductor
- Weather Simulation Test
- Salt Spray Test
- Raintightness
- Insulation
- Voltage Interruption Test
- Static Turn on/Turn off
- Incremental Power Cycling
- Overvoltage Withstand
- Electrical Fast Transient/Burst
- Surge Withstand Capability
- Effect of High Voltage Line Surges
- Effect of Radio Frequency Interference—Basic Radiation Susceptibility Test
- Effect of Radio Frequency Interference from Hand-Held Transmitter
- Radio Frequency Conducted and Radiated Emissions Tests
- Effect of Electrostatic Discharge (ESD)
- Effect of External Magnetic Field
- Configuration Port Communications at Temperature Extremes
- Configuration Port Communications in Sunlight
- AMR Serial Bus Communications at Temperature Extremes
- Mechanical Shock
- Vibration
- Transportation Drop
- Transportation Vibration
- Potential Terminal Contact Resistance
- PCB-Level Environmental Stress Screening (ESS)
- Baseplate Assembly
- Mounting Device Insertion

- Blowing Sand Evaluation
- Baseplate T-Seal Hole Strength
- Visual Display
- LCD Visibility Over Temperature
- Meter Assembly/Disassembly
- Internal Meter Losses
- Temperature Rise
- Internal Temperature Profile

ANSI Certified test results

Landis + Gyr has contracted with MET labs for ANSI Meter Certification. It is recognized as electricity sub meter testing laboratory for the Public Service Commission of Maryland and New York State Department of Public Service. Report of Compliance is to be provided By MET labs based on the established guidelines between NYPSC and Met labs.

Product Documentation

Spec sheet provided: PS_E650S4x.pdf
Manual Provided: S4X072016.pdf