1. **Administrators** have full access to all activities in the system. This includes all activities of the other users as well as the ability to administer users and system activities such as archiving data.

2. **Operators** can perform operations on devices. This includes the abilities to add, change, and delete devices and schedules. Most of the modifications to device configuration include the execution of commands over the air to the devices.

3. **Analysts** can run reports and exports in the system as well as view the monitoring functions. Analysts cannot send commands to devices.

4. **Contacts** are not actual users of the system and cannot log in. They can receive email notification of certain events.

- **Device Verification.** TMS is aware of those devices that should be reporting to it. If a message is received from a device outside of those registered, a message is logged as an alien message.

Enterprise Network Security: TNMP connectivity to SmartSynch's TMS & AT&T's Servers

The enterprise communications path for TNMP's AMS will be from the Smart Meter Texas portal to TNMP's back-office system (specifically the Meter Data Management System) which communicates to SmartSynch's TMS system. TMS sends and receives data from the AT&T servers which manage the AT&T cellular network. Messages sent to meters utilize a mailbox on the AT&T Server. The TMS system initiates a TCP/IP socket connection from inside the utility's firewall out to the AT&T Server in order to open the mailbox with an ID and password. TMS then polls the mailbox on the AT&T Server to see if any messages are available. Any messages are passed through the socket connection to TMS, which securely relays the data back to TNMP's MDMS.

Security Summary

The TNMP AMS utilizes several layers of distributed security to minimize the potential of unauthorized access to meter data. In addition, none of the messages actually provide identifying information of a device. Therefore, without access to a utility's billing system, there is no way to link a message to a particular customer.

Decommissioning

The most important cyber security risk is the unintended release of sensitive non-public data through the careless disposal of media and/or assets. TNMP's parent company PNMR, has an established a Media and Asset Disposal policy which outlines specific requirements that must be met for the secure disposal of PNM Resources media or equipment that contains sensitive non-public information.

a) Media or equipment that is known or suspected to contain information that may be associated with current/pending litigation or used in forensic activities must not be destroyed or released from PNM Resources control.

b) Media shall be disposed of securely when it is no longer usable, when the information contained on the media has no value, or when there is no legal reason to keep it.

c) Systems, network components, and storage media shall be purged of all PNM Resources information before being released from PNM Resources control to third parties for sale, lease return, donation, or salvage. Information on the magnetic media shall be rendered unrecognizable (purged/sanitized) prior to release.

d) In the event that PNM Resources cannot perform the required purging prior to the media being released from PNM Resources control, agreements must be in place with the receiving third party to perform and certify the required destruction.

e) If the media is not destined for maintenance, reuse, or salvage, it may be destroyed in lieu of being purged.

f) Under no circumstances shall deleting files or formatting the drive be considered an acceptable form of rendering magnetic media unrecoverable.

Security Inspection(s) or Audits

Security of TNMP's AMS infrastructure will be audited using both PNMR's internal and third-party security resources. Audits of security configurations and activity logs will be performed on several levels. Controls for review of access and alert logs will be maintained, and internal audits of these activities will be performed regularly. In addition, bi-annual third party audits of controls will also be conducted in accordance with current security practices. All audits will be conducted in accordance with published industry standards including those of NIST Computer Security Division, ISO/IEC 27001 & 27002, and NERC CIP 002-009[6].

Q. PLEASE SUMMARIZE WHY THE SELECTED COMMUNICATIONS TECHNOLOGY WILL WORK FOR TNMP'S SERVICE TERRITORY.

A. TNMP's selected technology is not a revolutionary approach to remote meter reading. It's an outgrowth of Moore's Law, where technology becomes available at cheaper prices every 12-18 months. The technology selected by TNMP has been used in the Commercial and Industrial (C&I) metering space for several years. C&I meters have been deployed and read remotely using Plain Old Telephone Service (POTS). Itron's MV90 product was created specifically for the purpose of reading C&I or Interval meters remotely. SmartSynch has replaced the POTS service with cellular technology and then built hardware that can be inserted into a meter, much like a communications card into a computer. With Cellular Carriers now actively embracing this technology and approach[7], the pricing for using cellular service is now as cost effective as traditional meter reading in urban/suburban areas and much cheaper than traditional meter reading methods in rural areas.

This technology is already widely deployed in Europe. Bern Insight, European Analyst firm, projects that by 2014 EU Countries will have installed 10M GPRS based meters. Norway/Finland deployment is expected to add another 10M to that total.

The Smart Synch technology is deployed in 120+ clients in North America as listed in Table GK 2. TNMP has been using this technology in the AMS meter trial for 18 months and is achieving a 99.9% first time read success rate. TNMP is currently using all of the AMS meters in the trial as production meters, providing daily 15-minute usage data, connects and disconnects, re-reads, and tamper detection. TNMP's experience is that once installed, these meters can go into production within a couple of hours. This technology requires no network build-out and limited network testing as it uses existing AT&T cellular network technology and footprint.

[6] Exhibit GLK-6

[7] Exhibit GLK-9

Table GK 2 lists 125 utilities that have deployed all or some portion of a SmartSynch GPRS meter solution within their service territories. In some cases, the deployed solution was for 2-way read of Commercial and Industrial meters, and in other cases utilities deployed a solution for "hard-to-reads" and remote meters. In all cases, the deployed solution utilizes similar technology and architecture as the proposed TNMP solution.[8]

Table GK 2 - Utilities deploying similar AMI solutions

4-County Electric Coop	Erie Thames	New Hampshire Electric	Southern Company : Southern Company Services
Ameren	Essex Power Services	Niagara Falls Hydro	Southern Company: Alabama Power
American Electric Power (AEP)	Exelon (ComEd)	Niagara Mohawk Power Corp. (NIMO)	Southern Company: Georgia Power
Austin Energy	Festival Hydro Inc.	Niagara on the Lake Hydro	Southern Company: Gulf Power
Austin International Inc	FirstEnergy	Niagara Peninsula	Southern Company: Mississippi Power
Baldwyn County EMC	Florida Power & Light (FPL)	NSTAR	Southern Pine EPA
Baltimore Gas and Electric	Fortis Ontario : Cornwall Electric	NYSEG	Southern Rivers Energy
Blue Ridge Electric Coop	Fortis Ontario : Westario Power Inc.	Omaha Power Public District	Southwest Mississippi Electric Power Assoc.
Canadian Niagra Power	Georgia Systems Operation Co	Orlando Utilities Commission	St. Thomas
Central Florida Electric Coop	Gila River Community Utility Authority	Pacific Gas and Electric (PG&E)	SunRun, Inc
Central Iowa Power	Goderich Hydro	PacifiCorp	Tampa Electric Co.
Choctaw Electric Coop	Greystone Power Company	Pennsylvania Power & Light (PPL)	Tennessee Valley Authority

[8] Exhibit GLK-8

Citizens Electric	Grimsby Power Inc.	Portland General Electric	Tillsonburg (Town of)
City of Anaheim	Haldimand Hydro	Potomac Electric Power Corp. (PEPCO)	TNMP (AMS trial)
City of Griffin	Halton Hills Hydro Inc.	PowerDash LLC	Toronto Hydro
Clark County REMC	Hydro One	PowerStream	Trico Electric Cooperative Inc.
Clark Public Utilities	Hydro Ottawa	Progress Energy	Tucson Electric
Clay Electric Coop	Hydro Quebec	Public Service Electric and Gas (PSE&G)	University of Colorado
COBB Energy	Imperial Irrigation District	Puget Sound Energy	University of Mississippi
Collingwood Hydro	Indyne, Inc. (Cape Canaveral Air Force Base)	Reliant Energy	University of Mississippi Medical Center
Connecticut Power & Light	Jackson EMC	Roseville Electric	Utility Specialists, Inc.
Consolidated Edison of NY	Jamaica Public Service	Salem Electric	Veridian
Consumers Energy Coop	Kitchener-Wilmot	Salt River Project	Wabash Valley Power
Delmarva	Lockhart Power	San Diego G & E	Wasaga Distribution
Dominion	Los Angeles Department of Water and Power (LADWP)	Santee Cooper	WE Energies
DTE Energy	Madison Gas & Electric	Sawnee EMC	Welland Hydro
Duke Energy	Memphis Light Gas and Water	SCANA (SCE&G)	West Perth
Energycom Networks	MidAmerican Energy	SMUD	Whitby Hydro
Enersource	Midland Power Cooperative	Snapping Shoals EMC	Woodstock Hydro
Entergy	National Grid	Southern California Edison (SCE)	Xcel Energy

In summary, data over cellular is a proven technology with a high reliability and repeatability factor. The network infrastructure associated with communications of meter data is now maintained and managed by AT&T, a company whose core business is the success and quality of that network. The use of these public networks, run and maintained by large Carriers, allows TNMP to avoid the cost and responsibility of maintaining a private network, and still be allowed to take advantage of AT&T disaster recovery mechanisms[9]. TNMP's cost burden for AMS is reduced by not having to bear the maintenance and repair costs for the AMS communications infrastructure or cost of disaster recovery for that infrastructure.

As TNMP will use data over cellular to provide transport of meter data, there will be a cellular data plan associated with each GE I210+c installed in the field. The data plan for TNMP will be arranged with AT&T to provide 1 Megabyte (MByte or MB, where one byte = 8 bits) of data transported each month bi-directionally for each meter. TNMP's plan is a "bucket" plan of 240MB, paid for monthly. TNMP is responsible for overages against the total plan, but not individual meters. TNMP will monitor usage for each individual meter to network performance, bandwidth consumption, and conformance to market rules on "pinging" the meter. Individual meter overages will be assessed to the offending REP via a new tariff as a method to manage bandwidth and enforce market rules.

The GE I210+c meter, using SmartSynch's communications board, is extremely efficient in compression and transmission of data. The meter data uses about 1.1 kilobytes (kBytes or kB) of data for each transmission. A standard transmission is one day's worth of data at 1.1 kB for 96 increments of 15-minute data. A meter "ping" is also about 1.1 kB of data.

Q. PLEASE DISCUSS HOW TNMP CAN TAKE ADVANTAGE OF AT&T DISASTER RECOVERY MECHANISMS.

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[9] Exhibit GLK-5

A. AT&T has a comprehensive and extremely mobile disaster recovery solution. As part of my testimony, I have attached exhibits[10] from AT&T's Disaster Recovery Webinar which provides summary overview of their Disaster Recovery capabilities and some examples of the response to Hurricane Ike and 9/11 in New York City.

Functionality of the TNMP AMS network during a disaster event would be compromised to some extent with regard to priority-of-service and possible outage of cell towers, affecting coverage. During a disaster event, as depicted in the attached exhibit[11] from the Webinar, AT&T will roll a large contingent of trucks to an area to re-establish cell coverage in the affected geographies. This is done using mobile cell towers, placed in strategic locations. Satellite service is also utilized for voice and data should there be extensive damage to the cell network. Once emergency service is restored, first responders and public safety will always have first priority in utilization of AT&T disaster resources. However, as a utility customer for AT&T with a private network, the AMS would have access to unused bandwidth during the evenings to collect meter data. As normal service is restored by AT&T, TNMP's AMS would resume normal operations.

By utilizing the AT&T network as our communications backbone, TNMP avoids the building and maintenance costs of the infrastructure of a private network dedicated to AMS, as well as the capital and O&M costs of repair during and after a disaster. These factors allow TNMP to lower overall costs during a disaster event and positively affect any ensuing proceeding to recover those AMS repair costs.

V. VENDOR SELECTION

Q. PLEASE DESCRIBE THE AMS VENDOR SELECTION PROCESS.

A. Vendor selection was accomplished via the Request for Proposal (RFP) process issued by PNMR's supply chain organization. An RFP was released to five of the AMS vendors currently doing business in the market. Three vendors responded with questions, and two submitted proposals. The process was managed by PNM Resources Supply Chain organization and supported by TNMP operations, PNMR Regulatory and PNMR

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[10] Exhibit GLK-5

[11] Exhibit GLK-5

Business Technical Services groups. Proposals were evaluated on requirement conformance, technical merit, and submitted costs.

Q. WHAT WAS THE OBJECTIVE OF THE REQUEST FOR PROPOSAL?

A. The purpose of the proposal was to acquire a solution that meets the requirements of Substantive Rule §25.130 and could be implemented to meet all AMIT market use cases. In addition, TNMP wanted an AMS solution that would provide long term functionality without the burden of maintenance and management of AMS communications infrastructure, and which would provide a cost effective solution for rural and remote areas of the service territory. As TNMP is a highly capital constrained utility, effective use of O&M monies and Capital is of priority concern to management. Core business drivers for this solution were, and still are:

- Meet all requirements outlined in PUCT Substantive Rule §25.130.
- Meet all requirements generated by the PUCT AMIT meetings.
- Avoid building, designing, and maintaining a private network.
- A wireless network is preferred, with no or few Utility owned or operated assets.
- Wherever possible, use of utility or public network assets is preferred, preferably IP based.
- Avoid the use of public frequencies for reasons of security, bandwidth, and future spectrum clearing.
- Minimize network costs; ensure optimal use of network bandwidth for meter data
- Simple installation "Plug & Play" hardware. Flexible solution options.
- Modularized technology approach to minimize stranded assets and "future-proof" investment.
- Support of multiple meter vendors; no single source.
- Secure and reliable transactions; repeatable and measureable 99% first time read success.
- In-field meter and network diagnostic capabilities for troubleshooting.

- Communications framework that will support Smart Grid technologies at low lifecycle cost.
- Proven existing technologies with proven network protocols and architecture.
- Products that can support TNMP's service area geography, particularly very desolate meter locations.

Q. ONCE THE BIDS WERE RECEIVED, HOW WERE THEY EVALUATED?

A. Two teams were created: Core evaluation team and a Management evaluation team. The proposals were evaluated against TNMP business requirements, PUCT requirements, AMIT use case requirements, technical capabilities, financial soundness, vendor capability, vendor financial fitness, and proposed costs. Each proposal was scored against the requirements and cost evaluations. Vendor references were contacted and evaluated. Significant research was done on the vendor's products using blogs, internet research, and industry information about vendors' ability to deliver product and solutions. Then, as there were not large differences in costs, final selections from the core evaluation teams were done on technical merit and capability. The recommendations were passed to the management evaluation team, which reviewed the presentations from the core team, with the final selection made by the management team.

Q. WHAT FURTHER PROCEDURES WERE USED AFTER THE SHORT LIST OF PROPOSALS WERE SELECTED?

A. As there were only two responses, no short list was created.

Q. HAS TNMP ENTERED INTO THE CONTRACT FOR THE AMS?

A. At this time, TNMP has negotiated terms and conditions with SmartSynch, but no specific contract or statement of work for an AMS implementation. TNMP is not under contract for an MDMS vendor.

Q. IF TNMP HAS NOT ENTERED INTO CONTRACTS, IS TNMP PLANNING TO ENTER INTO CONTRACTS DUE TO THIS FILING?

A. Yes. It is TNMP's intention to complete contract negotiations with all major suppliers associated with providing software, hardware, and services necessary to complete this project. Specific negotiations will be completed by PNM Resources Supply Chain organization in behalf of TNMP.

Q. WHAT PROCESS DID TNMP USE IN SELECTING A CONTRACTOR FOR METER INSTALLATION?

A. The selected vendor, SmartSynch, contacted five industry experienced meter installation vendors. Each vendor was provided identical deployment requirements and asked to respond in writing with their respective implementation approach, deliverables, and price. Upon receipt of responses from all five vendors, they were asked to present their response to TNMP and SmartSynch, whereby they were scored and their response and experience weighted. With the field of five narrowed to the top two, a Scope of Work was provided by SmartSynch, outlining the requirements and best practices required for deployment, and both vendors were invited to provide best and final response and pricing. Upon receipt of their best and final responses, each of the two vendors were invited to present a second time to SmartSynch and an expanded TNMP management team, where their responses and experience were scored. A mutual decision for vendor of choice was made by SmartSynch and TNMP.

VI. ADVANCED METER CAPABILITIES

Q. WHAT ARE THE FUNCTIONALITIES OF THE ADVANCED METERS INCLUDED IN TNMP'S AMS DEPLOYMENT PLAN?

The selected GE I210+c meter incorporates the appropriate technology and firmware to meet all of the functionality described in Substantive Rule § 25.130(g). A manufacturers technical and users manual is included as an exhibit[12] to corroborate listed technology and functionality.

The table below lists each requirement of Substantive Rule § 25.130(g) and the technology embedded in the TNMP AMS and/or meter which enables the AMS to meet the rule requirement:

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[12] Exhibit GLK-2

Rule	Functionality	AMS Technology
(A)	Automated or remote meter reading;	The AMS provides a remote communications path using a cellular network and an embedded communication card within the GE I210+c meter.
(B)	Two-way communications;	The SmartSynch communications card provides GPRS communications using AT&T Cellular network.
(C)	Remote disconnection and reconnection for meters rated at or below 200 amps;	A 200 amp disconnect switch is built into the GE I210+c meter and is activated remotely from a head end server.
(D)	The capability to time-stamp meter data sent to the independent organization or regional transmission organization ("RTO") for purposes of wholesale settlement, consistent with time tolerance standards adopted by the independent organization or RTO;	The meter timestamps data in GMT format, consistent with RTO requirements and utilizes an atomic clock for time synchronization.

Rule	Functionality	AMS Technology
(E)	The capability to provide direct, real-time access to customer usage data to the customers and the customer's REP, provided that: Hourly data shall be transmitted to the electric utility's web portal on a day-after basis. The Commission Staff using a stakeholder process, as soon as practical shall determine, subject to Commission approval, when and how 15-minute interval recorder data shall be made available on the electric utility's web portal;	The AMS provides 115kbps access to the meter over a cellular GPRS connection. Hourly data is collected in the meter storage and transmitted to the utility on a daily basis. It is then processed and uploaded to the SMT webportal in accordance to the AMIT use cases currently under development.
(F)	Means by which the REP can provide price signals to the customer;	The AMS utilizes the cellular network to deliver a price signal to the meters Zigbee hardware, which is then broadcast to the customer's Zigbee device as defined in the developing AMIT HAN use cases.
(G)	The capability to provide 15-minute or shorter interval data to REPs, customers, and the independent organization or RTO, on a daily basis, consistent with data availability, transfer and security standards adopted by the independent organization or RTO;	The AMS meter can collect 5 or 15-minute data for transmission to the head-end system on a daily basis.

Rule	Functionality	AMS Technology
(H)	On-board meter storage of meter data that complies with nationally recognized non-proprietary standards such as in American National Standards Institute (ANSI) C12.19;	GE I210+c meters store meter data tables in ANSI 12.19 format. This is stated on page one of the GE Energy | GEH 7101 Users manual for the GE I210+c meter.
(I)	Open standards and protocols that comply with nationally recognized non-proprietary standards such as in ANSI C12.22, including future revisions thereto;	The AMS had been selected because it supports open standards from the meter to the back-office. ANSI C12.22 will be implemented as available from SmartSynch.
(J)	Capability to communicate with devices inside the premises, including, but not limited to, usage monitoring devices, load control devices, and prepayment systems through a home area network, based on open standards and protocols that comply with nationally recognized non-proprietary standards such as ZigBee, HomePlug or the equivalent; and	The SmartSynch communications board, installed inside the GE I210+c meter, utilizes 802.15.4 protocol, which is currently used in the Zigbee and 6LoWiPAN communications stacks. The deployed meters will utilize a Zigbee SE1.0 compliant stack to communicate with in premises devices.
(K)	The ability to upgrade these minimum capabilities as technology advances and, in the electric utility's determination, become economically feasible.	The GE I210+c is fully "over-the-air" (OTA) firmware upgradable, including the hardware used to provide in premise communications.

Q. DO THESE ADVANCED METERS MEET THE TECHNOLOGICAL REQUIREMENTS OF PUC SUBSTANTIVE RULE § 25.130(g)?

A. Yes, the advanced meters to be deployed by TNMP pursuant to its AMS Deployment Plan provide the capabilities that comply with the AMS requirements outlined in Substantive Rule § 25.130(g). There are, however, certain customer types and meter types where exceptions to those requirements are appropriate, and we are requesting in this proceeding a waiver which would relieve us of the obligation of installing a fully functional advanced meter that would have all of the functionalities contemplated by §25.130 in those circumstances. We are requesting waivers for the following circumstances:

- Loads that may cause a safety or health issue if disconnected will not have an advanced meter with disconnect functionality installed. For example, we propose not to include the disconnection functionality for traffic lights, metered street lights, railroad crossings, police stations, hospital facilities, service points providing cathodic protection, and TNMP's emergency facilities.
- Loads that do not require and/or will never require a HAN device will not have an advanced meter with a HAN device installed. For example, we propose not to include a HAN device for traffic lights, metered street lights, and other applications that would not benefit from a HAN device, such as electric gates, communications power supplies, sprinkler controls, cathodic protection power supplies, and TNMP's emergency facilities.
- Loads that currently have poly-phase, class 200 (200 amp rating) meters, which includes commercial customers and some residential customers, will not have a service switch until a poly-phase meter with those devices becomes available in the market and are requested by the customer or designated REP.
- Loads that have poly-phase and instrument rated meters will not have a HAN device embedded in the meter. If poly-phase meters with HAN devices become available in the market, then TNMP shall review installing those meters on a requested basis by the customer or designated REP.

As the ANSI Standard C12.22 has not yet been adopted, and is not widely deployed, the advanced meters and communication modules that TNMP is deploying may not initially be compliant with that standard. TNMP intends to have the AMS (end-to-end) compliant with ANSI Standard C12.22 when the product upgrades are available from the vendor. All TNMP advanced meters have the proven capability to remote-upgrade meter firmware so that the Company can ensure that the advanced meters do comply with ANSI Standard C12.22 when the appropriate firmware is available from SmartSynch.

Q. WHAT STEPS HAS TNMP TAKEN TO ENSURE THAT THE ADVANCED METERS WILL HAVE THE LONGEST POSSIBLE TECHNICAL LIFE?

In the selection of SmartSynch, TNMP evaluated all technologies available in the market place to understand the most robust technology for the TNMP service area. As part of the evaluation, one of the key requirements that emerged is "future-proofing" of the technology. At the expense of some initial upfront cost, but to ensure a lower asset lifecycle cost, TNMP chose to avoid metering technologies that had embedded communications on the meter board. Instead, TNMP has pursued a modular approach, where each meter has an under glass communication module that is installed into a meter chassis. Figure GK 4 depicts an installed communications module inside a GE I210+c meter. These modules can be removed and retrofitted with newer communications and hardware functionality. The current update process for TNMP is a retrofit process. AMS meters would be replaced with new technology over a 2-7 year period as part of the normal meter testing process required by the PUCT. Each removed meter would be replaced by a meter containing newer technology. The removed meter(s) would be shipped to the factory for retrofit and recertification. The retrofitted meters would then be returned to TNMP, placed in inventory, and reinstalled in the field. This process requires TNMP to purchase a small number of newer technology meters for initial installation, but appears to be the most cost-efficient use of equipment and resources for TNMP and the ratepayers.

VII. <u>BACK-OFFICE SYSTEMS</u>

Q. WHAT ARE THE BACK-OFFICE SYSTEMS BEING DEPLOYED IN CONNECTION WITH THE DEPLOYMENT OF ADVANCED METERS?

A. Implementation of AMS will require TNMP to perform a complete enterprise retrofit of the back-office systems. TNMP will not replace its CIS, but will need to install a Meter Data management system from Itron and an Outage Management system from MilSoft to manage meter alarms and create work orders for actionable events created by the AMS. In addition, TNMP will need to install a new complex billing system to support creation of EDI billing data for 15-minute increments. In addition, SmartSynch's TMS meter reading server and software will require integration into the back-office. There will be significant work required to integrate all these systems together in order to communicate effectively with the Smart Meter Texas Web portal and existing TNMP legacy systems.

New systems integrated are:

- Itron's Enterprise Edition Meter Data Management
- Itron's Complex Billing System and Interval Data Capture
- MilSoft's DisPatch Outage Management System
- SmartSynch's Transaction Management System (Meter Reading Server)

Q. **WHAT MODIFICATIONS TO THE EXISTING BACK-OFFICE SYSTEMS ARE NECESSARY TO SUPPORT THE PROPOSED AMS?**

A. The following have to occur to support the proposed AMS solution:

1. Purchase and install a new Meter Data Management System (MDMS)
2. Purchase and install a new Complex Billing System to support interval data billing.
3. Purchase and install new Outage Management System (OMS) to support reading, routing, and management of AMS Meter alarms
4. Integration of new systems with TNMP's existing systems. This will require extensive work to allow the new systems to share data with Banner (CIS), GIS, the Meter Head-End System (TMS), Texas Common Portal, Meter Inventory System, EDI Transaction management system, and TIBCO Enterprise Data Transport.
5. Modifications to TNMP's EDI Gateway and Banner (Customer Information System) will be required so that these systems can handle messages and information required by new AMS market rules associated with EDI transactions to ERCOT.

Q. **WHAT SYSTEMS RELATED TO THE TEXAS MARKET TRANSACTIONS WILL NEED MODIFICATIONS TO SUPPORT THE PROPOSED AMS?**

A. Modifications to TNMP's EDI gateway, Banner, Meter Head-End System (TMS) and TIBCO are required to support the Texas Market Transaction.

Q. ARE THERE ASPECTS OF THE CURRENT IT HARDWARE AND SOFTWARE INFRASTRUCTURE THAT WILL NEED TO CHANGE TO SUPPORT THE PROPOSED AMS?

A. Yes, new acquisition of Hardware and Software is needed to support TNMP's AMS program. All new systems listed above will require both hardware servers and software purchases. Legacy support software and databases, such as Oracle will also require potential license negotiation as the MDMS and OMS will utilize these packages, therefore requiring more licenses.

Q. HAS TNMP ENTERED INTO ANY CONTRACTS TO PURCHASE THESE SYSTEMS?

A. No contracts have been established to purchase any systems. The vendors for the new systems have provided quotations only and have not been contracted to provide goods and services. This will occur after the approval of this filing.

Q. IS TNMP PLANNING TO USE A THIRD-PARTY SYSTEMS INTEGRATOR TO ASSIST WITH ANY OF THE IT EFFORTS?

A. Yes, TNMP will use the following (currently identified)Third-Party vendors namely:

1. Meter Head-End System Vendor: Itron
2. Meter Data Management Product Vendor: SmartSynch
3. Complex Billing System Product Vendor: Itron
4. System Integrator for Back-Office Integration: To Be Determined.

Q. WILL THE COMMON AMS WEB PORTAL BE AVAILABLE UPON TNMP'S INITIAL AMS METER DEPLOYMENT?

A. The Smart Meter Texas Web portal will not be available with TNMP data upon TNMP's initial meter deployment. TNMP data will be available in the common web portal after the implementation of TNMP Back-Office systems.

Public information relating to the Web portal can be found at the Public Utility Commission of Texas web site at the following URL link:

http://www.puc.state.tx.us/electric/projects/34610/34610.cfm

Q. WILL THE BACK-OFFICE SYSTEMS AND AMS WEB PORTAL FUNCTIONS BE AVAILABLE FOR THE INITIAL AMS DEPLOYMENT?

A. No. These are capital intensive projects which TNMP cannot begin spending for until approval of the deployment plan.

Q. PLEASE DESCRIBE THE SECURITY FEATURES THAT THE AMS WEB PORTAL IS EXPECTED TO HAVE.

A. Security features for the common AMS Web Portal developed by IBM is defined by the Portal Security Requirements.

The following Security features for the Integration between TNMP and Texas AMS Web Portal will be implemented:

Web Security: One-way HTTPS/SSL transport security for all data sensitive communications between the TNMP & AMS Web Portal

Web Services Security: WS-Security over HTTPS/SSL transport security with possible all/part SOAP message encryption for communications between TNMP and AMS Web Portal

FTP Security: Secure FTP communication with two-way SSL for communication b/w TNMP & AMS WEB PORTAL

Q. WILL TNMP MAKE PERIODIC REPORTS TO THE COMMISSION REGARDING DEVELOPMENT AND DEPLOYMENT OF THE AMS WEB PORTAL?

A. Yes, TNMP will make periodic reports to the commission as part of the overall deployment per requirement in Substantive Rule §25.130.

Q. TO DATE, HAS TNMP INCURRED COSTS ASSOCIATED WITH THE AMS WEB PORTAL OR ANY OTHER SYSTEMS AS PART OF THE PILOT?

A. Yes, TNMP has incurred cost associated with the AMS Web Portal; this includes participation in the Smart Meter Texas (SMT) program (Texas Common Portal Meeting, HAN Meetings). TNMP has also incurred cost in evaluating a suitable Meter Data Management Product Vendor, Complex Billing System product vendor, RFI, and RFP generation.

Q. ARE THESE SYSTEMS CRITICAL TO THE DEPLOYMENT OF ADVANCED METERS?

A. Yes. These are the core systems required to effectively acquire, process, and publish AMS data to the Smart Meter Texas Web Portal, create billing data for the REP, and to meet all necessary AMIT business use cases and TNMP operational requirements. Currently, TNMP has no back-offices systems that can support any functionality of AMS as defined in the current rule. This project would require installing and integrating all of the above mentioned back-office systems in order to comply with Substantive Rule § 25.130.

VIII. CONCLUSION

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS REGARDING THE MODIFICATIONS AND ENHANCEMENTS TO THE BACK-OFFICE SYSTEMS, THE CHANGES TO EXISTING IT INFRASTRUCTURE, AND THE WEB PORTAL.

A. Based on my experience, knowledge, and review, the modifications and enhancements to the IT systems that I have described are required to support the proposed AMS and the estimated costs that I sponsor for these activities are reasonable and necessary.

Q. IS THIS THE CONCLUSION OF YOUR TESTIMONY?

A. Yes.

AFFIDAVIT

STATE OF TEXAS §
§
COUNTY OF DALLAS §

BEFORE ME, the undersigned authority, on this day personally appeared Gary L. Kessler, who, upon proving his identity to me and by me being duly sworn, deposes and states the following:

"My name is Gary L. Kessler. I am of legal age, a resident of the State of Texas, and have never been convicted of a felony. I certify that the foregoing testimony, offered by me on behalf of Texas-New Mexico Power Company, are true and correct and based upon my personal knowledge and experience."

Gary L. Kessler

SWORN TO AND SUBSCRIBED before me, Notary Public, on this 25th day of May, 2010, to certify which witness my hand and seal of office.

SEAL:

OFFICIAL SEAL
Julia Miller
NOTARY PUBLIC - STATE OF NEW MEXICO
My Commission Expires: April 23, 2013

NOTARY PUBLIC in and for the
State of New Mexico

My Commission expires April 23, 2013

GE
Energy

I-210+c
Singlephase Meter

I-210+c Singlephase Meter

The I-210+c is the latest addition to GE Energy's singlephase advanced meter family offering features beyond basic energy — such as demand, time of use, and load profile recording. It is GE's most robust and flexible meter, designed to offer utilities the ability to customize to suit their specific needs—adding or subtracting as much functionality as conditions require The I-210+c also comes with the option of an integrated, factory-installed remote disconnect switch to help utilities more efficiently address issues such as non-payments, move-in, move-outs, and demand side management. The meter is also offered in network forms allowing utilities to more cost-effectively meter network services.

The meter's hardware and software platforms are designed to be highly versatile, offering plug-n-play capabilities for many features.

In its simplest configuration, the I-210+c can act as a basic energy meter, with no additional functionality. The design of the meter allows for easy upgrade of virtually all of the additional metering functionality available (with the exception of remote connect/disconnect, which must be installed at the time of order, at the GE factory). In its most robust configuration, the I-210+c acts as a flexible, advanced meter uniquely qualified to suit the needs of a dynamic utility environment.

Softswitches

With the addition of a softswitch, the I-210+c can be enabled with advanced metering functionality and/or become compatible with a suite of third-party AMI solutions. The softswitch, which is a software application used to enable the meter with additional functionality, can be loaded onto the meter at the time of order or after the meter has been put in service to add additional functionality to the meter. Features such as time-of use, cycle insensitive demand, load profile recording, AMI communications, and event logging can be added.

I-210+c Available Softswitches:

- **T_2:** Time-of-Use
- **R_2:** Demand and load profile recording (2-channel)
- **K_2:** Second measure
- **A_2:** Alternate communications (AMI modules or other communication devices)
- **E_2:** Event logging of up to 200 events
- **Q_2:** Power quality activates low voltage monitoring

AMI Plug-n-Play

Many utilities are in the process of making AMI related decisions and many have chosen to utilize more than one AMI solution to effectively manage the needs of their service territory. For these reasons, the I-210+c has been designed to allow for the interchangeability of AMI modules (that GE is compatible with). AMI communications can be added at the GE factory, added after the fact, or changed out and replaced with another compatible AMI module should the meter be redeployed to another part of the service territory.

Cycle Insensitive Demand

With the appropriate softswitches enabled, the meter can be set to calculate "Cycle Insensitive Demand" based on a GE-proprietary algorithm. This provides an alternative method for calculating the maximum demand where one-way AMI systems are employed, and eliminates the need for manual demand reset with 1-way AMI systems. This feature eliminates a significant limitation impacting utilities that have implemented, or who are considering implementing one-way AMI systems.

MeterMate* Meter Reading and Programming

GE Energy's MeterMate software is compatible with the I-210+c and provides unparalleled flexibility for customers to read and customize their I-210+c. Some advanced features allow the user to:

- Change factory program defaults including measurement detents
- Set or change sag and swell thresholds
- Perform a master reset to clear energy values, voltage event and power fail counters
- Obtain a meter program and data summary report
- Select Demand, Demand/LP or TOU modes of operation and the use of the program manager to create and edit programs for the selected modes of the meter
- Transfer programs created in the MeterMate system to the I-210+c meter using MM Comm*

The meter is equipped with technology to more fully address a utility's softey concerns while ensuring the most efficient use of resources and protecting its revenues.

Remote Connect/Disconnect

The I210+c can be ordered with an integrated remote connect/disconnect switch mounted under the meter's cover. This is a factory installed option that must be specified at the time of order. To take advantage of all of the functionality this option offers, a two-way AMI device and system should be employed. This functionality is ideal for:

- Locations with frequent move-in/move-outs and locations that are undesireable or dangerous. With this switch, the utility will be able to remotely connect or disconnect service and avoid sending a technician to the site
- Situations involving non-paying customers
- New applications such as demand side management, emergency conservation, prepayment systems, customer system premises protection, and controlled outage restoration

State-of-the-Art Tamper Detection

The I-210+c has an optional Event Log feature which captures information about the 200 most recent events that happen in the meter including reverse energy flow (caused by meter inversion). This can be used to check for confirmation of meter action or evidence of tampering.

I-210+c has enhanced features to help utilities improve the level of service they provide their customers.

IEEE Reliability Indices

The I210+c has an optional power quality feature (activated when appropriate softswitches are added) that provides support for calculating IEEE® reliability indices (such as MAIFI, SAIFI, etc.) by collecting momentary and sustained interruptions and the accumulated duration of sustained interruptions.

Interval Recording

The interval recording option (which is enabled via a softswitch), in addition to being used as a billing tool for the utility, can be used as a customer service tool which can provide the customer with useful data regarding their energy consumption.

Meter specifications and related information

I210+c Meter ANSI® forms:

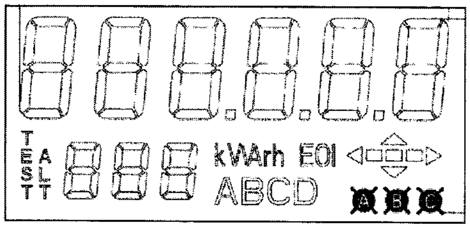
Form	Class	Volts
1S	100	120 & 240
2S	200 & 320	240
3S & 3CS	20	120 & 240
4S	20	240
12S	200 & 320	120 & 240
25S	200 & 320	120 & 240

A single polycarbonate cover is available with either of two variants including:

- With RESET latch and Optocom "D" ring
- Plain cover without RESET or "D" ring

I-210+c Display

Performance meets or exceeds ANSI C12 1, C12.10, C12.20, C37.90.1



Operating Range:

- Voltage: +20% -20% (or ±20%)
- Temperature. -40°C through +85°C
- Typical Starting Watts: <=5.0 Watts (Form 2S 240V CL200)
- Typical Watts Loss: 0.7 Watts
- Typical Accuracy: Within +/- 0.2%

For more information, please contact us via e-mail at energy.tdsolutions@ge com, or visit our web site at ge.com/energy

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GEA-14872 (03/07)

GE
Energy

GE I210+c™ Electronic Meter

Product Description, Operating Instructions, Maintenance Instructions, Upgrading.

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FCC COMPLIANCE STATEMENT

This product generates and uses radio frequency energy. It has been tested and verified that it complies with the limits for the Code of Federal Regulations (CFR) 47, Part 15–Radio Frequency Devices, Subparts A–General and B–Unintentional Radiators issued by the Federal Communications Commission for Class "B" digital devices. If, however, the product causes radio or television interference, notify:

Manager–Technology
General Electric Company
130 Main Street
Somersworth, NH 03878–3194

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Equations

1. Product Description

GE's I210+c™ meter is an electronic, single-phase or network, demand and time-of-use (TOU) electricity meter intended primarily for residential applications.

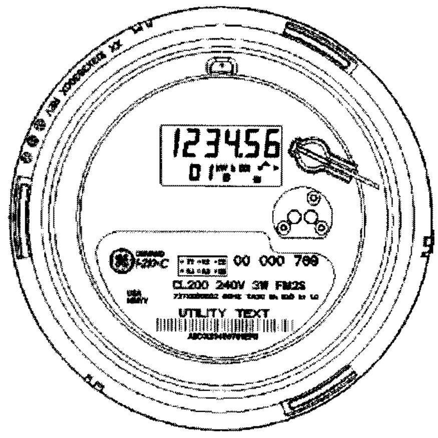

Figure 1-1 The I210+c™ Meter

The I210+c™ meter provides a wide range of additional features including: an extended range of software-configurable features (soft-switches); accurate timekeeping with the presence of an optional super capacitor or battery; enhanced energy, demand, and time-of-use billing measures; load profile recording; self-read capability; demand reset support; test mode; real-time pricing functionality; and rolling status and rolling billing period functions.

1.1 General Information

The I210+c™ meter is similar to the I210+ meter in physical construction while providing additional features as follows:

- May be configured for various metering needs: demand-only metering, demand/load profile (LP) metering, TOU or TOU/demand metering, TOU or TOU/demand meter with load profile metering.
- Supports AMR communications with any of above configurations.
- Supports up to two summations from the following: delivered-only kWh, received-only kWh, delivered + received kWh, delivered - received kWh, lagging-only kvarh, leading-only kvarh, lagging + leading kvarh, lagging – leading kvarh, phasor apparent kVAh, phase A line-to-neutral voltage. The values chosen for summations must be the same as the values used in demand and load profile recording.
- Provides up to four distinct TOU tiers, allowing time-of-use energy and demand values to be calculated for specific time periods, in addition to the overall energy and demand calculations. Also supports up to four seasons. Each season can have up to three day-types and one holiday day-type. The meter can store a total of 80 distinct tier switches.
- Includes a calendar with up to 50 programmable dates for specifying when daylight savings time changes, season changes, self-reads, demand resets, and holidays are to occur.
- Supports load profile recording for up to two channels.
- Provides memory for two self-reads
- Includes a test mode
- Provides both immediate and pending real-time pricing commands via communications.
- Supports ANSI Standards C12.18 and C12.19

The I210+c™ meter additionally incorporates several new features enhancing its capability.

- The rolling billing period feature provides up to two peak demands over a programmable period of time. The meter stores the overall daily peak demands, as well as the daily peak demands for two tiers, for the last 35 days. The peak demands are available for reading and display.
- Rolling status provides the cautions and errors that have occurred in the meter over the last programmable number of days. The meter stores the daily caution and error flags for the last 35 days. Rolling status is available for reading.
- DC detection is available as a meter caution. The meter will detect the presence of DC in the current signal. This caution can be selected for display and for reporting in the event log.

1.1.1 Physical Description

The I210+c™ meter uses a clear polycarbonate cover that is molded in one piece. Two types of covers are available, one with an integrated ANSI Type 2 optical communications port and a demand reset mechanism in the cover, and one without these two features.

The meter base assembly provides direct interchangeability with existing ANSI form single-phase meters. This standardization allows retrofit to existing installations and use with existing ring and ringless sockets.

The nameplate displays all information required by ANSI, including an area for customer-specific information.

A liquid crystal display is provided to indicate energy consumption and various other data. The display is covered in detail in Chapter 2, Operating Instructions.

An Alternate Display Switch, located on the right side of the meter face slightly above the one o'clock position, may be activated by a magnet. The switch and its use are also described in detail in Chapter 2, Operating Instructions.

The Demand Reset and Test switches are located at the two o'clock position of the meter face. The Test Switch has no external access. The cover must be removed to operate the switch.

An ANSI Type 2 optical port is located in the three o'clock position of the meter face. The optical port allows a computer to communicate with the meter for reading and programming using Standard Tables (ANSI C12.19) and PSEM (Protocol Specification for Electricity Meters [ANSI C12.18]). The I210+c™ optical port operates at a fixed baud rate of 9600.

The battery for the time-of-use option is visible at the 12 o'clock position. It is the industry-standard battery. An optional super capacitor is available instead of a battery.

1.1.2 Meter Forms

The mechanical configuration allows the meter to be directly interchanged with existing ANSI form single-phase and network meters. The standardization allows retrofitting to existing installations and use with existing ring and ringless sockets.

1.1.3 Physical Variants Available

The description of the meter and the available S-base forms have been provided below.

Table 1-1. ANSI Standard Meter Forms
The Form 2S is available with or without the test link.

Form	Wires	Circuit	Elements	SC/TR	Class
1S	2	1Ø	1	SC	100
2S	3	1Ø	1	SC	200 or 320
3S	2	1Ø	1	TR	20
4S	3	1Ø	1	TR	20
12S	3	Network or 3ØΔ	2	SC	200 or 320
25S	3	Network	2	SC	200 or 320

1.1.3.1 Voltage Ratings

The standard meter voltage rating is either 120 or 240 VAC with +/-20% line voltage variations. The meter will maintain an accuracy of 0.5% with line voltage variations of +/-10% from normal per ANSI C12.20 -1998.

1.1.3.2 Time Base

The standard meter keeps time from the line frequency. The meter may be programmed to use a crystal oscillator for timekeeping in areas where line frequency does not provide adequate stability for line-based timekeeping.

1.1.4 Hardware Options

The I210+c™ meter supports optional add-on AMR communication modules.

1.1.5 Demand Operating Mode

The basic I210+c™ meter has several operating modes. It is not necessary to buy different versions of the meter to get these features; all modes are built into every meter.

Demand mode is the most basic mode of operation. Demand mode does not require a battery. The demand soft-switch, N, must be enabled. The basic meter in demand mode provides:

- Energy measurement (two quantities)
- Demand (two quantities - block, or rolling demand, maximum, cumulative, and continuously cumulative displays). Alternatively, up to two thermal demand measures are also available.
- Fundamental-plus-harmonics measurements only
- Bidirectional energy measurements with various detenting choices
- Self-monitoring of meter operation for error conditions and caution conditions.
- Alternate display scroll
- Test mode, to test meter operation and site characteristics without affecting billing quantities or load profile data.
- Programming seal function for enhanced security (Canadian requirement)
- Security table of key meter events
- Up to two self-reads
- Demand reset support

- Programmable event logging
- Real-time pricing support
- Immediate real-time pricing activation through communications
- Support for ANSI Standards C12 18 and C12.19

1.1.6 Demand/Load Profile Operating Mode

Demand/load profile mode requires a battery or super capacitor and the R2 load profile recording soft-switch. The following features are provided in addition to the basic features provided by the meter in demand mode:

- Load profile recording for up to two channels
- Daylight savings time change support

1.1.7 TOU/Demand Operating Mode

TOU/demand mode requires a battery or super capacitor and the T2 time-of-use soft-switch. The following features are provided in addition to the basic features provided by the meter in demand mode:

- Programmable daily tier schedules for time-of-use support
- Programmable calendar for scheduling holidays, daylight savings adjustments, season changes, demand resets, and self-reads
- Pending real-time pricing activation through communications
- Rolling billing period support
- Rolling status

1.1.8 TOU/Demand and Load Profile Operating Modes

TOU/demand and load profile mode requires a battery or super capacitor and the T2 time- of-use and R2 load profile recording soft-switches. The following features are provided in addition to the basic features provided by the meter in TOU/demand mode:

- Load profile recording for up to two channels

1.1.9 On-site User Features

1.1.9.1 Operation

The I210+c™ meter has several features for ease of use on site, including:

- Nameplate and label information
- Numeric display with key annunciators, and several display modes including normal, alternate and test.

1.1.9.2 Maintenance

The I210+c™ meter is designed for unattended operation over a long life. When the meter or the site requires attention, the meter has features to facilitate these tasks.

- Many modes of operation and enhanced functions are built into the meter software and may be enabled without physical change to the meter.
- Upgrading from demand to demand/load profile or time-of-use operation requires no added hardware, aside from the battery or super capacitor that supports timekeeping during power outages.
- Disk analog on the display for field calibration testing.
- Test mode for convenient calibration testing without affecting billing data.
- Self-test of meter operation
- Flexible control of display for error conditions and cautions in the meter.

Maintenance instructions are covered in Section 3 of this manual.

1.1.10 Advanced Features and Soft-switches

Many advanced features of the I-210+c™ meter can be enabled with soft-switches. Soft-switches are logical controls that enable related groups of meter features. Without activation of a soft-switch, operation of the controlled features is suppressed. Soft-switches may be enabled in the meter as shipped from the factory, or may be turned on at any time by the use of MeterMate™ software.

The following soft-switches are available in the I-210+c meter:

- E2 Switch - Event log
- K2 Switch - Kvar and kVA measures
- Q2 Switch - Power quality measures
- R2 Switch - Two-channel recording
- T2 Switch - Time-of-use
- N2 Switch - Billing demands
- A2 Switch - Alternate communications

Operating features controlled by soft-switches are described in Section 4, Upgrading.

1.2 Programming and Reading Software

The meter is supported by the MeterMate™ software suite. This software facilitates setting up and using many meter features:

- Creation of custom meter programs
- Loading programs into the meter
- Setting site-specific meter parameters
- Viewing real-time data
- Reading meter data
- Load profile data analysis and reporting
- Meter program and meter data reporting
- Batched meter communications
- Meter mode conversion and soft-switch upgrading

Refer to Reading and Programming Instruction manual for MeterMate™ (GEH-5084l MeterMate™ MMCOMM Instruction Book).

1.3 Technical Information

This section contains the theory of operation and general circuit configuration of the GE I210+c™ meter.

1.3.1 Theory of Operation

The theory of operation of the I210+c™ meter is described in conjunction with the block diagram shown in Figure 1-3.

1.3.1.1 Sensing Devices

Voltages are sensed by high-impedance resistive voltage dividers. Currents are sensed by up to two current transformers, each feeding to the current signal sampling circuit. The sensors provide scaled signals to the metering chip.

1.3.1.2 Metering Chip

The voltage and current sampling, signal processing, and basic meter calculations are performed by the metering chip. The meter chip has a 22-bit delta-sigma ADC with an effective sampling rate of 2520 samples per second. It has two voltage and two current inputs, so it can meter single-phase and network services. The metering chip also drives the meter's LCD, provides real-time clock functionality, and drives the meter's calibration pulse.

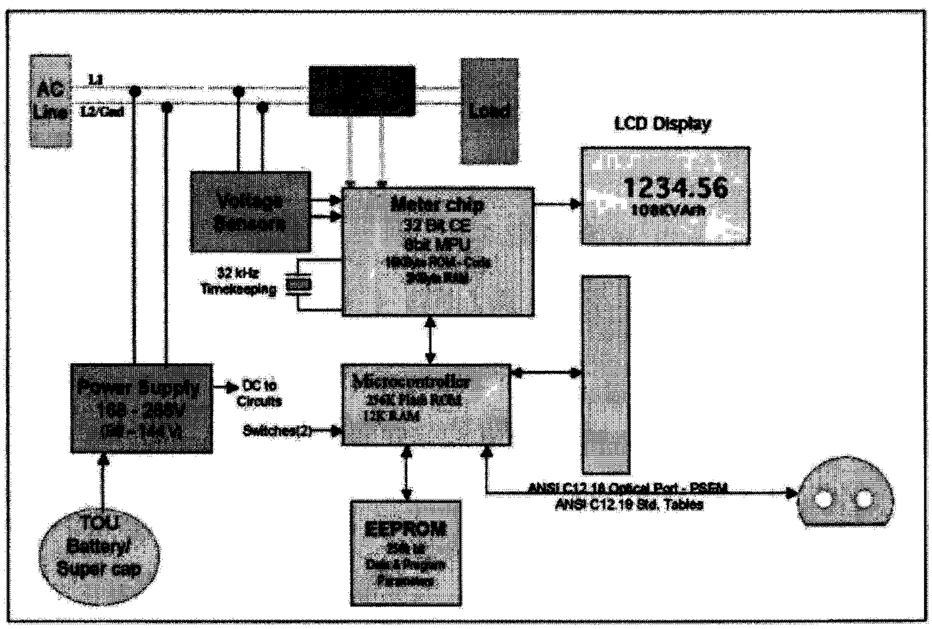

Figure 1-2. I210+c™ Meter Block Diagram

1.3.1.3 *Microcomputer*

The microcomputer is a 32-bit expandable single chip microcomputer. It receives basic metering data (Wh, varh, V2h) and status information from the Teridian meter chip every second. The microcomputer performs all of the high level metering functions such as summations, demand calculations, time-of-use functions and load profile recording. It also provides the communications interface to the optical port and the AMR communication port.

1.3.1.4 *Nonvolatile Memory*

The I210+c™ meter is equipped with two 32K x 8 EEPROM devices. All data values and program parameters are stored in these EEPROMs; a battery is not required for data storage. Meter data quantities are updated at each power fail event. Stored data is constantly checked to detect errors.

1.3.1.5 *Power Supply*

The I210+c™ meter is powered from the A-phase voltage line. It has a solid-state switching type power supply. The meter is available in two voltage ratings: 120V or 240V, +/-20% of rating. The supply operates for either 50Hz or 60Hz line frequency. (Note: the frequency at which the meter will operate is factory configured, it is not user programmable.)

Caution: *Do not exceed 288 volts RMS on the power supply voltage input terminals.*

1.3.1.6 *Time Keeping Battery*

A standard 3.6V, half-size AA, lithium battery maintains the meter clock when the meter is programmed as a time-of-use meter or demand meter with load profile recorder. Since all billing and programming information is stored in nonvolatile memory, the battery is primarily used for maintaining date and time information during a power outage. Under normal conditions, the battery should provide more than one year of service during outage conditions (time on battery backup) and more than 10 years of service during storage conditions (disconnected from terminals) or when properly installed in an energized meter.

A super capacitor is also available and may be ordered in place of a battery. The super capacitor, when fully charged, will provide a minimum of eight hours of backup. It is charged from the meter's power supply.

1.3.1.7 *AMR Modules*

In order to support meter communications with AMR modules, the basic meter provides a connector containing a power fail signal and power for AMR modules.

Note: *Only AMR vendors with Non-Disclosure Agreements with GE, providing modules tested by GE, will be considered within the warranty agreement.*

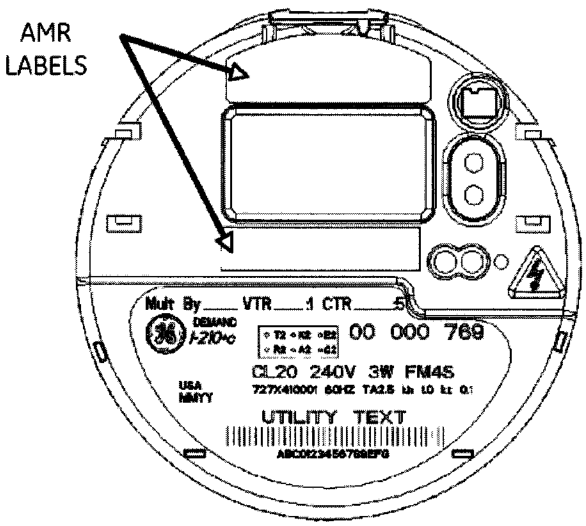

Figure 2-1 Meter Nameplate

2. Operating Instructions

2.1 Nameplate Information and Labels

The I210+c™ meter will include all ANSI-required nameplate. An area specified by ANSI shall be available for customer information and bar code data when it is provided by the customer.

Meters that incorporate AMR devices will include the AMR device ID (or serial number, as appropriate) either on the meter nameplate or on a separate nameplate.

Month and two-digit year of manufacture will be included along with the assembly.

Nameplate "Multiply By" shall be printed with the appropriate display multiplier filled in on any factory-programmed meter with a display multiplier other than one.

Provision has been made to allow an additional nameplate and/or label for AMR devices per FCC or other statutory guidelines.

See Figure 2-1 for a graphic representation of the meter nameplate. The meter nameplate is found on the front of the meter.

2.1.1 Labels

Space for AMR vendor-specific labels is also available on the nameplate. See Figure 2-1 for details.

2.2 Display Information

A maximum of up to 75 items can be selected for display from a total of 397 different user-selectable quantities. As the meter is very flexible, a wide range of quantities can be defined for mapping to meter calculations and display. In the table below "UOM" refers to "Unit of Measure", a general term for measurements that can be displayed as defined by the meter program. UOM quantities can be kWh or other integrating volt-amp quantities (such as kVA) or voltages.

Table 2-1 User-Selected Display Information

Display Item	Operational Modes Available
Current Season	
Maximum 1,2 UOM:	
Maximum Demand	All
Maximum Demand Date	TOU
Maximum Demand Time	TOU
Maximum Demand Rate A,B,C,D	TOU
Maximum Demand Rate A,B,C,D Date	TOU
Maximum Demand Rate A,B,C,D Time	TOU
Cumulative 1,2 UOM	
Cumulative Demand	All
Cumulative Demand Rate A,B,C,D	TOU
Continuously Cumulative 1,2 UOM	
Continuously Cumulative Demand	All
Continuously Cumulative Demand Rate A,B,C,D	TOU
Summations 1,2 UOM	
Total Summation	All
Summation Rate A,B,C,D	TOU
Instantaneous:	
Momentary Interval Demand	All
Momentary Interval Power Factor	All
Momentary Interval Va RMS fundamental plus harmonics	All
Momentary Interval V_C RMS fundamental plus harmonics (network meters only)	All
Previous Interval 1,2 UOM:	
Previous Interval Demand	All
Rolling Billing Period Demand 1,2 UOM:	
Maximum Demand for Peaks 1 and 2	TOU
Maximum Demand Date for Peaks 1 and 2	TOU
Maximum Demand Time for Peaks 1 and 2	TOU
Maximum Demand Rate A,B for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Date for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Time for Peaks 1 and 2	TOU
Cumulative Demand for Peaks 1 and 2	TOU
Cumulative Demand Rate A,B for Peaks 1 and 2	TOU
Daily Maximum Demand	TOU
Daily Maximum Demand Time	TOU
Daily Maximum Demand Rate A,B	TOU
Daily Maximum Demand Rate A,B Time	TOU

Display Item	Operational Modes Available
Previous Season	
Maximum 1,2 UOM:	
Maximum Demand	TOU
Maximum Demand Date	TOU
Maximum Demand Time	TOU
Maximum Demand Rate A,B,C,D	TOU
Maximum Demand Rate A,B,C,D Date	TOU
Maximum Demand Rate A,B,C,D Time	TOU
Cumulative 1,2, UOM:	
Cumulative Demand	TOU
Cumulative Demand Rate A,B,C,D	TOU
Summations 1,2, UOM:	
Total Summation	TOU
Summation Rate A,B,C,D	TOU
Rolling Billing Period Demand 1,2 UOM:	
Maximum Demand for Peaks 1 and 2	TOU
Maximum Demand Date for Peaks 1 and 2	TOU
Maximum Demand Time for Peaks 1 and 2	TOU
Maximum Demand Rate A,B for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Date for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Time for Peaks 1 and 2	TOU
Cumulative Demand for Peaks 1 and 2	TOU
Cumulative Demand Rate A,B for Peaks 1 and 2	TOU
Last Reset	
Maximum 1,2, UOM:	
Maximum Demand	All
Maximum Demand Date	TOU
Maximum Demand Time	TOU
Maximum Demand Rate A,B,C,D	TOU
Maximum Demand Rate A,B,C,D Date	TOU
Maximum Demand Rate A,B,C,D Time	TOU
Cumulative 1,2 UOM:	
Cumulative Demand	All
Cumulative Demand Rate A,B,C,D	TOU
Summations 1,2, UOM:	
Total Summation	All
Summation Rate A,B,C,D	TOU
Rolling Billing Period Demand 1,2 UOM:	
Maximum Demand for Peaks 1 and 2	TOU
Maximum Demand Date for Peaks 1 and 2	TOU
Maximum Demand Time for Peaks 1 and 2	TOU

Maximum Demand Rate A,B for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Date for Peaks 1 and 2	TOU
Maximum Demand Rate A,B Time for Peaks 1 and 2	TOU
Cumulative Demand for Peaks 1 and 2	TOU
Cumulative Demand Rate A,B for Peaks 1 and 2	TOU
Real Time Pricing (RTP) 1,2 UOM:	
RTP Maximum Demand	Dmd/ DmdLP
RTP Cumulative Demand	Dmd/ DmdLP
RTP Summation	Dmd/ DmdLP
Last Reset	
Last Reset RTP Maximum Demand	Dmd/ DmdLP
Last Reset RTP Cumulative Demand	Dmd/ DmdLP
Last Reset RTP Summation	Dmd/ DmdLP

SECURITY LOG

Number of Bad Passwords	All
Number of Demand Resets	All
Number of EEPROM Writes	All
Number of OPTOCOM Communications	All
Number of Power Outages	All
Number of Times Programmed	All
Number of Times for Real-Time Pricing Entries	All
Cumulative Power Outage Duration in seconds	TOU/DmdLP
Date of Last Calibration	All
Time of Last Calibration	All
Date of Last Demand Reset	TOU
Time of Last Demand Reset	TOU
Date of Last OPTOCOM Comm.	TOU
Time of Last OPTOCOM Comm.	TOU
Date of Last Power Outage	TOU/ DmdLP
Time of Last Power Outage	TOU/DmdLP
Date of Last Programming	All
Time of Last Programming	All
Date of Last Real-Time Pricing Entry	TOU
Time of Last Real-Time Pricing Entry	TOU
Date of Last Time Change	TOU
Time of Last Time Change	TOU

TEST MODE

Test Mode Demand Interval length in minutes (block)	All
Test Mode Demand No of Subintervals. (rolling only)	All
Test Mode Demand Subint. length in minutes (rolling)	All
Test Mode Maximum Demand 1,2 UOM	All
Test Mode Time Out Length in minutes	All
Test Mode Thermal Interval Type: "0"=15 min., "1"=1 min.	All
Test Mode Accumulating Demand 1,2 UOM	All
Test Mode Power Factor	All
Time Remaining in Test Mode (Sub)interval in min. & sec. (Not valid for thermal demands)	All

CONSTANTS

Demand Interval Length in minutes (block only)	All
Demand No. of Subintervals (rolling only)	All
Demand Subinterval Length in minutes (rolling only)	All
Demand Delay Length in minutes	All
Minimum Outage for Demand Delay in seconds	TOU
Display Demand Units ("0"=kW,kVA, etc.;"1"=W,VA,etc.)	All
Display Scalar: (for GE internal use)	All
Display Primary Volts/Amps Flag: "0"= Sec, "1"= Pri.	All
Display Multiplier (Scaled): (for GE internal use)	All
Meter ID 1	All
Meter ID 2	All
Program ID	All
Transformer Ratio - Current: X:5	All
Transformer Ratio - Voltage: X:1	All
EOI Duration in seconds	All
Load Profile # Channels	TOU/ DmdLP
Load Profile Interval Length in minutes	TOU/ DmdLP
Real-Time Pricing State: "0"= Disabled, "1"= Enabled	All
Seal Flag State: "0"= Unsealed, "1"= Sealed Official Government Metrology Control	All
Blank Data Display	All
All Segments	All
Firmware Version No. = 1, 2,...	All
Hardware Version No. = 1, 2,...	All
Transformer Factor	All
Network Status Info	All

VARIABLES

Current Season	TOU
Current Date	TOU/ DmdLP
Current Day Of Week (1-7 means Sun-Sat)	TOU/DmdLP
Current Time	TOU/ DmdLP
Time Remaining in Demand (Sub)interval in minutes (Not valid for thermal demands)	All
Real-Time Pricing time remaining until activation in min.	All

2.2.1 Display Modes

There are three display modes:

- Normal
- Alternate
- Test

The user can switch between display modes using the display switch and the test switch.

2.2.1.1 Display Switch Actions

The display switch is actuated using a magnet as shown in Figure 2-2. Holding a magnet next to the Display Switch for varying lengths of time causes the meter to change display modes:

Less than 3 seconds.	Restarts the Normal Display scroll, or produces one Normal Display scroll if an Error, Caution or Diagnostic is frozen on the display.
More than 3 seconds:	Enters the Alternate Display mode for one scroll then returns to the Normal Display mode.

TIP: *The magnetic end of the SMARTCOUPLER™ will activate the display switch.*

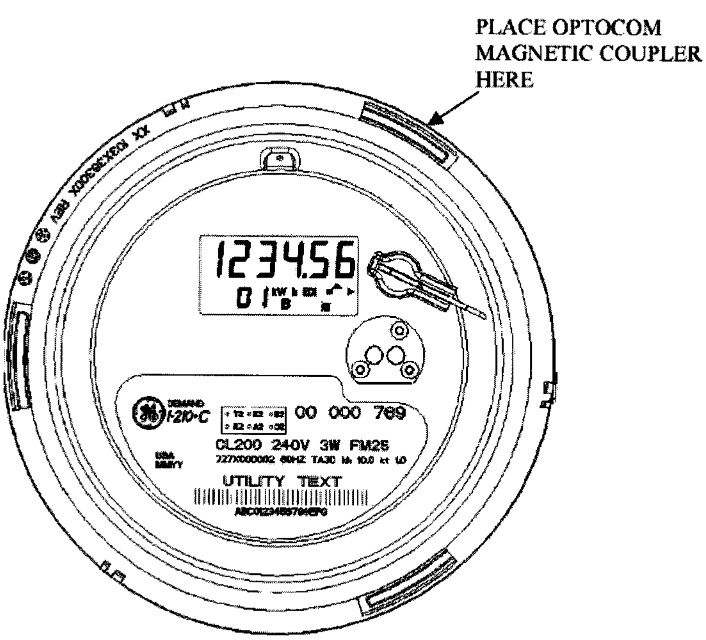

Figure 2-2 Alternate Display Mode Switch

2.2.1.2 Normal Display Mode

In Normal Display mode, the meter display scrolls continually through the Normal Display items until one of the following occurs:

- Demand reset is invoked
- Display Switch is actuated
- Communication is initiated
- Test mode is invoked
- A frozen error or caution message is triggered.

Note: *The test mode push button is not accessible with the cover in place.*

Normal Display items are selected during program development using MeterMate™ software. The meter returns to the Normal Display mode when other display modes have completed or timed-out.

TIP: *While the meter is communicating, the data annunciators are off and the LCD displays "BUSY".*

2.2.1.3 Alternate Display Mode

The Alternate Display is used to display information for the meter technician that is not contained in the Normal Display.

- *Display items:* Selected during MeterMate™ program development
- *Initiate:* Actuate the display switch for more than 3 seconds
- *Scroll:* The meter automatically scrolls through the Alternate Display items
- *Exit:* The meter automatically returns to the Normal Display mode after the last Alternate Display item

2.2.1.4 Test Mode

Test mode is used to display data for testing the meter. Normal accumulation of billing data is suspended in test mode.

- *Display Items:* Selected during MeterMate™ program development.
- *Initiate:* Hold the test (T) switch for one second (requires removing the cover) or use MeterMate™ software commands. See Figure 2-3 for the location of the test switch.

- *Scroll:* Momentarily actuate the display switch to advance to the next item in the Test Display scroll.
- *Reset Accumulators.* Hold the reset (R) switch to zero all accumulators and light all display segments. Test mode processing resumes when the reset switch is released. Pressing the reset switch does not affect billing data.
- *Exit.* Hold the test switch for one second or wait for the programmable test mode timeout period.

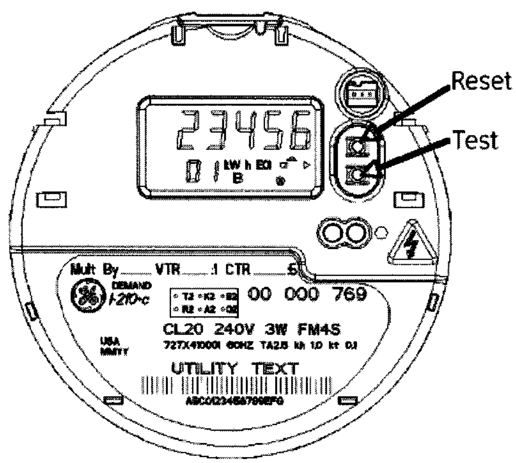

Figure 2-3. Reset and Test Switches

2.2.1.5 *Frozen Display Mode*

The Frozen Display mode stops the Normal Display to draw attention to an error, caution, or diagnostic in the meter.

- *Display Items.* Select errors, cautions and diagnostics to freeze the display during MeterMate™ program development.
- *Initiate.* Automatic when the meter detects a frozen error, caution or diagnostic.
- *Scroll:* Use a magnet to activate the display switch. The meter will perform one Normal Display scroll and then return to the Frozen Display.
- *Exit:* Clear the condition that caused the error, caution or diagnostic to return to the Normal Display mode.

2.2.2 Liquid Crystal Display Information

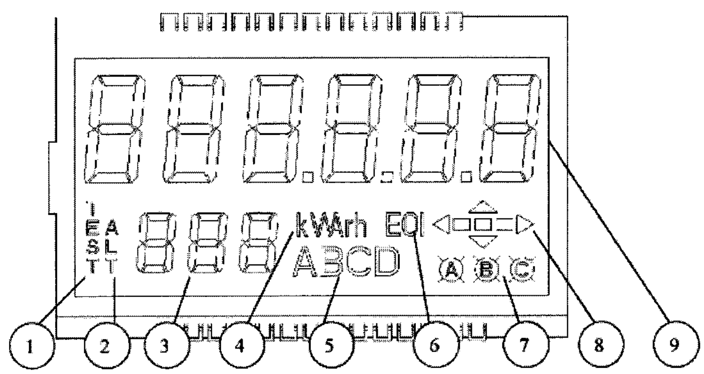

Figure 2-4 Liquid Crystal Display Information

1. The "TEST" annunciator indicates the meter is in Test mode.
2. The "ALT" annunciator indicates the meter is in Alternate Display mode.
3. The three small digits are used to display the current display label or code. "CA" or "Er" appearing in this location indicates a Caution or Error message in the display.
4. These letters are used to display the units of measure for the quantity currently being displayed. For example, energy displays will have a "kWh" annunciator and Apparent Power will have a "kVA" annunciator.
5. The letters A through D indicate the time-of-use (TOU) rate that is in effect. Only one letter at a time is displayed when the meter is operating in TOU Mode. If no letters are lit, the meter is in a non-TOU rate.
6. This display indicates an end-of-interval (EOI) condition.
7. When displayed, the "A" annunciator indicates the A voltage is present at the meter. If this annunciator is blinking, phase-A voltage is low.

The "B" annunciator will only be displayed during an all-segments display.

When displayed, the "C" annunciator indicates the C voltage is present at the meter. If this annunciator is blinking, C voltage is low (Network meters only.)

8. The left-right arrows indicate watt-hour direction of energy flow. The right arrow will be lit if the energy is delivered; the left arrow will be lit if the energy is received.

   The up-down arrows indicate var-hour direction of quadergy flow. The up arrow will be lit if the quadergy is lagging, the down arrow will be lit if the quadergy is leading.

   The meter's magnitude indicator consists of three segments, used to simulate the rotation of the disk on an electromechanical meter. Each state change represents Kt. One complete "revolution" represents ten state changes, which represent Kh watt-hours or var-hours. The meter illuminates the segments as follows:

   State

   0 ■□□
   1 ■■□
   2 ■■■
   3 □■■
   4 □□■
   5 □□□
   6 □□□
   7 □□□
   8 □□□
   9 □□□
   0 ■□□
   ...

   If the Wh direction is delivered (or the varh direction is lagging), the states change in increasing order with respect to the above illustration. If the Wh direction is received (or the varh direction is leading), the states change in decreasing order.

   Note: *If the calculated phasor VAh is below the configured creep threshold, the meter will turn off the Wh and varh direction arrows.*

9. These characters display the programmed metering quantities. There are three possible decimal point positions located between the four rightmost digits.

2.2.3 Display Examples

The following three figures show examples of possible I210+c™ meter displays.

2.2.3.1 *kWh Display*

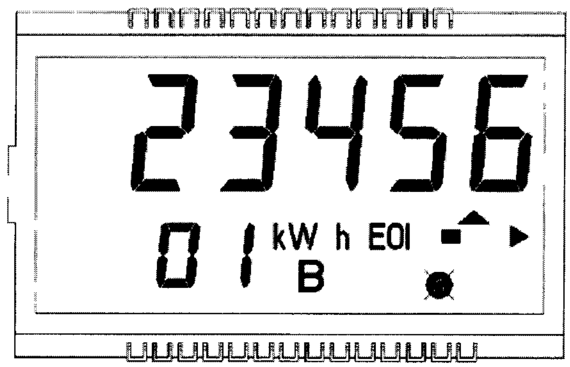

Figure 2-5 kWh Display

Figure 2-5 shows the following conditions:

- The Display Label is "01"
- Five-digit display of energy (kWh)
- Phase A voltage is present
- End-of-demand-interval indication. This indicator is lit at the end of each demand subinterval
- Displayed quantity is measured in kilowatt-hours
- Energy is being delivered to the load
- The one block indicates State 0 of the magnitude indicator
- Quadergy (kvarh) is lagging
- TOU rate B is in effect

2.2.3.2 Alternate Display Mode

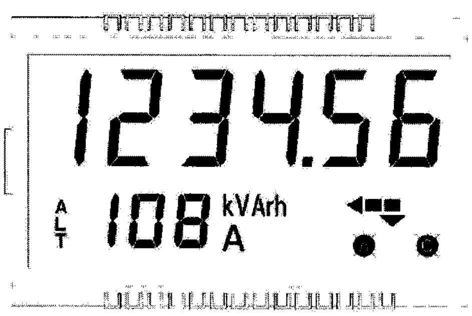

Figure 2-6 Alternate Display

Figure 2-6 shows the following conditions:

- Meter is in Alternate Display mode
- Display label "108" is displayed
- Phase A and C voltages are present
- Six-digit display of quadergy (kvarh)
- Displayed quantity is measured in kvarh
- The two blocks indicate State 1 of the magnitude indicator
- Quadergy (kvarh) is leading
- Energy is being received from the load
- TOU rate A is in effect

2.2.3.3 Test Mode Display

Figure 2-7 shows the following conditions:

- Meter is in TEST mode
- Display label is "905"
- Meter display is a six-digit demand display (kW) with three digits to the right of the decimal point
- Phase A voltage is present
- Meter display is in watt-hours
- Energy is being delivered to the load
- The three blocks indicate State 2 of the magnitude indicator
- Time-of-use metering rate D is in effect
- Quadergy (kvarh) is lagging

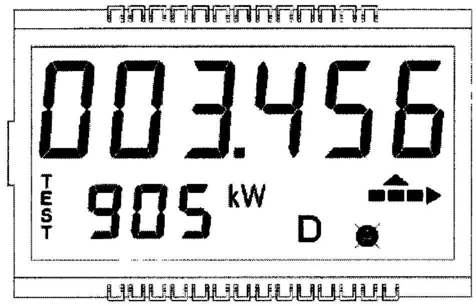

Figure 2-7 Test Mode Display

3. Maintenance Instructions

The information contained within this document is intended to be an aid to qualified metering personnel. It is not intended to replace the extensive training necessary to install or remove meters from service. Any work on or near energized meters, meter sockets, or other metering equipment presents the danger of electrical shock. All work on these products must be performed by qualified industrial electricians and metering specialists only. All work must be done in accordance with local utility safety practices and the procedures outlined in the current edition of the Handbook for Electricity Metering. The handbook is available from the Edison Electric Institute, 701 Pennsylvania Avenue N.W., Washington D.C. 20004-2696.

3.1 Recommended Procedures

The procedures described on the following pages are those recommended by the General Electric Company. Any procedures not described herein or referenced herein are not recommended.

3.1.1 Meter Testing Tools

The meter is equipped with a light-emitting diode (LED) for calibration and a liquid crystal display with disk analog and test displays. The calibration LED is part of the ANSI Type 2 Optical port as shown in Figure 3-1.

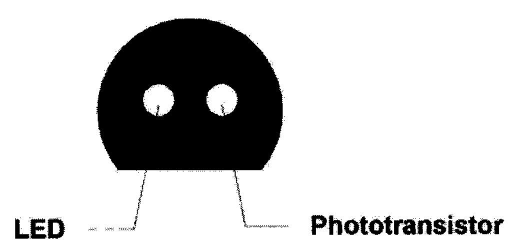

Figure 3-1 Optical Port

3.1.1.1 *Calibration LED*

The optical port LED emits calibration pulses (infrared light) until the meter detects the presence of optical port PSEM communications. This LED is the source of watt-hour and var-hour calibration pulses. Each calibration pulse is equal to the value assigned to Kt (watt-hours or var-hours). The duration of each output pulse is approximately 25 milliseconds.

The default unit for the calibration pulses is watt-hours. The meter may be switched to varh calibration pulses using MeterMate™ software.

3.1.1.2 *LCD Display*

The meter display has annunciators for quadrant, phase voltage, and energy flow indication as shown in Figure 3-2. The annunciators provide valuable information during the testing process

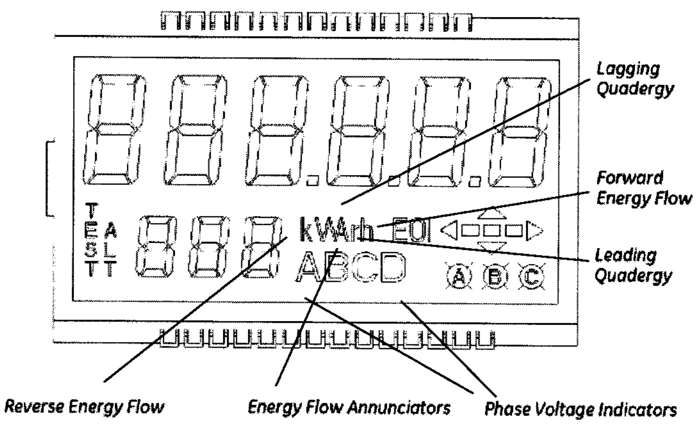

Figure 3-2 Liquid Crystal Display

Refer to section 2.2.2 for more information on these annunciators.

3.2 Test Mode

Test mode allows the meter to be tested without disturbing billing data or setting a new maximum demand. Test mode performs the same function as setting the pointers back on an electromechanical meter after testing.

Test mode may be entered by pressing the test switch for one second or by using MeterMate™ software commands. The test mode switch is operated by removing the Lexan cover and pushing the test switch.

3.2.1 Starting the Test Mode

To enter test mode, use the test switch on the face of the meter or MeterMate™ Meter Comm commands.

Upon entering test mode, several actions occur:

- The current demand interval is terminated.
- All test accumulators are set to zero.
- The subinterval countdown timer starts.
- Load profile recording is suspended, and load profile interval status bits reflect test mode was in effect during affected interval(s).

When test mode begins, the test annunciator is lit and the first item programmed for the test display is shown.

3.2.2 Operation During Test Mode

The same summation quantities that are calculated during normal operation are calculated in test mode. The selection of quantities to be displayed in test mode is fully programmable in the MeterMate™ software. Watt-hour, var-hour, and volt-ampere-hour are displayed in units rather than kilo-units; i.e. the data is displayed as Wh, varh, and VAh rather than kWh, kvarh, and kVAh. The same demand values calculated during normal operation are also calculated in test mode. The display formats for the demands are the same in test mode as they are in normal mode.

3.2.2.1 *Energy Calculations*

If the metering constants are not programmed, default values are used. Table 3 1 contains the default test mode values.

Table 3-1 Default Test Mode Values

Constant	Default Value
Demand decimal position	XXX.XXX
Number of demand subintervals	3
Demand subinterval length	5 minutes
Energy display format	XXX.XXX

The display does not scroll while the meter is in test mode. Each item remains displayed until the display switch is activated with a magnet. At that time, the next item in the display program is shown. The quantity displayed is updated every second.

The test mode display is fully programmable. Table 3 2 lists the default test mode display items for an unprogrammed meter. Items can be added or deleted using MeterMate™ software.

Table 3-2 Test Mode Default Display

Display ID	Display Quantity
94	Accumulating Wh
95	Previous interval kW demand
91	Time remaining in subinterval (MM SS)
92	Momentary interval demand
93	Maximum test kW demand

3.2.2.2 *Displays Available in Test Mode Only*

The following display items are available for display only in the test mode:

- Test mode maximum demands;
- Time remaining in test demand interval in block demand only;
- Time remaining in test demand subinterval in rolling demand only;
- Test mode summations;
- Test mode accumulating demand.

3.2.2.3 *Test Reset*

A test reset is initiated by pressing the reset switch while the meter is in the test mode. A test mode reset causes all test quantities to be reset to zero and a new subinterval to be started. An all-segments display is shown until the reset switch is released. The item displayed when the reset occurred remains in the display, but the value will be initialized.

In the event of a power outage, data for test mode energy and demand are not saved. These data are reset when power returns. Upon power-up, the meter remains in test mode and the item displayed when the outage occurs remains on the display. In a TOU meter or demand meter with load profiling, there may be a slight delay before re-entering test mode on power-up. During the delay, the meter is performing its catch-up tasks.

3.2.2.4 *Exiting Test Mode*

Test mode is exited in one of three ways:

1. By pressing and holding the test switch for more than one second;
2. By an MMDOS or MMCOMM command;
3. By expiration of the test mode time-out timer.

All test mode data is lost when test mode is exited. Upon exiting test mode in a meter programmed for rolling demand, the meter will start a new, possibly partial, subinterval. The past subinterval, as well as the current subinterval, is zeroed. Upon returning to the normal operating mode, a TOU meter or demand meter with load profiling will complete the time remaining in the current partial subinterval such that subsequent subintervals will be synchronized with the midnight boundary. The new subinterval in demand-only mode is the number of minutes remaining in the subinterval prior to entering test mode.

For meters that are programmed for thermal emulation, the thermal demand reading is set to zero immediately after test mode is exited.

The meter will automatically exit test mode when the time that the meter has been in test mode time has exceeded its programmed limit. This test mode time limit prevents accidentally leaving the meter in the test mode and losing billing information. The test mode time-out function is programmable from one minute to 99 hours.

Note: *Normal billing and load profile data accumulation is suspended during test mode operation. Upon exiting test mode accumulation of billing and load profile quantities will resume from the values in place when test mode was entered.*

3.3 Field Accuracy Test

Test mode allows the meter to be tested for accuracy in the field, without disturbing any billing data.

3.3.1 Field Testing with Test Mode

Testing the meter in the field can be accomplished three ways in test mode by using the:

1. Maximum demand reading in the display;
2. Disk analog display;
3. Instantaneous demand feature of the I210+c™.

3.3.2 Maximum Demand Reading Testing

This is the most accurate of the three test methods. For this test, you need a portable standard with a start/stop switch and a phantom load.

1. Make sure that the voltage coils are in parallel and the current coils are in series.
2. Connect the phantom load and the portable standard to the meter to be tested.

3. Apply voltage to the meter and the standard and wait 20 seconds for settling time.
4. Put the meter into test mode.
5. Change the display to maximum demand (display ID 93 using the default display items).
6. Switch on the desired current.
7. Check the flow indicator on the meter to make sure that the polarity is correct.
8. Reset the standard.
9. Simultaneously reset the meter and start the standard. The test reset takes effect when switch is released.
10. Turn the current off when the end-of-interval (EOI) annunciator comes on.
11. Compare the meter readings with the standard's readings. EOI comes at the end of every subinterval; numbers won't match before interval is completed and display is updated. Where rolling demand is used (n sub intervals composing a complete demand interval) the display value needs to be multiplied by n for comparison to the standard value.

3.4 Disk Analog Testing

The disk analog provides a precise means of checking the calibration of the meter. There are some practical limits to this method of testing. For example, if the load on the meter is very low, the test may take a long time. Conversely, if the load is high, it may be difficult to accurately time the switching of the standard.

The disk analog in the I210 Demand/TOU works as follows:

The meter's magnitude indicator consists of three segments, used to simulate the rotation of the disk on an electromechanical meter. Each state change represents Kt. One complete "revolution" represents 10 state changes, which represents Kh watthours or varhours. The meter illuminates the segments as follows:

State

0 ■□□
1 ■■□
2 ■■■
3 □■■
4 □□■
5 □□□
6 □□□
7 □□□
8 □□□
9 □□□
0 ■□□
...

If the Wh direction is delivered (or the varh direction is lagging), the state changes occur in increasing order. If the Wh direction is received (or the varh direction is leading), the state changes occur in decreasing order.

For this test you need a portable standard with a start/stop switch. Field-testing using the disk analog allows you to check the calibration of the meter without having to install a phantom load.

1. Make sure the voltage coils are in parallel and the current coils are in series.
2. Connect the portable standard to the meter.
3. Reset the standard.
4. Observe the disk analog. Each cycle of the disk analog represents Kh watt-hours of accumulation. (The Kh value is printed on the meter nameplate.)
5. When the disk analog transitions from all segments on to all segments off, start the standard.
6. Let the disk analog scroll through a predetermined number of times (10, for example).
7. Stop the standard when the disk analog transitions from all segments on to all segments off the desired number of times.
8. Calculate the accumulated watt-hours as shown in Equation 3-1.

   Accumulated Energy = (Kh) × (the number of complete disk analog cycles)

   Equation 3-1 Accumulated Watt-hours Calculation

   For example: if Kh equals 10 and 10 complete cycles were counted, then: *10 Wh x 10 complete scrolls = 100 Wh.*
9. Compare the results of the calculation to the reading on the standard.

3.5 Shop Test

Shop testing consists of verifying the meter's accuracy.

3.5.1 Meter Shop Equipment

The meter loading equipment must be capable of maintaining accuracy while supplying energy to the meter's switching power supply. Otherwise, meters may be tested in any shop that meets the requirements outlined in the current editions of the Handbook for Electricity Metering published by the Edison Electric Institute and the American National Standard Code for Electricity Metering.

3.5.1.1 Equipment Setup

The meter mounting equipment and its electrical connections must be used as required for the meter form number on the meter nameplate. If required for the test equipment used, the test link(s) must be opened.

3.5.2 Test Constant

The meter test constant (Kt) is the number of watt-hours per calibration pulse. This value is printed on the meter label.

3.5.3 Watt-hour Test Procedure

To test the meter, proceed as follows:

1. Note the meter Kt value listed on the nameplate.
2. Select the desired voltage and current level(s) on the test equipment. (Test voltage of 120V is assumed.)
3. Install the meter in the test socket, making certain that the socket is wired and/or configured for the appropriate meter form.
4. Align the optical pickup of the test equipment with the calibration LED.
5. Begin testing according to standard test procedures. Allow 15 seconds of settling time after applying voltage before making accuracy measurements.
6. Check the meter calibration under three load conditions: full load, light load, and full load with lagging power factor. A minimum test time of 30 seconds is needed to reduce test uncertainty. (Check the instruction book for your test board or standard to determine the actual minimum test time. Standards with heavily filtered inputs may require longer test times.)

3.5.4 Var-hour Testing

GE I210+c™ meters are digital sampling meters. All quantities are derived mathematically from the same set of voltage and current sample data used to compute watt-hours. Therefore, it is only necessary to check watt-hour calibration to ensure that all revenue quantities are accurate. However, some utilities are required by their public utilities commissions to verify the accuracy of var-hour data as well as watt-hour data.

1. Use MeterMate™ software to put the meter calibration LED into VArhour pulse output mode.
2. Set up the meter for testing as described above in the watt-hour test procedure. The test pulse value is now Kt var-hours per pulse.
3. Begin testing according to your standard var-hour test procedures. Allow 15 seconds of settling time after applying voltage before making accuracy measurements.

NOTE: *Test conditions with high power factors require very long varh test times. Typically varh testing is done at 120V and 0.5 PF.*

3.6 Battery and Super Capacitor Replacement

Lithium Inorganic 3.6 Volt Battery (Safety Precautions)

- Do not expose battery to temperatures above 100 degrees C. Do not incinerate, puncture, crush, recharge, short circuit and over-discharge battery.
- The contents are water reactive and the battery contents can form HCL (hydrochloric acid), SO_2 (sulfur dioxide) and H_2 (hydrogen), upon contact with water (only when forced open). Do not expose contents of battery to water. Do not expose contents to high humidity for extended periods of time.
- Dispose of batteries in accordance with local, state and federal hazardous waste regulations.

To obtain an MSDS (Material Safety Data Sheet), contact your local GE supplier.

Super Capacitor Safety Precautions

- Do not expose super capacitors to temperatures above 100 degrees C. Do not incinerate, puncture, crush, or disassemble super capacitors.
- Dispose of super capacitors in accordance with local, state and federal hazardous waste regulations

3.6.1 Replacing the Battery

CAUTION: *Battery and super capacitor installation must be done with NO power applied to the meter.*

1. Read data from meter;
2. Remove power from the meter;
3. Remove the meter cover;
4. Disconnect the battery or super capacitor wire from the connector on the front of the nameplate carrier;
5. Grasp the front and back edges of the battery holder and squeeze them together;
6. Pull the battery holder out of the slot at the top of the nameplate carrier.
7. Remove the old battery;
8. Place the new battery in the battery holder;
9. Slip the battery holder into the slot at the top of the nameplate carrier and press down until the battery holder clicks into place;
10. Connect the battery wire to the nameplate carrier battery connector;
11. Replace the meter cover;
12. Energize the meter;
13. Reprogram meter;
14. Reset the Accumulated Outage Duration (time on battery backup) value using MMCOMM commands (Reset, Battery).

3.6.2 Replacing the Super Capacitor

The procedure for replacing the super capacitor, should that be necessary, is the same. It will take approximately 5 minutes for a super capacitor to fully charge.

3.7 Service

The GE I210+c™ meter is factory-calibrated and requires no routine or scheduled service by the user.

3.8 Repair

Factory repair or replacement service is offered when you cannot fix a problem. Because of the high density and integrated design, the repair of on-board components is not recommended. Instead, return the whole meter to General Electric as described in the following paragraph.

3.9 Returning a Meter

If you wish to return a meter, call your General Electric sales representative for a Returned Material Authorization (RMA). The entire meter should be returned with the GE supplied Returned Material Authorization information form completed. Key information includes quantity, catalog number, serial number(s) and a complete description of the problem. Your General Electric sales representative will provide return instructions.

3.10 Cleaning

CAUTION: *Care must be taken during cleaning not to damage or contaminate any gold-plated contacts of the connectors.*

CAUTION: *Do not immerse the meter in any liquid. Do not use abrasive cleaners on the Lexan covers. Do not use chlorinated hydrocarbon or ketone solvents on the covers.*

3.11 Storage

The I210+c™ meter is a durable device; however, it should be handled and stored with care. The temperature and humidity levels in storage are not critical, but extremes of either factor should be avoided.

3.12 Troubleshooting Guide

The meter displays two types of codes: Error codes begin with Er and are shown in Table 3-3. Caution codes begin with CA and are shown in Table 3-4. Problems that do not cause any display codes are listed in Table 3-5.

3.13 Errors and Cautions

The GE I210+c™ meter continually checks for internal errors, hardware failures, and cautions. These events are reported in coded form on the LCD.

3.13.1 Error Reporting

The meter continuously checks its hardware components — ROM, EEPROM, flash, battery, metering chip, and microprocessor — to ensure that they are operating properly. When the meter detects that a hardware component is not operating properly, an error is reported. Error codes are displayed as soon as they are detected. The meter can be programmed to freeze error codes in the display when an error is detected. Refer to Table 3-3 for a list of errors. If subsequent tests indicate that the hardware component is operating properly, the meter will clear the error automatically.

Table 3-3 Error Code Display

Error Display	Probable Cause	Remedy
Er 000 002	Power outage occurred, and: a. Battery disconnected. b. Battery defective.	Set meter's date and time, read meter's load profile data and restart load profile recording (if applicable), and: a. Connect battery. b. Replace battery.
Er 000 020	Hardware failure	a. Check for proper installation. b. Check for proper grounding. c. Call for factory assistance
Er 000 200	Non-volatile memory data error	a. Check for proper installation. b. Check for proper grounding. c. Call for factory assistance
Er 001 000	Firmware ROM code error	Replace meter.
Er 100 000	Meter Chip error	Replace meter.

Errors are serious events and usually indicate a condition has occurred that may have compromised the meter data. Unless GE has issued a service advisory indicating that other actions should be taken, you should remove the meter from service and contact your GE sales representative. The only exception to this rule is the Battery Failure & Power Loss error display, Er 000 002. ***Do not return meters displaying Er 000 002.***

The Er 000 002 display indicates that the meter lost time during a power outage because of a weak, missing, disconnected, or defective battery. Replace the battery and set the meter's date and time to resolve this problem. If the meter has load profile data, the load profile recording function must be restarted. Be sure to read the meter's load profile data before doing this.

TIP: *When the meter is read through the optical port, error and caution conditions are returned with the meter data regardless of what display options are chosen in the meter program.*

3.13.1.1 Er 000002—Battery Failure & Power Outage

The Battery Failure & Power Outage error indicates that the battery failed to maintain power during an outage. The meter has reverted to a demand mode of operation. The meter will increment only billing summation, and maximum demand values upon energizing the meter after loss of date/time information. It will update these values for the overall quantities and the programmed default TOU rate. TOU operations are suspended. Load profile data accumulated prior to the loss of date/time information is stored in non-volatile memory. TOU and load profile data is available for reading via the optical port or remote communication link. The battery should be replaced after reading the meter electronically to extract the data. The time and date should be programmed to resume proper TOU operations. The load profile function must be restarted to restore load profile operations. The meter can stay in service.

Date & Time:	Lost
Load Profile recording:	Stopped
Register Function:	Remains TOU, but operates as a demand meter with a default TOU rate
Program:	OK
TOU schedule:	Stopped
TOU calendar:	Stopped
Billing Data:	Total summations and max. Demands are OK (rolling billing period demand if enabled will cease, and traditional demand will begin); summations and demands for the programmed default TOU rate will also be updated.

3.13.1.2 Er 000020—Hardware Failure

The Hardware Failure error indicates that the meter detected an internal hardware failure. The meter should be taken out of service and returned to GE.

Date & Time:	Stopped
Load Profile recording:	Stopped
Register Function:	Demand Only
Program:	OK
TOU schedule:	Stopped
TOU calendar:	Stopped
Billing Data:	May be corrupt

3.13.1.3 Er 000200—Non-volatile Data Error

The Non-volatile Data error indicates a failure in the memory used to store configuration information, billing data, self-reads, event logs and load profile data. When the meter is not communicating, it continually tests the integrity of the data stored in non-volatile memory. If the meter detects an error in the non-volatile data, it sets the Non-volatile Data error. If subsequent tests pass, the error is cleared. A meter with a persistent Non-volatile Data error should be removed from service and returned to GE.

Date & Time:	OK
Load Profile recording:	May be corrupt
Register Function:	Unchanged
Program:	May be corrupt
TOU schedule:	May be corrupt
TOU calendar:	May be corrupt
Billing Data:	May be corrupt

3.13.1.4 Er 001000—Firmware Code Error

The Firmware Code error indicates a failure in the memory used to store firmware. When the meter is not communicating, it continually tests the integrity of the firmware stored in memory. If the meter detects an error in the firmware, the meter sets Firmware Code error. If subsequent tests pass, the error is cleared. A meter with a Firmware Code error should be removed from service and returned to GE.

Date & Time:	OK?
Load Profile recording:	OK?
Register Function:	Unchanged
Program:	OK?
TOU schedule:	OK?
TOU calendar:	OK?
Billing Data:	OK?

3.13.1.5 Er 100000—Meter Chip Error

The Meter Chip error indicates the meter has detected an error in the operation of its meter chip. If subsequent correct operation occurs, the error is cleared. A meter with a persistent Meter Chip error should be taken out of service and returned to GE.

Date & Time:	OK?
Load Profile recording:	Corrupt data
Register Function:	Unchanged
Program:	OK
TOU schedule:	OK
TOU calendar:	OK
Billing Data:	Corrupt data

3.13.2 Caution Reporting

The meter also checks other conditions that are of concern but do not indicate a problem with the meter hardware. The meter reports these as cautions. Individual cautions may be enabled or disabled selectively. If a caution is enabled, it can be configured to be displayed and optionally freeze the display.

Table 3-4 Caution Code Display

Caution Display	Probable Cause	Remedy
CA 000 001	Low battery. Battery failed test.	Replace battery.
CA 000 010	Meter unprogrammed. Using default values.	Program the meter.
CA 000 040	Loss of program. Programming interrupted. Using previous values.	Program the meter.
CA 000 050	Loss of program and Meter is unprogrammed. Programming interrupted, Using default values.	Program the meter.
CA 000 100	DC detected	Investigate cause of DC component.
CA 000 400	Low potential on phase A.	Check circuit voltage.
CA 000 500	DC detected and Low potential.	Check circuit voltage. Investigate cause of DC component.
CA 004 000	Demand overload warning has exceeded programmed threshold.	Check for service overload conditions. Check programming threshold value.
CA 040 000	Leading kvarh warning.	a. Disable the warning. b. Check system operating parameters if leading kvarh is unexpected.
CA 400 000	Received kWh warning. a. CT polarity is incorrect b. Energy is flowing from load to line. c. Meter's internal wiring defective	a. Check meter socket and CT wiring. b. Disable caution. Check system operating parameters if reverse energy flow is unexpected. c. Check that sensor connector is properly seated.