FCC Part 15 Certification
Test Report

FCC ID: F9CC1A-1

FCC Rule Part: 15.247

ACS Report Number: 03-0248-15C

Manufacturer: Schlumberger Electricity, Inc.
Equipment Type: Electricity Meter With Dual RF Transmitters
Model: CENTRON ™ ICARe

Installation and Operators Guide

SchlumbergerSema

CENTRON® Meter
Technical Reference Guide

Effective Date: August 2002

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CENTRON® Meter Technical Reference Guide

RES-CEN-0025-08.02

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Compliance With FCC Regulations

FCC Part 15, Class B

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These rules are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential/ commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help. This device complies with Part 15 of the FCC rules.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION

FCC Part 15, Subpart C

When equipped with a radio transmitter option, this equipment has been tested and found to comply with the limits for an intentional radiator, pursuant to Part 15, Subpart C of the FCC Rules. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause interference to radio communications.

The limits are designed to provide reasonable protection against such interference in a residential situation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception. which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one of more of the following measures:

- Reorient or relocate the receiving antenna of the affected radio or television.
- Increase the separation between the equipment and the affected receiver.
- Connect the equipment and the affected receiver to power outlets on separate circuits.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by SchlumbergerSema Inc. could void the user's authority to operate the equipment.

Factory Repair of Meters

SchlumbergerSema recommends that all repairs be performed at the factory. Certain repairs may be performed by the user; however, unauthorized repairs will void any existing warranty. All surface mounted parts must be replaced by the factory.

Repair of Meters Under Warranty

If the meter is under warranty, then SchlumbergerSema will repair the meter at no charge if the meter has failed due to components or workmanship. A return authorization number must be obtained before the equipment can be sent back to the factory. Contact your SchlumbergerSema Sales Representative for assistance.

Repair of Meters Not Under Warranty

The same procedure as above applies. SchlumbergerSema will charge for the necessary repairs based on the failure.

Service Return Address

SchlumbergerSema
Customer Repair Department
313 North Highway 11 Dock C
West Union, SC 29696

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions manual, this equipment can cause interference to radio communications. The equipment has been tested and found to comply with the limits for a Class A computing device pursuant to FCC Part 15, Class A registration of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference in which case the user will be required to correct the interference at his own expense. The user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver

Consult the dealer or an experienced radio/TV technician for help

ATTENTION

The product you have purchased contains a battery (or batteries), circuit boards, and switches. The batteries are recyclable. At the end of the meter's useful life, under various state and local laws, it may be illegal to dispose of certain components into the municipal waste system. Check with your local solid waste officials for details about recycling options or proper disposal.

North American Business Offices

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Chapter 1 General Information

This technical reference guide explains the installation, operation, and maintenance of the SchlumbergerSema CENTRON® meter family. SchlumbergerSema urges you to read the entire manual before attempting installation, testing, operation, or maintenance of a meter. To operate the SchlumbergerSema PC-PRO+® Programming Software and the PRO-READ® handheld reader programmer discussed in this manual, refer to their respective user manuals.

About This Manual

This manual contains the following information as listed in the chapter descriptions below:

Chapter 1 General Information	Provides a general description, operation, physical and functional descriptions, and complete meter specifications.
Chapter 2 Installation	Gives instructions for the proper handling and installation.
Chapter 3 Operation: Base Metrology	Describes the measurement technique used for the base metrology on the CENTRON meter.
Chapter 4 Operation: C1S	Provides a physical description and operational characteristics of the basic watthour (kWh) only meter for Clock, Cyclometer, and LCD versions.
Chapter 5 Operation:C1SD, C1ST, C1SL	Provides detailed information and theoretical operation for Demand (C1SD), Time-of-Use (C1ST), and Load Profile (C1SL) versions. Gives step-by-step procedures for accessing the three operational modes and associated displays.
Chapter 6 Operation: C1SR	Provides a physical description and the operational characteristics of the R300 900 MHz radio frequency personality module.
Chapter 7 Operation: C1SC	Provides a physical description and the operational characteristics of the CellNet personality module.
Chapter 8 Testing, Troubleshooting, and Maintenance	Provides an explanation of the testing, troubleshooting, and maintenance of the CENTRON meter.
Chapter 9 Specification Numbers and Drawings	Provides a listing of meter part numbers and drawings.

General Description

The CENTRON meter family is a solid-state, singlephase and network meter used for measuring electrical energy consumption. The CENTRON incorporates a two-piece design combining a base metrology with a variety of personality modules that snap on the standard meter base. Utilizing the Hall Effect technology for accurate power measurement, the metrology portion of the meter contains all measurement circuitry and calibration information, while the personality modules contain the register functionality and communication mediums.

Each version of the meter is distinguished by the various personality modules that mount to the standard meter metrology base (see Figure 1.1) The personality modules available include the following versions:

- Energy only—C1S (clock, cyclometer, or LCD)
- Demand—C1SD
- Time-of-Use (TOU) with Demand—C1ST
- Load Profile with TOU and Demand—C1SL
- Energy only with radio frequency AMR—C1SR
- CellNet Fixed Network—C1SC
- Energy plus demand with radio frequency AMR - R300CD

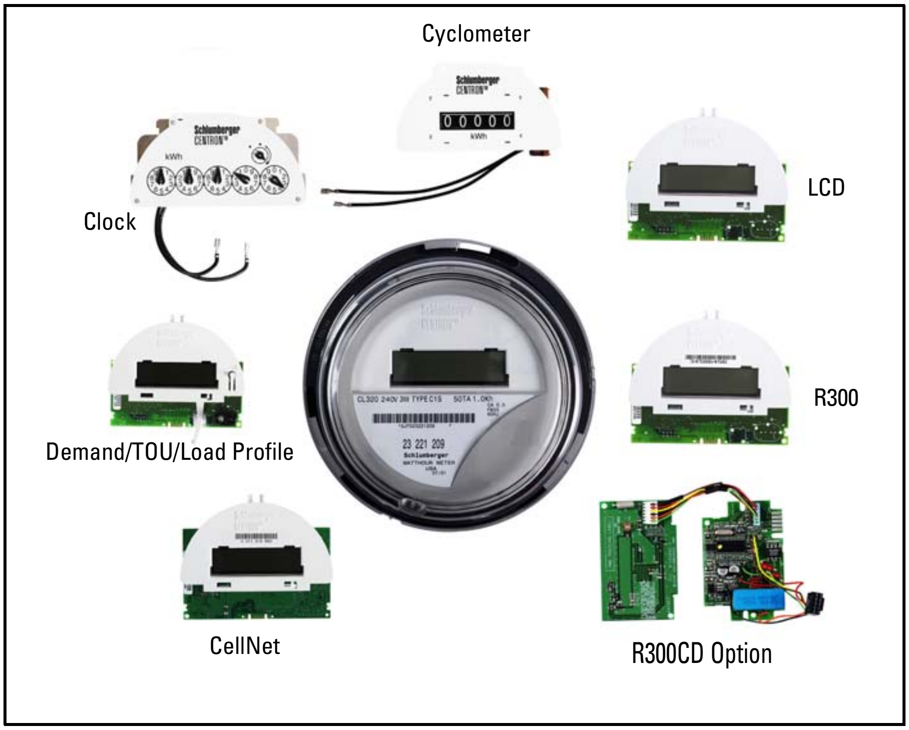

Figure 1.1 Personality Modules

Physical Description

The CENTRON meter features a common meter base to which various personality modules are attached. The covers come in configurations of polycarbonate and glass.

Meter Base

The CENTRON meter base contains all of the measurement circuitry and calibration information on a SchlumbergerSema metrology board.

The meter base assembly includes two current conductors, a flux-directing core, a Hall Effect device, the metrology circuit board, and the ultrasonically welded module support. The base also contains a MOV, metal oxide varistor, which is used to protect the meter from line surges.

Meter bases are built specific to the metering form and are available in Form 1S, 2S CL200, 2S CL320, 3S 120V, 3S 240V, 4S, and 12/25S configurations.Examples are shown in Figure 1.2, Figure 1.3, and Figure 1.4.

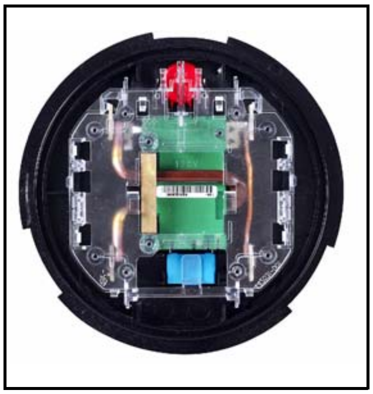

Figure 1.2 Form 1S, 120 Volt

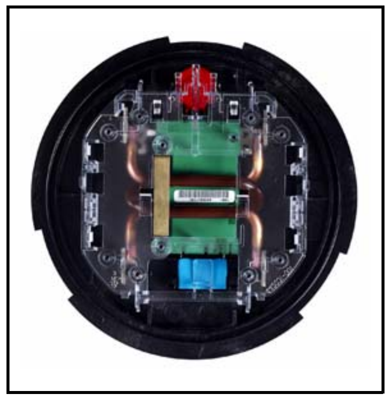

Figure 1.3 Form 2S, CL200 240 Volt

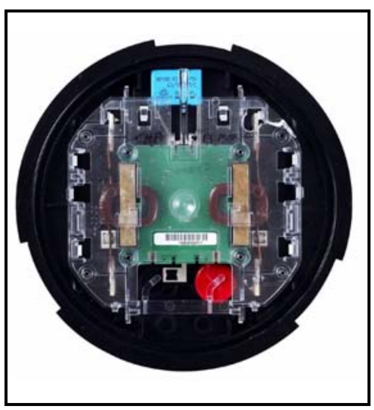

Figure 1.4 Form 4S, 20 Amp Transformer-Rated

Personality Modules

All of the personality modules in the CENTRON meter family snap into the module holder located on the standard meter base (see Figure 1.5). From the base metrology, the energy data is transmitted to the personality modules, which contain the meter display, communication mediums, and register functionality.

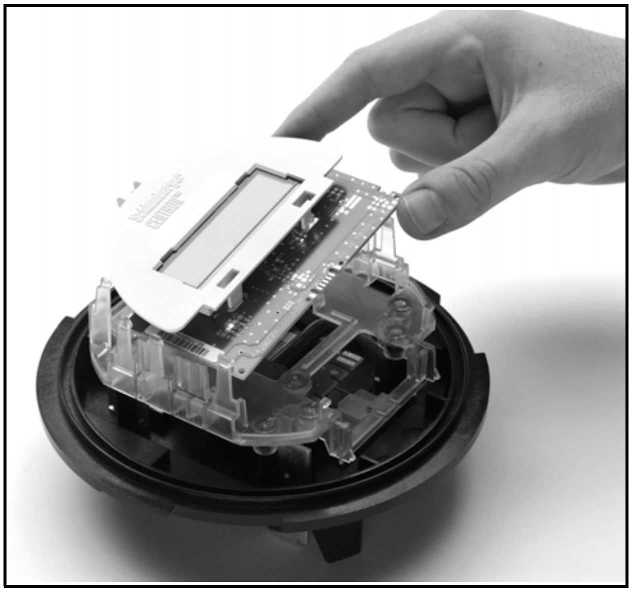

Figure 1.5 Personality Module Assembly

Product Availability

The current offerings for the CENTRON are:

Metrology	Class 100, 120V, Form 1S	Class 20, 240V, Form 4S
	Class 200, 240V, Form 2S	Class 200, 120V, Form 12S
	Class 320, 240V, Form 2S	Class 200, 120V, Form 25S
	Class 20, 120V, Form 3S	
	Class 20, 240V, Form 3S	
Personality Modules	C1S—Clock (5x1 or 4x10)	C1SC—CellNet Data System
	C1S—Cyclometer (5x1 or 4x10)	C1SD—Demand
	C1S—LCD (5x1 or 4x10)	C1ST—Time-of-Use (TOU)
	C1SR—R300C (Radio Frequency)	C1SL—Load Profile
Option Boards	R300CD	

Battery

The CENTRON C1ST and C1SL modules contain a battery that powers the clock circuit during a power outage. The battery is permanently soldered to the module and is expected to last the life of the module.

The TOU and Load Profile modules display a Low Battery error code (Er 000001) if the minutes on the battery counter exceeds 525600 minutes (1 year). Refer to Chapter 5,"Operation: C1SD, C1ST, and C1SL Versions" for detailed battery information.

Covers

The outer cover configurations available for CENTRON meter family are described in Table 1.1.

Table 1.1 Outer Cover Configurations

Meter Versions	Cover Options	
	Polycarbonate	**Glass**
C1S, C1SR, C1SC	Standard	Optional
C1SD, C1ST, C1SL	Including Demand Reset+ Optical Tower	Not Available

Outputs

The C1SD, C1ST, and C1SL personality modules are available input/output-ready (I/O-ready). These modules contain circuitry that allows future functionality expansion through I/O modules.

Display Functions

The C1S and C1SR modules can display kWh readings in either a 5x1 or 4x10 configuration.

The C1SD, C1ST, and C1SL modules can display a maximum of 32 Normal, 32 Alternate, and 8 Test display items, up to a total of 48 items.

Specifications

Electrical

Voltage Rating	120V, 240V
Operating Voltage	± 20% (60 Hz); ± 10% (50 Hz)
Frequency	60 Hz, 50 Hz
Operating Range	± 3 Hz
Battery Voltage	3.6 V nominal (C1ST, C1SL only)
Operating Range	2.7V - 3.8V
Carryover	1 year cumulative and 15 year shelf life

Operating Environment

Temperature	-40°C to +85°C
Humidity	0% to 95% non-condensing
Accuracy	± 0.5% @ unity power factor ± 0.5% @ 50% power factor
Transient/Surge Suppression	ANSI C37.90.1 - 1989 IEC 61000-4-4 ANSI C62.45 - 1992

Characteristic Data

Starting Watts		
	2S CL200	5W
	1S, 2S CL320, 12S, 25S	10W
	3S CL20	1.2W
	4S CL20	2.4W
Temperature Rise	Meets ANSI C12.1 Section 4.7.2.9	

Burden Data

Metrology	Voltage	Watt Loss	VA
1S	120	0.45	3.7
2S Class 200	240	0.45	7.2
2S Class 320	240	0.65	10.2
3S	240	0.65	10.2
4S	240	0.65	10.2
12S/25S	120	0.65	5.4

240V Register	Clock	Cyclo	LCD	R300	CellNet	D/T/L
Watt Loss	0.01	0.01	0.01	0.45	0.90	0.90
VA	—	—	—	7.16	14.76	14.76

120V Register	Clock	Cyclo	LCD	R300	CellNet	D/T/L
Watt Loss	0.01	0.01	0.01	0.28	0.90	0.90
VA	—	—	—	2.4	11.1	11.1

120V Option Board	R300CD
Watt Loss	2.2
VA	23
240V Option Board	
Watt Loss	2.2
VA	42

To get the watt loss or VA of the overall product, add the metrology watt loss to the register watt loss and option board watt loss.

VA (Meter) = VA (Metrology) + VA (Register) + VA (Option Board)

Watt Loss (Meter) = Watt Loss (Metrology) + Watt Loss (Register) + Watt Loss (Option Board)

Technical Data

Meets applicable standards:

- ANSI C12.1-1995
- ANSI C12.1-1997
- ANSI C12.20 (Class 0.5) - 1998
- IEC 61000-4-4
- IEC 61000-4-2

Dimensions

The following dimensional measurements are shown in inches and (centimeters).

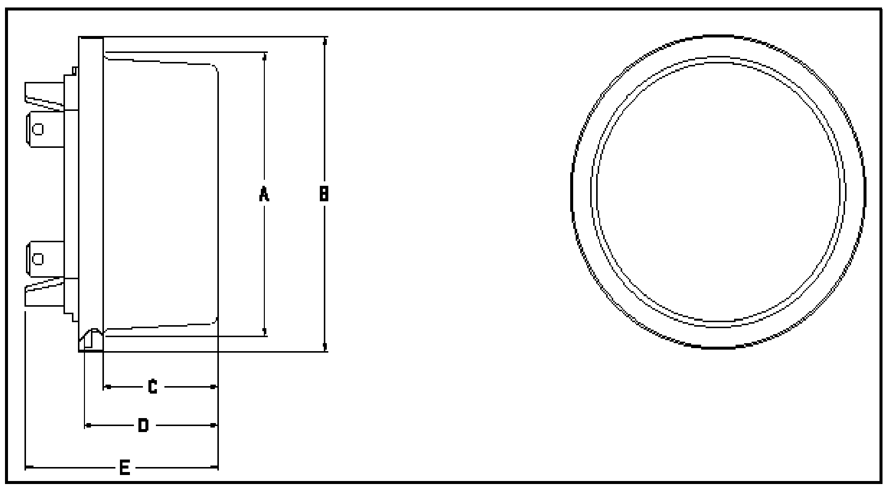

Figure 1.6 Dimensions

A	B	C	D	E
Polycarbonate				
6.29 (16.00)	6.95 (17.70)	2.70 (6.90)	3.16 (8.00)	4.53(11.50)
Glass				
6.42 (16.30)	6.95(17.70)	3.17 (8.10)	3.64 (9.20)	5.01 (12.70)

C1SD/C1ST/C1SL Dimensions

The following dimensional measurements are shown in inches and (centimeters).

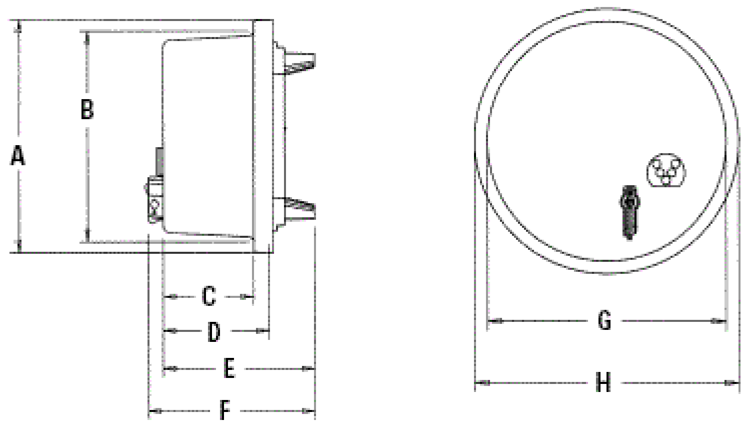

Figure 1.7 C1SD/C1ST/C1SL Dimensions

Polycarbonate							
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
6.29 (16.00)	6.95 (17.70)	2.70 (6.90)	3.16 (8.00)	4.53(11.50)	4.98(12.70)	6.29(16.00)	6.95 (17.70)

Shipping Weights

The following weight measurements are shown in pounds and (kilograms).

	Polycarbonate	Glass
Meter	1.375 (0.623)	2.75 (1.247)
4 Meters and Carton	8.90 (4.04)	13.96 (6.35)
96 Meter Pallets	214 (97.30)	335 (152.30)

Chapter 2 Installation

This chapter of the guide gives instructions for the proper handling and installation of the CENTRON meter.

Inspection

Perform the following inspections when you receive the meter:

- Inspect for obvious damage to the cover, base, and meter assembly.
- Be sure the optical connector is free of debris.
- Compare the meter and register nameplates to the record card and invoice. Verify the type, class, voltage, form number, and other pertinent data.
- Save the original packing materials.

Battery

The lithium battery is soldered to the register module circuit board (C1ST and C1SL only). A low-power mode for the battery preserves the capacity of the battery. Factory-programmed C1ST and C1SL meters should be put into service in a timely manner to avoid degradation of the battery. Programmed meters are not in low-power mode.

The product you have purchased contains a recyclable lithium battery. At the end of its useful life, under various state and local laws, it may be illegal to dispose of this battery into the municipal waste stream. Check with your local area solid waste officials for details about recycling options or proper disposal.

The C1SR also contains a tilt switch that may contain mercury. Please dispose of properly.

Storage

Store the meter in a clean, dry (Relative Humidity < 50%) environment between -40° C to +85° C (-40° F to +185° F). Avoid prolonged storage (more than one year) at temperatures above +70° C(+158° F). Store the meter in the original packing material. The lithium battery has a shelf life of approximately fifteen (15) years.

Unpacking

As with all precision electronic instruments, the meter should be handled with care in an outdoor environment. Follow these precautions when handling the meter:

- Avoid damaging the meter base, cover, reset mechanism (if supplied), and optical connector (if supplied).
- When handling personality modules, grip the circuit board by its edges. Do not touch the liquid crystal display.

Selecting a Site

The meter is designed and manufactured to be installed in an outdoor environment, at operating temperature ranges between -40° C and +85° C (-40° F to +185° F). Operation in moderate temperatures increases reliability and product life.

When using a Demand, TOU, or Load Profile meter where the line frequency is not stable, SchlumbergerSema recommends using either the C1ST or C1SL meter version with Crystal Time synchronization if a clock is needed (TOU or Load Profile).

Installing the Meter into Service

Install the meter base using standard meter installation practices.

The current and potential terminals extend as blades, or bayonets, from the back of the meter. The meter is plugged into the socket so that the bayonets engage the main socket jaws that connect to the service lines. Clamping pressure on the bayonets is provided by the heavy spring pressure of the socket jaws. In some heavy-duty sockets, jaw clamping pressure is provided by a handle or wrench.

On meters equipped with LCD displays, verify register operations by observing the display:

- LCD displays the correct number of digits (4 or 5).
- If the test mode annunciator is flashing, depress the Test mode button to return the meter to the Normal mode (C1S D/T/L only).
- If the register only displays a Segment Test (all display items shown) and flashes "**CNTRON**", the register has not been programmed.
- Verify that no errors are displayed.

Programming the C1SD,T,L Meter

The personality module should be powered prior to programming. The module can be programmed using the optical connector. The default communications rate when programming through the optical tower is 4800 baud; 9600 baud is selectable. Refer to PC-PRO+ documentation for detailed programming information.

Retrofitting with Personality Modules

CENTRON meters can be upgraded to increase functionality by changing the Personality Modules.

Do not power ON the meter without the inner cover in place. Power the meter OFF before removing the inner cover. Personality modules are sensitive to ESD damage. Take appropriate grounding measures before retrofitting!

To change or add a Personality Module:

1 Remove power from the meter.

2 Remove the outer (polycarbonate or glass) cover.

3 Remove plastic inner cover by holding the meter with both hands and applying equal pressure on either side of the three and nine-o’clock positions (see Figure 2.1). The inner cover is held in place by four plastic tabs on the meter base.

Figure 2.1 Removing the Inner Protective Cover

4 Do *one* of the following:

- If a mechanical register is present, remove the two leads that connect the register to the metrology board (see Figure 2.2).

  Mechanical registers built after June 2000 have two individual connectors that are removed by pulling away from the metrology board.

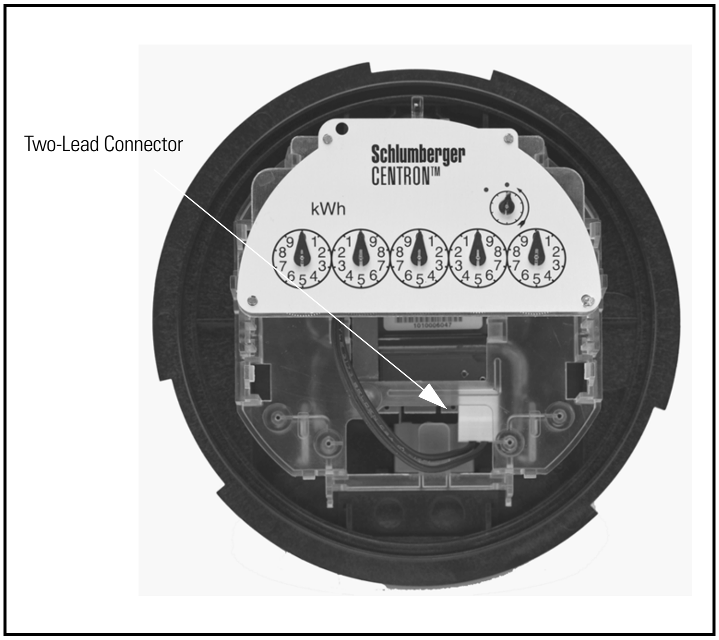

Figure 2.2 Removing the Two-lead Connector

- If an electronic register is present, remove the black board-to-board connector between the circuit board and the metrology board by pulling it by its middle while moving it side-to-side (see Figure 2.3). To maintain the integrity of the connector, only remove it when you are upgrading the meter.

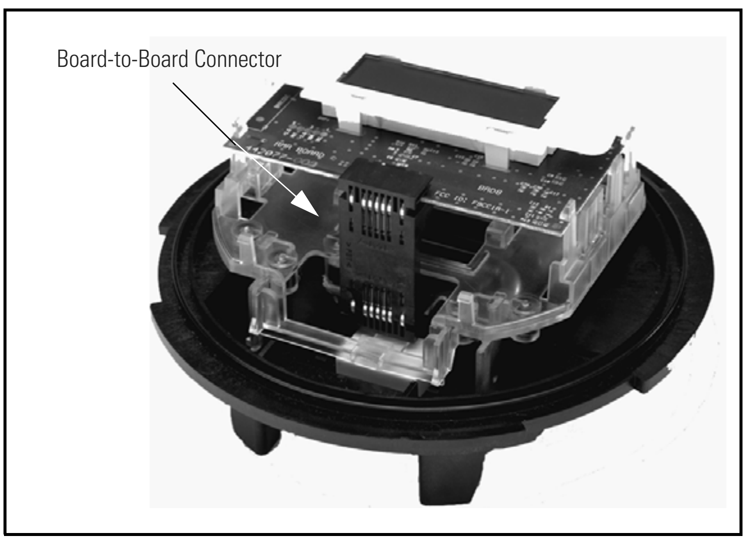

Figure 2.3 Removing the Board-to-Board Connector

5 Remove the register module, one side at a time, by pulling gently outward on the meter frame snaps (see Figure 2.4) while lifting the module up.

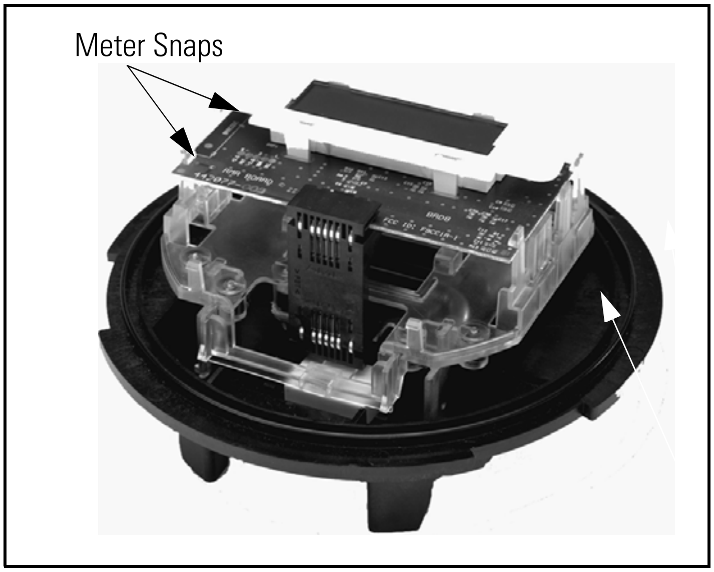

Figure 2.4 Removing the Register Module

6 Snap the new module into the meter frame by aligning the notches at bottom of the circuit board with the lower two snaps (see Figure 2.5).

The module must be aligned properly in the snaps to avoid damaging the connector or circuit board.

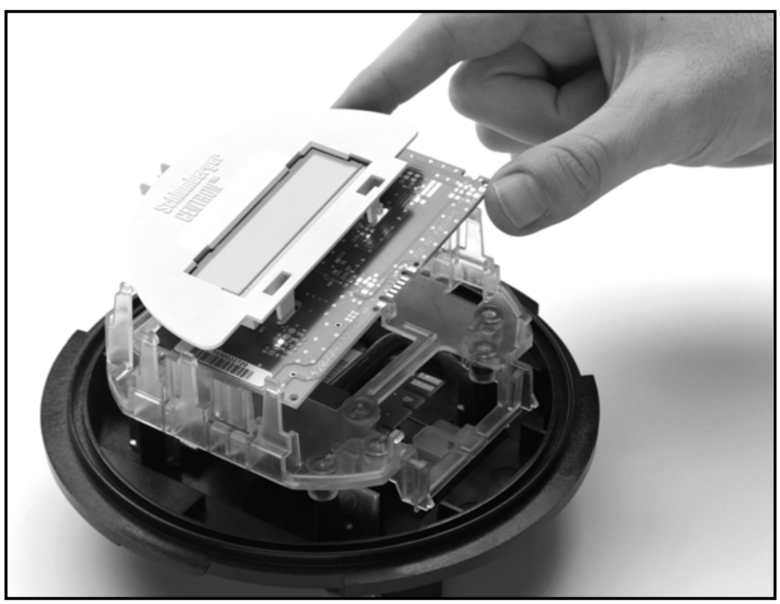

Figure 2.5 New Module Snap-in

7 Replace the board-to-board connector by aligning the top of the connector with the notches in the circuit board (see Figure 2.6) and pressing gently at the bottom of connector to mate the connector to metrology board (see Figure 2.7). Then, gently press the top of the connector to mate it to the register module (see Figure 2.8). The connector is seated correctly when you hear it snap into place.

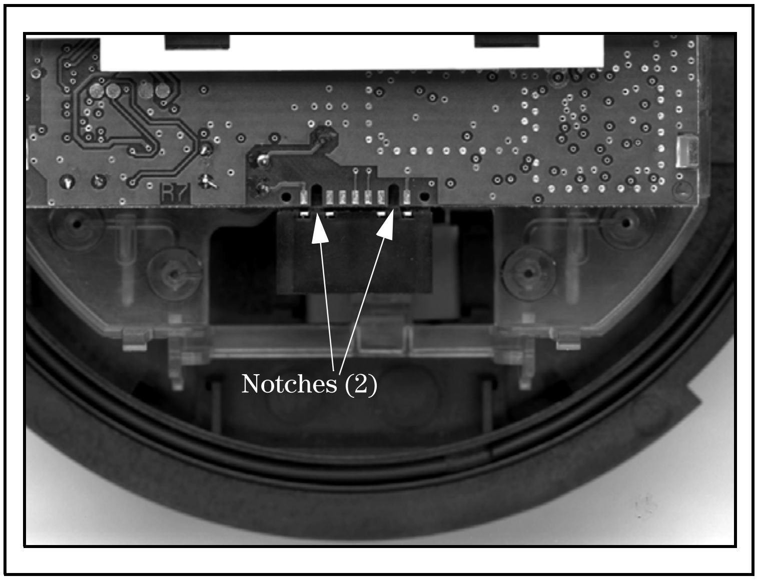

Figure 2.6 Circuit Board Notches

Be sure to use the meter base for leverage instead of the LCD holder (see Figure 2.7). Pressure on the LCD holder may damage the personality module.

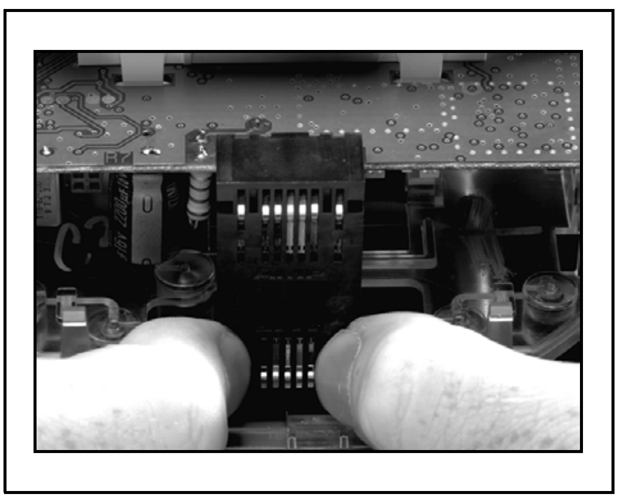

Figure 2.7 Board-to-Board Connector, Bottom

8 Ensure the board-to-board connector is fully seated by pressing firmly in on the middle of the connector.

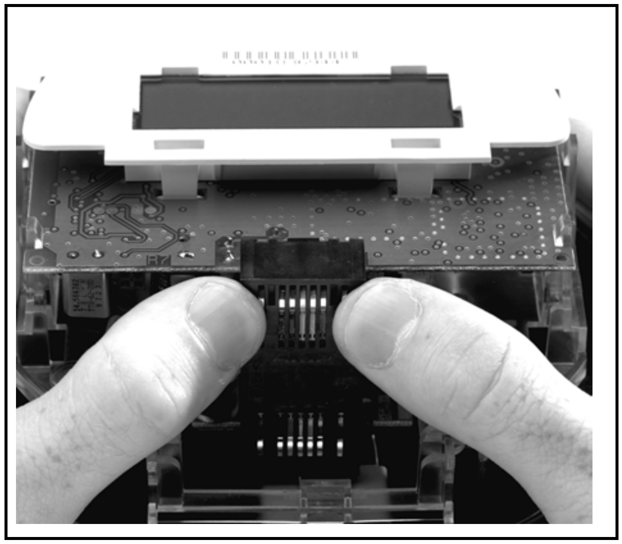

Figure 2.8 Board-to-Board Connector, Top

9 Carefully replace the inner protective cover. Engage the top snaps first, taking care to place the slot at the top of the cover over the IR light pipe. Failure to do so could break the light pipe. Ensure that all four meter base tabs are engaged with the slots at the top and bottom of the inner cover.

10 Place the cover over the meter base until the flange on the cover is flush with the flange on the meter base.

11 Turn the cover clockwise until the locking tabs are fully engaged with the meter base.

12 If the cover has a Demand Reset or an Optical Connector, be sure these are properly aligned with their corresponding accessory on the register faceplate. If not aligned correctly, the Demand Reset or Optical Connector will not function properly. If the Demand Reset plunger is not in the retracted position before turning the outer cover, the mechanism may be damaged.

Notes:

Chapter 3 Operation: Base Metrology

This chapter describes the measurement technique used for the base metrology on the CENTRON meters.

CENTRON 1S, 2S CL200, and 3S

The CENTRON meter is a solid-state meter which uses the inherent multiplication properties of the Hall Effect to measure power. The Hall Effect principle relies on a physical property: a conductor which carries a current in a magnetic field generates a voltage difference across the conductor proportional to the product of the current and the magnetic field.

The voltage V_{out} created at the output of the Hall device:

$$V_{out} = Ki_b \times B$$

Where

i_b is the biasing current (derived from the line voltage)
B is the magnetic field density (derived from the line current)
K is the Hall coefficient (analogous to a gain factor in any meter)

K could be viewed as the Hall sensor intrinsic gain and is maximized by the appropriate choice of semiconductor materials that have been uniquely optimized by SchlumbergerSema for the CENTRON meter.

For the metering application, the biasing current i_b applied to the sensor is generated from the line voltage (V) using a resistor (R).

$$i_b = V/R$$

The magnetic field (B) is generated by the line currents ($I = I_1 + I_2$) that flow through two conductors looped around the core.

$$B = C \times I = C \times (I_1 + I_2)$$

Where

C is a constant that is dependent upon the geometric and magnetic properties of the coil

This field is focused to flow through the Magnetic Core's air gap where the Hall sensor is precisely positioned. The voltage, *Vout*, which is formed on the Hall Effect device is proportional to the input watts (see Figure 3.1).

The output voltage of the Hall Effect device is then:

$$V_{hall} = Vout = GIV = GPower$$

$$\text{Where } G = (C/R)K$$

G is the combined gain factor of the entire system (Voltage to biasing current, line Current to flux density, Hall sensor).

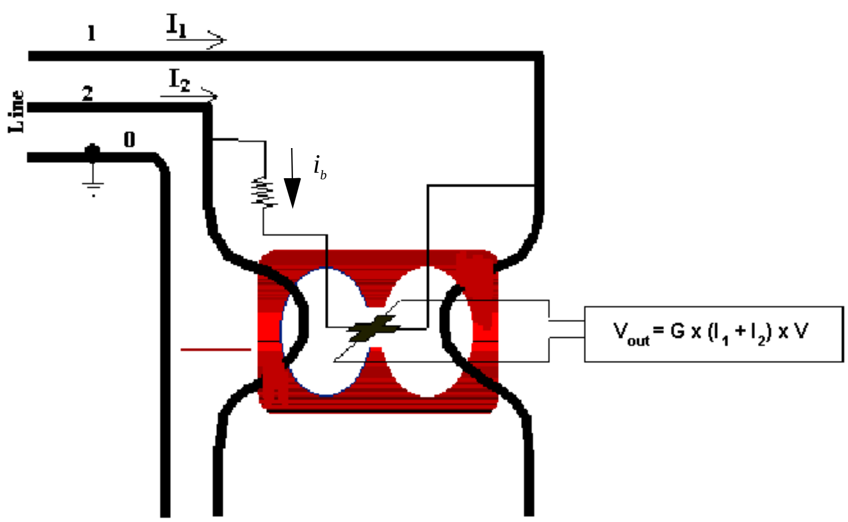

Figure 3.1 Power Measurement Principle in 2S

From the power information available at the output voltage of the sensor, the meter architecture is simplified over previous designs as the multiplication has already taken place (see Figure 3.2).

The Hall sensor output voltage is amplified by a differential amplifier in order to bring the signal within the nominal level of the analog to digital converter (ADC). The output of the ADC is integrated over time to get the energy information and generates a pulse stream that is accumulated into a counter. When the accumulated pulses reach a threshold set by meter calibration, a Wh pulse is emitted and the meter LED is flashed. The counter threshold is programmed at the factory and serves as the permanent gain calibration for the life of the product. The calibration is a digital feature and has no variation or adjustment. All the processing steps described above are integrated into a SchlumbergerSema Application Specific Integrated Circuit (ASIC) to improve reliability and reduce cost.

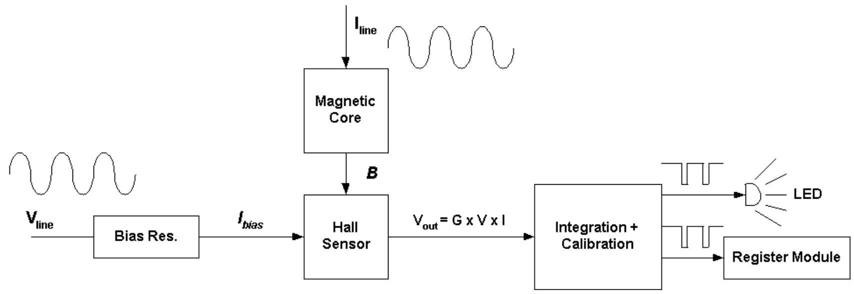

Figure 3.2 Simplified CENTRON Architecture

The custom ASIC cancels all the offset generated by the meter and removes the need for a light load adjustment of the metrology. This allows the meter to have excellent accuracy over a very large dynamic range, especially at the low current levels. For this reason, no offset adjustment is needed or provided for the CENTRON meter.

There is a slight phase shift in the current to flux density conversion due to eddy currents in the magnetic core material. This shift causes a small power factor error that is uniform across the dynamic range (load curve) of the meter. SchlumbergerSema compensates for this shift in the CENTRON by the use of a capacitor in the biasing current circuit. This correction is permanent.

The custom ASIC provides:

- Wh pulses to drive the Test LED

  The same signal is also provided to the electronic register attachments.
- energy direction (sign)
- 60Hz clock signal synchronized with the line voltage (for time keeping)
- pulse that drives the stepper motor for the mechanical register attachment (1 pulse every 10 watthours)

The metrology board, which houses the measurement components described above, passes the following signals to the personality module attached to the meter base:

- When a cyclometer or clock register is used, the motor pulse signals drives the single pole stepper motor.
- When an electronic module is used, the Wh pulse, energy direction, and 60Hz clock are provided by the metrology. The two line voltages (one is referred to as meter ground), and power supply references are also supplied for reference purposes.

An inherent feature built into the design of each CENTRON ensures that the calibration of the product is not affected by any electronic board (existing or planned) added to the meter. This is achieved by a distributed power supply and documented design requirements in the CENTRON developer's kit.

CENTRON 2S CL320, 4S, 12/25S

The advanced metering forms of the CENTRON (2S CL320, 4S, and 12/25S) meter use the same Hall Effect measurement principle that is used in the form 1S, 2S, and 3S metering forms described earlier in this chapter.

The major difference with these metering forms is the presence of two Hall cells, magnetic cores, and ADCs (see Figure 3.3).

For these metering applications, the biasing current *Ibias* (I_{bias1} and I_{bias2}) applied to each sensor is generated from the line voltage (V_{line1} and V_{line2}) using a resistor. The magnetic field is generated by the line current (I_{line1} and I_{line2}) that flows through the conductor looped around each core. The voltage (V_{out1} and V_{out2}) that is formed on each Hall Effect device is proportional to the watts produced by each phase.

Each Hall sensor output voltage is amplified by a differential amplifier in order to bring the signal within the nominal level of the ADC. ADC 1 sums the signal from ADC 1 and ADC 2. The output of ADC 1 is integrated over time to get the energy information. Each time the integrated signal exceeds a predetermined amount of energy, a pulse is generated. The pulse stream is accumulated into a counter. When the accumulated pulses reach a threshold, a Wh pulse is emitted and the meter LED is flashed. The counter threshold is programmed at the factory and serves as the permanent gain calibration for the life of the product. The calibration is a digital feature and has no variation or adjustment. ADCs 1 and 2 are calibrated independently, which means that each phase is calibrated independently.

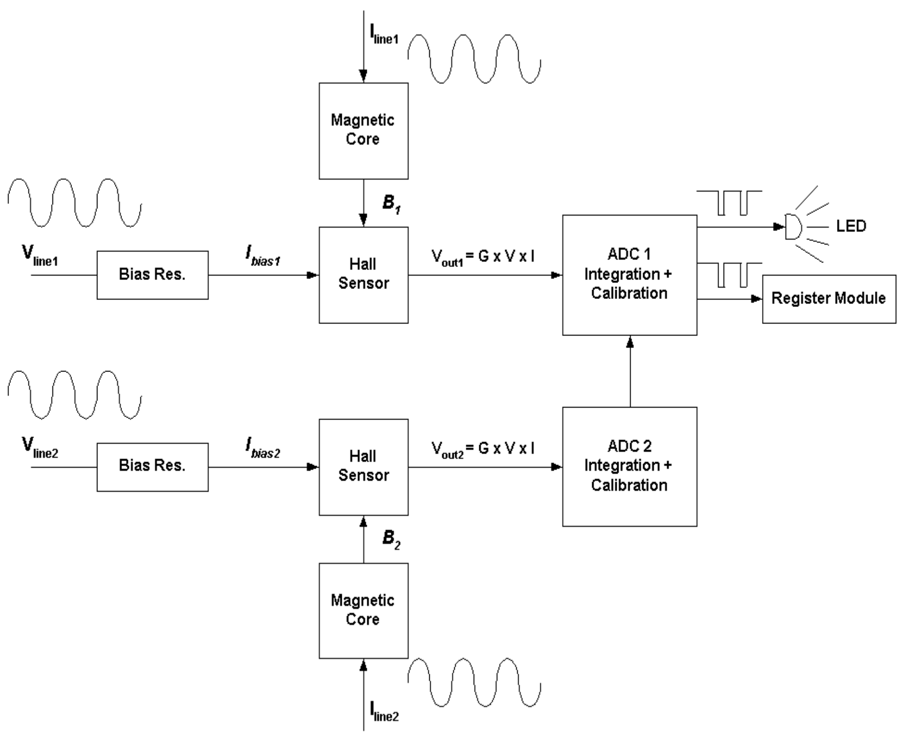

Figure 3.3 Hall Cells and ADCs

Chapter 4 Operation: C1S Version

The kWh only version of the CENTRON meter is available with one of three personality modules to register energy accumulation:

C1S Clock Register C1S Cyclometer Register C1S LCD Register

Figure 4.1 C1S Personality Modules

All three modules are interchangeable and may be ordered with a 5x1 or 4x10 register for self-contained meters, and a 5xTR or 4xTR register for transformer-rated meters.

The kWh only version of the CENTRON provides very accurate measurement for energy accumulation for today's needs, but also provides a platform for easy upgrade to higher functionality in the future.

Physical Description

The CENTRON Personality Modules snap into the meter register mounting brackets to ease installation of the board.

The clock and cyclometer modules are connected to the metrology board via a two-wire connector that easily attaches to the edge of the metrology board (see Figure 4.2). Clock and cyclometer modules manufactured after June 2000 are attached via two individual connectors. A pulse is sent every 10 watthours from the metrology board to these modules. This pulse drives the electromechanical stepper motor which, in-turn, drives the movement of the clock or cyclometer dials. A test dial is located above the two right meter dials on every clock module. One revolution of the test dial is equivalent to 1 kWh.

The LCD module is connected to the metrology board using the board-to-board connector. The following information is sent to the LCD module from the metrology board:

- Line voltage
- Reference voltage
- Energy flow direction
- Energy pulse data
- Line frequency

A connector is located at the 12 o'clock position behind the LCD for resetting the energy register. This is done using the ZRO-C2A Resetter.

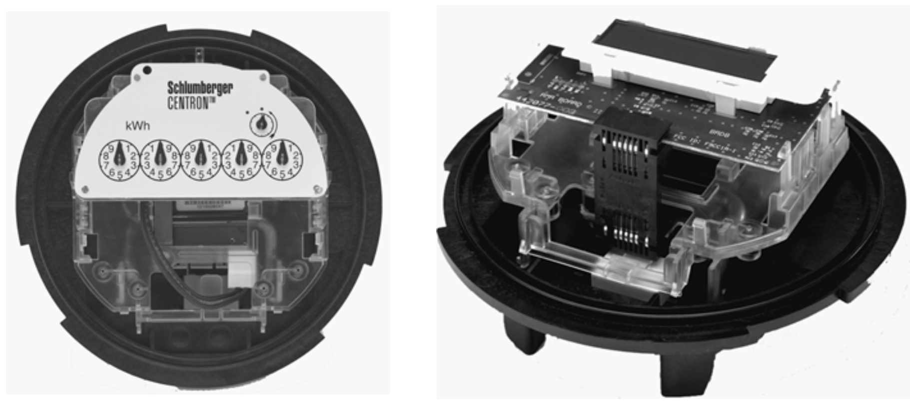

Figure 4.2 Mounted Clock and LCD Registers

Registers

Kilowatt Hours

The modules display energy in increments of whole values of kWh. Standard operation for all modules is to add forward and reverse energy flow. Therefore, if the meter is inverted, the registers will accumulate in the forward direction, thus providing uni-directional operation. At the time of order, the LCD module can be selected to have a detent register. Programmed at the factory, this feature will cease registration while the meter is inverted, or power flow is otherwise reversed.

Resetting Values

The pointers on the clock module are spring fitted to their staffs and can be easily repositioned to reset the register (see Figure 4.3).

Figure 4.3 Clock Register

To reset the cyclometer register dials:

1 First move the spring-loaded wire off of the hook that holds it in place.

When the hook is in place, it puts tension on the individual cyclometer dials. After moving the wire off of its hook, a washer that helps to hold the dials in place will be free to move on the dial axle.

2 At that point, move all of the dials to the left (as viewed from the front of the cyclometer). From right to left, one by one, move each dial to zero.

3 After each dial is set to zero, press it to the right and hold all zeroed dials in place. They will interlock with each other and will not move.

4 After resetting each dial to zero, keep the dials locked together, move them to the right side, and reset the spring-loaded wire to its hooked resting place.

5 Be sure to secure the washer against the left-most dial with the hinge by replacing the spring-loaded wire on the left side of the washer.

At that point, the spring-loaded wire will place tension against the washer and dials and the cyclometer will be ready to operate again.

The ZRO-C2A (see Figure 4.4) resets the energy register through a direct connection to the connector at the 12 o'clock position on the LCD and R300 modules.

Figure 4.4   ZRO-C2A Resetter Connected to the CENTRON

The ZRO-C2A is a pocket-sized handheld device for resetting the electronic meter readings in the CENTRON LCD kWh meter (C1S) and the R300 meter (C1SR). The ZRO-C2A also resets the tamper indicators in the C1SR.

The ZRO-C2A requires that the meter **Not Be Powered**. The device connects to the CENTRON meter through a hole in the plastic inner cover located at the 12 o'clock position on the meter (see Figure 4.4). Extending from the ZRO-C2A is a cable terminating in a connector which mates to the programming connector of the CENTRON.

Beginning February 20, 2002, the C1SR module for the CENTRON meter uses a new EEPROM component. This new EEPROM operates at a different voltage level requiring revision to the CENTRON resetter.

Use of a ZRO-C or ZRO-C2 resetter without the C2A upgrade *WILL CAUSE DAMAGE* to the personality modules on both the C1S LCD and C1SR meters produced after the new EEPROM implementation date; damaged modules will show "Error" on the display.

All current production resetters and resetters produced after June of 2001 were built with the C2A upgrade and are labeled accordingly as shown in Figure 4.5 below. Although personality modules with the new EEPROM are only compatible with the C2A version of the CENTRON resetter (ZRO-C2A), the older revisions of the personality modules are also compatible with the ZRO-C2A.

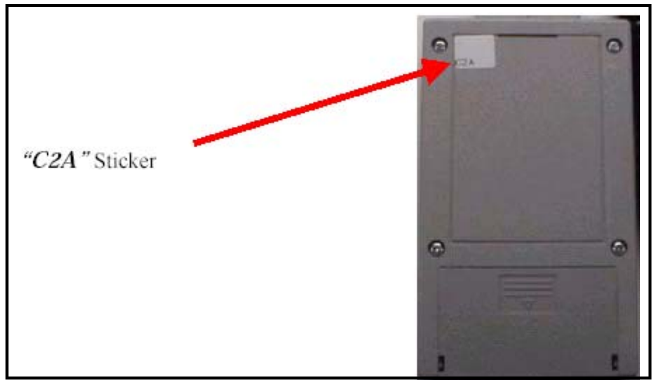

Figure 4.5 Reverse Side of ZRO Resetter

LCD Display Function

Two separate versions of the LCD are available. Both versions may be configured for either four or five digits and will roll over at 100,000 KWh. The LCD is automatically adjusted for contrast over the operating temperature range.

The non-segment check version displays only the kWh reading. A downward pointing arrow on the LCD pulses at a rate equal to the energy consumption (see Figure 4.6). The arrow flashes on for 1 watthour and off for 1 watthour. This effectively produces an equivalent Kh of 2.0.

Infrared LED Kh is 1.0.

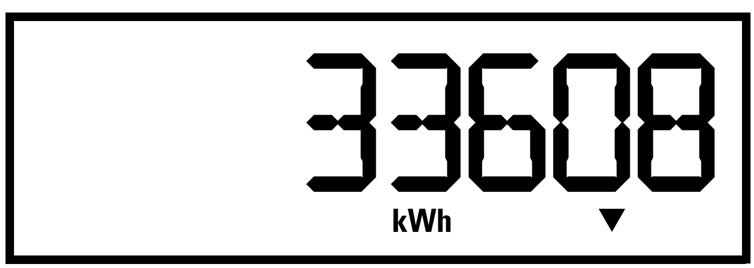

Figure 4.6 LCD Display without Segment Check

A second version of the LCD is available which displays the kWh reading and a segment check (see Figure 4.7). The display scrolls between the kWh reading and segment check with 7 seconds of on-time for each display item.

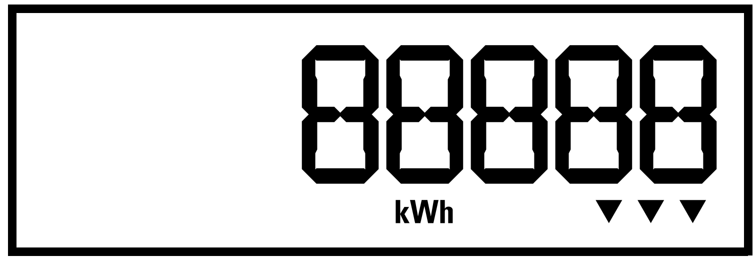

Figure 4.7 LCD Display with Segment Check

The three triangle segments in the bottom right corner of the display represent a watt disk emulator. This electronic load indicator will advance with each pulse, since each pulse is equivalent to one watthour. Reverse power is indicated by a reversal in the direction of the electronic load indicator.

Stepper Motor Revision

As of May 2000, the stepper motor connector on the CENTRON C1S Clock and Cyclometer personality modules, as well as the mating connection point on the metrology board was revised. This revision, as shown in Figure 4.8 below, will increase accessibility when removing or installing the registers.

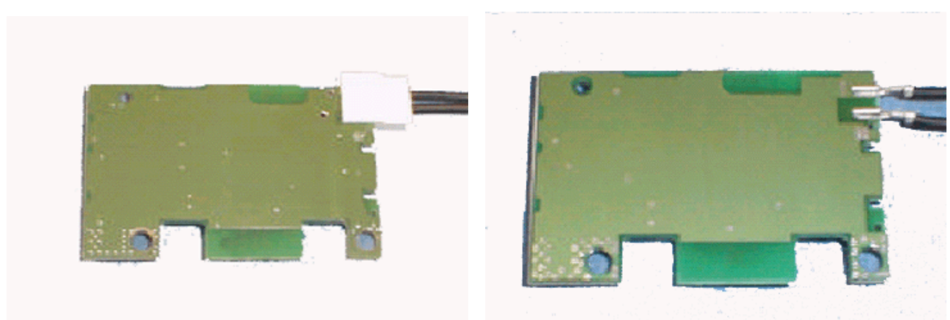

Figure 4.8 Stepper Motor Connections

When replacing the stepper motor, be sure to order the proper motor for your configuration.

Chapter 5 Operation: C1SD, C1ST, and C1SL Versions

The CENTRON meter is available with interchangeable personality modules that snap-into the standard CENTRON metrology base. The three multifunction modules available include the following versions:

- C1SD—a demand module
- C1ST—a Time-of-Use (TOU) module with demand
- C1SL—a load profile module with TOU and demand

Figure 5.1 C1SL Meter with Cover

These personality modules utilize the SCS protocol which allows the C1SD, C1ST, and C1SL meters to mimic the SchlumbergerSema 200 Register Series product line for use with existing systems.

Features

Features of these multifunction modules include:

- **Non-Volatile Memory**—Programming, register, and load profile data are stored in the EEPROM during a power outage. The TOU and load profile modules contain a battery that maintains the clock circuitry during a power outage.
- **Optical Port Communication**—Each module can be programmed to communicate 9600 or 4800 baud through the optical tower.
- **Self-Read Capability**—Billing data can be stored automatically at programmable times to be read later.
- **Load Profile**—The C1SL module provides 32K RAM for load profile data.
- **Expansion Capability**—An expansion port is available for future functions.

- **Bidirectional Metering**—All three multifunction versions are capable of measuring and displaying forward and reverse energy only (kWh). These modules have two separate registers; one for forward kWh and one for reverse kWh. When the meter is programmed with electronic detent, both the forward kWh register and the reverse kWh register will be utilized. When the meter is programmed to be undetented, the forward and reverse energy will accumulate in the forward kWh register.

The C1SD, C1ST, C1SL modules are available with an LCD display and a polycarbonate cover. The cover contains the optical port adapter and demand reset button.

Controls and Indicators

All controls and indicators are shown in Figure 5.2. For detailed instructions about a feature or control, refer to the appropriate subsection.

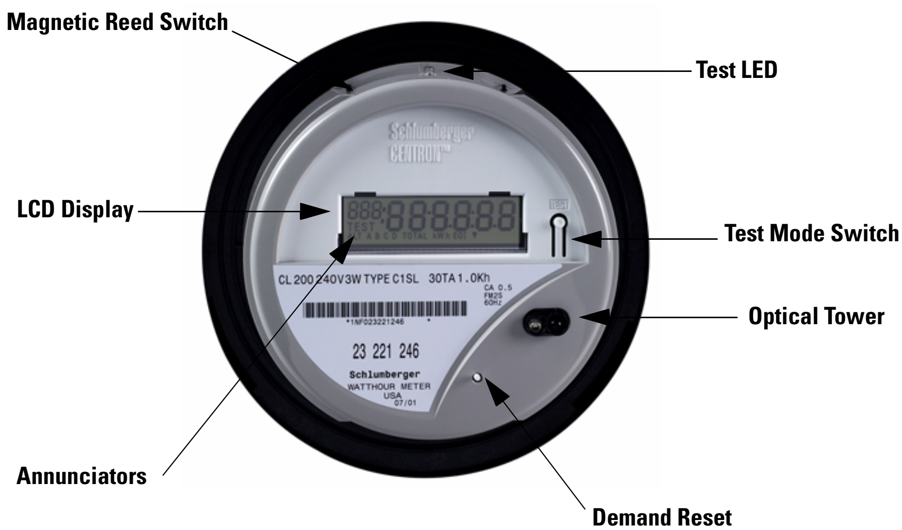

Figure 5.2 C1SL Controls

Modes of Operations

When the C1SD, C1ST, and C1SL modules are powered, they automatically enter the normal display mode, perform self-diagnostics and display any appropriate error codes. If no error codes are detected, an unprogrammed module will alternate between **CNTRON** and **Segment Test**. A programmed module will scroll through the Normal display sequence, displaying each selected quantity, annunciator, and code number for the programmed duration.

The C1SD, C1ST, and C1SL modules each have three modes of operation:

- Normal
- Alternate
- Test

Normal Mode

In Normal mode, the module display automatically sequences through the programmed displays and annunciators in the programmed sequence. Each parameter is displayed for the program-specified period (from 1 to 15 seconds), followed by a blank display for one second. Only the annunciator appropriate to the selected module display can appear while its data is displayed. Each display can have a two-digit identifier. If selected, this code can be programmed to be any number from 00 to 99.

Calculations are performed to obtain programmed quantities. Specific details of the calculated values are covered under Programmable Functions in this section. The meter will continue to operate in Normal mode until power is disconnected, the Alternate display sequence is initiated, Test mode is selected, or an error condition occurs.

Alternate Mode

The Alternate mode provides an additional set of customizable display items that are not typically used for billing applications. The Alternate mode is accessible only from the Normal mode and is activated using either the magnetic reed switch or a meter programming device. To activate the Alternate mode using the magnetic reed switch, move a small magnet (approximately 30 gauss) near the reed switch located at the 10 o'clock position on the side of the module (see Figure 5.2). The magnetic reed switch can be accessed with the meter cover in place. To activate the Alternate mode with a programming device, refer to the PC-PRO+ documentation. Immediately upon activation, Alternate mode is indicated by a flashing ALT annunciator. The ALT annunciator will not appear if there are no Alternate mode display items programmed.

Once the Alternate mode has been selected, the display will sequence once through the alternate program items and return to the Normal display sequence. The quantities displayed are selected during programming and have the same display timing as in Normal mode. Like the displays in Normal mode, each display in Alternate mode can have a two-digit identifier, programmable from 00 to 99. The calculations and operations performed in Alternate mode are identical to those in Normal mode.

Test Mode

Selecting the Test mode causes the current interval demand to be compared to the stored maximum demand and the current billing data to be transferred to non-volatile memory. If the current interval demand value is greater than the maximum demand, the current interval demand becomes the maximum demand. All Test mode program parameters are then retrieved from nonvolatile memory for use in the Test mode. In the C1SL version, a status bit is set to indicate the register was placed in Test mode.

The Test mode can be activated while in either Normal or Alternate mode using the Test mode switch (see Figure 5.3) or a meter programming device. To activate the Test mode with a programming device, refer to the PC-PRO+ documentation. Immediately upon activation, the Test mode is indicated by a flashing "TEST" annunciator in the lower left hand corner of the module display. The TEST annunciator will not appear if there are no Alternate mode display items programmed.

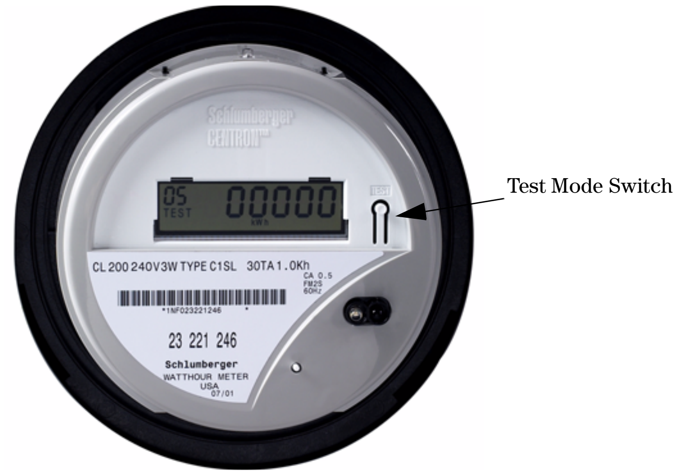

Figure 5.3 Test Mode

Refer to the PC-PRO+ documentation for information on selecting the Test mode using a programming device. A programmable "Time-Out Length" from 1-to-99 minutes is available. After the programmed Time-Out Length has ended, the register will automatically exit the Test mode. The demand test interval is initialized whenever the Demand Reset button is pressed.

The magnetic reed switch, when activated, advances the Test mode display to the next quantity. Calculations performed in Test mode are performed in the same manner and based on the same program parameters as in Normal mode with the exception of interval (subinterval) length. Test mode interval length and the number of subintervals are specified independently for Test mode. The results are displayed according to the display configuration selected when the register is programmed. To exit the Test mode and return to the Normal mode, do *one* of the following:

- De-energize the meter.
- Push the Test mode button.
- Wait for the selected Test mode time-out to occur.

Calculated values performed in Test mode are not added to previous billing values or stored for retrieval. After exiting Test mode, all billing data previously transferred to nonvolatile memory is retrieved, an End of Interval (EOI) is initiated, and a new demand interval begins.

Any time-dependent events such as rate switches, self-read, or daylight savings time that occur while the meter is in Test mode are performed when the Test mode is exited.

Low Power Mode

The demand, TOU, and load profile modules are shipped from the factory in low power mode unless factory programming is specified at time of order. This mode consists of a default program and minimizes drain on the battery. The user can place the meter in low power mode by performing a three button reset or by programming the meter with the programming software as a demand-only meter. While the module is on battery carryover, the display will show "on battry" while the power is off. This can be observed by viewing the display at an angle at close range.

Low power mode can be verified in one of the following ways:

- By observing that the minutes on battery counter does not increase during a power outage.
- By observing the display during a power outage (from close range at an angle) and verifying that the display does not show “on battry”.

See "Three Button Reset" on page 5-24 for instructions.

Displays

A nine-digit liquid crystal display, with a variety of annunciators, is provided on these multifunction personality modules (see Figure 5.4).

Figure 5.4 Display

Six large digits are available to display all billing and informational data. Three decimal points are provided for programmable resolution of billing data.

Three small digits in the upper left-hand corner of the display are used to provide code numbers to identify any display item. These three digits are used along with the six data digits to display ID numbers such as the meter serial number and user fields.

There are three triangle segments in the bottom right corner of the display that represent a watt disk emulator. This electronic load indicator will advance with each pulse, since each pulse is equivalent to one watthour. Reverse power is indicated by a reversal in the direction of the electronic load indicator.

Directly below the three code number digits is the Test mode annunciator (TEST). This annunciator will flash on and off once per second whenever the meter is in Test mode.

On the far left of the bottom line is the Alternate mode annunciator (ALT). This annunciator will flash on and off once per second whenever the meter is in Alternate mode.

To the right of the Alternate mode annunciator are the TOU rate indicators (A, B, C, D, Total). These indicators correspond to the four programmable TOU and TOTAL rate. The TOU rate indicators can be programmed to be displayed with the appropriate energy and demand quantities. When an energy or demand quantity for the currently active TOU rate (A, B, C, or D) is displayed, the corresponding TOU rate indicator will flash on and off once per second.

To the right of the TOU rate annunciators is the kWh annunciator. This annunciator can be programmed to display with any energy quantity. The kWh annunciator can be programmed to display as kW with any demand quantity.

The EOI annunciator is located to the right of the kWh annunciator. This annunciator will turn on for four seconds at the end of each demand interval (or at the end of each subinterval when rolling demand is used).

Programmable Functions

The CENTRON can be programmed using SchlumbergerSema's programming software: PC-PRO+ or PC-PRO+ 98.

Table 5.1 describes each display item and indicates the display mode in which each is available. The display items and sequence of their display, along with any desired annunciators or Identification (ID) code numbers, are selected during the programming process. Detailed information on these display items can be found in the PC-PRO+ documentation.

Table 5.1 LCD Display Items

	Display Mode		
Display Item	**Normal**	**Alternate**	**Test**
kWh	x	x	x
Maximum kW Demand	x	x	x
Cumulative kW Demand	x	x	
Continuous Cumulative kW Demand	x	x	
Previous Interval kW Demand	x	x	x
Self Read kWh	x	x	
Self Read kW Demand	x	x	
Last Season Billing Values (TOU only)	x	x	
Present Interval Demand kW Demand	x	x	
Segment Test	x	x	
Time Remaining in (Sub) interval	x	x	
Meter ID (up to two 9-digit fields)	x	x	
User Defined Fields (up to three 9-digit fields)	x	x	
Firmware Version	x	x	
Software Version	x	x	
Number of Times Programmed	x	x	
Number of Demand Resets	x	x	
Number of Power Outages	x	x	
Number of Days Since Demand Reset	x	x	
Demand (Sub) interval Length	x	x	
Register Full Scale Value	x	x	
Kh Value	x	x	
Demand Threshold Value	x	x	
P/DR Value	x	x	

Table 5.1 LCD Display Items

	Display Mode		
Display Item	**Normal**	**Alternate**	**Test**
Register Multiplier	x	x	
Date (C1ST and C1SL version only)	x	x	
Time (C1ST and C1SL version only)	x	x	
Day of Week (C1ST and C1SL version only)	x	x	
Date of Last Reset (C1ST and C1SL version only)	x	x	
Time of Last Reset (C1ST and C1SL version only)	x	x	
Time on Battery Carryover (min) (C1ST and C1SL only)	x	x	
Program ID Number	x	x	
TOU Schedule ID (TOU only)	x	x	
Input Pulse Count			x
Previous Interval Pulse Count			x
Time Remaining in Test Mode			x

Register Display Options

All calculated billing quantities to be displayed are specified through the programming software. The following billing quantities are available for display in the Normal and Alternate modes:

- kWh
- Received kWh
- Max kW Demand
- Cumulative kW Demand
- Continuous Cumulative kW Demand
- Previous Interval kW Demand
- Self-read kWh
- Self-read kW Demand

Energy and demand registers can be programmed to be displayed in any of the specified formats (see Table 5.2).

Table 5.2 Register Display Formats

	3 Digits	4 Digits	5 Digits	6 Digits
Demand		X.XXX	XX.XXX	XXX.XXX
	X.XX	XX.XX	XXX.XX	XXXX.XX
	XX.X	XXX.X	XXXX.X	XXXXX.X
	XXX	XXXX	XXXXX	XXXXXX
	X.X.X*	X.X.X.X*	XX.X.X.X*	XXX.X.X.X*

Table 5.2 Register Display Formats

	3 Digits	4 Digits	5 Digits	6 Digits
Energy	XX.X XXX	XXX.X XXXX	XXXX.X XXXXX	XXXXX.X XXXXXX
*indicates floating decimal point format				

Self Reading

The C1SD is capable of storing one block of self-read data consisting of kWh and maximum kW. The TOU versions, the C1ST and C1SL, will store one block of self read data consisting of kWh and kW for all rates when a self-read is performed. Self-read data is displayable in Normal or Alternate mode.

A self-read is programmed to initiate in one of three ways:

- Read on manual or electronic demand reset. When a demand reset is initiated, all energy and maximum demand quantities are immediately transferred to non-volatile memory.
- Read on a programmed day of the month (C1ST and C1SL only). A specified date (1st - 28th) can be programmed into the meter to indicate the exact day that a self-read is to be performed. On this date at 00:00 hours, register readings are transferred to nonvolatile memory.

  If desired, an automatic demand reset can be performed after this self-read.

Only the first 28 days of the month can be selected since February has only 28 days.

- Read on a programmable number of days since the last manual or automatic demand reset (C1ST and C1SL only). If the selected number of days (1 to 150) passes without a demand reset, a self-read is initiated.

If desired, an automatic demand reset can be performed after this self-read.

Last Season Registers

For a C1ST or C1SL meter, Last Season Registers are selectable in the programming software. For every Current Season Register there is a Last Season Register for the same quantity. Last Season registers are stored in memory when a season change occurs. Last Season registers are designated as LS in the programming software. Last Season Registers are selectable for display in Normal and Alternate modes.

Operating Parameters

Programmable parameters establish the meter's configuration and define its operation in Normal, Alternate, and Test modes (see Table 5.3). Only parameters specific to the Test mode are displayable in Test mode. Parameters that can be uploaded using a reading device, but cannot be displayed on the meter are indicated with an asterisk.

Table 5.3 Programmable Parameters

Parameter	Description
Display Scroll Time *	The number of seconds (1 to 15) that each item is to be displayed before the next item appears.
Cold Load Pickup Time *(CLPU)	The number of minutes (0-255) before demand calculations are restarted after a recognized power outage occurs. Setting this value to zero will cause demand calculations to start immediately following a power outage.
Power Outage Length Prior to CLPU *	The number of minutes (0 to 255) that power must be out for the CLPU to take effect. Defining this value as zero will cause CLPU to be activated after any recognized power outage.
Normal Mode Demand Interval Length	The time in minutes (1 to 60) that each demand interval lasts before a new interval begins. Valid interval lengths are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60 minutes.
Test Mode Demand Interval Length*	The time in minutes (1 to 60) that each Test mode demand interval lasts before a new interval begins. Valid interval lengths are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60 minutes.
Normal Mode Number of Subintervals*	The interval length divided by the sub-interval length is equal to the number of subintervals. Valid entries are from 1 to 10 and must be evenly divisible into the demand interval length. For block demand, the number of subintervals is 1.
Test Mode Number of Subintervals*	The interval length divided by the sub-interval length is equal to the number of subintervals. Valid entries are from 1 to 10 and must be evenly divisible into the demand interval length. For block demand, the number of subintervals is 1.
Register Full Scale	A kW demand value that defines the maximum rated demand for a particular meter installation. Valid entries range from 0 to 999999.
Test Mode Timeout	The number of minutes the meter will remain in Test mode before exiting to Normal mode. This timeout function is active when Test mode has been activated via remote communications. Valid entries range from 1 to 99 minutes.
Operating Frequency*	The operating frequency must be programmed to 50 Hz or 60 Hz line operation.
Line or Crystal Sync*	The real time clock can be synchronized off the input line frequency or the internal crystal.

Table 5.3 Programmable Parameters

Parameter	Description
Register Multiplier	A programmable value that is used in calculations of energy and demand readings. This can be used by setting the register multiplier equal to the CT ratio times the PT ratio of the installation for primary read meters. Valid entries are from 1 to 9999. **Note:** Energy and demand display formats should be adjusted accordingly.
Optical Communications Baud Rate*	The optical communications default baud rate is 4800 baud, however, a rate of 9600 baud is selectable.
Expansion Port Comm. Baud Rate*	The expansion port communications default baud rate is 2400 baud; however, rates of 300, 1200, 2400, 4800, and 9600 baud are selectable.
*Indicates parameters that can be uploaded to a reading device but cannot be displayed.	

Informational Data

The following items are for information purposes (see Table 5.4). All informational data, except those items indicated by an asterisk, can be displayed in Normal and Alternate modes.

Table 5.4 Information Data Items

Item	Description
Time and Date of Maximum Demands (C1ST and C1SL only)	The time and date that each maximum demand occurred for A, B, C, D and Total Rates.
Time Remaining in (Sub) interval	The amount of time in minutes and seconds before the end of the current demand interval.
Segment Test	The display illuminates all segments and selected annunciators on the LCD in order to verify proper operation. The watt disk emulator continues to function normally.
Meter ID Numbers 1 and 2	Two separate nine digit display items that can be used to identify the meter with an alpha character displayed as a dash, a space displayed as a blank, and a number displayed as the appropriate value.
User Fields	Up to three separate user fields are available to display any desired numerical information. Each user field can be up to nine digits in length with an alpha character displayed as a dash, a space displayed as a blank, and a number displayed as the appropriate value.
Firmware Revision	A sequential number identifying the firmware revision level of the meter. This number is automatically provided and does not require operator input.

Table 5.4 Information Data Items

Item	Description
Software Revision	A sequential number identifying the revision level of the software used to program the meter. This number is automatically provided by the programming software and does not require operator input.
Number of Times Programmed	A counter identifying the number of times (up to 9999) the meter has been programmed.
Number of Power Outages	A counter identifying the number of times (up to 9999) the meter has recognized a power outage.
Number of Demand Resets	A counter identifying the number of times (up to 9999) a demand reset has occurred.
Number of Days Since Demand Reset (C1ST and C1SL only)	A counter identifying the cumulative number of in service days since the last demand reset.
Date and Time of Last Reset (C1ST and C1SL only)	The date and time of the last demand reset.
Date and Time Last Programmed (C1ST and C1SL only)	The date and time the meter was last programmed.
Date (C1ST and C1SL only)	The current date recognized by the meter
Time (C1ST and C1SL only)	The current time recognized by the meter. **Note:** For time of occurrence registers, time is displayed as HH:MM:SS. All dates are displayed in the format chosen in the programming software.
Day of Week (C1ST and C1SL only)	A single digit denoting the current day of the week is displayed where Monday is denoted by a one and Sunday by a seven.
Time on Battery (C1ST and C1SL only)	A counter identifying the cumulative number of minutes, 0 to 999,999, the meter has been in battery carryover mode.
Program ID Number	A three digit number identifying the program downloaded to the meter.
TOU Schedule ID Number (C1ST and C1SL only)	A three digit number identifying the TOU rate schedule downloaded to the register.
TOU Expiration Date *	A date that indicates when the register's TOU schedule will no longer be valid.
Register Full Scale Value	A kW demand value that represents the maximum rated demand for a particular meter installation. Exceeding this value triggers error code 100000.
Demand Threshold Value	A programmed threshold value in kW that determines when the demand threshold output turns on.
Mass Memory Size * (C1SL only)	The amount of mass memory actually being used for recording of interval data. Valid entries are 0 to 32K, in 8K increments.
Note: * Indicates parameter that can be uploaded to a reading device but cannot be displayed.	

Test Mode Data

The following items shown in Table 5.5 can be displayed in Test mode.

Table 5.5 Test Mode Data Items

Item	Description
Time Remaining in the (Sub) interval	The amount of time in minutes and seconds before the end of the current Test mode demand interval.
Maximum kW	The maximum demand since the meter was put into Test mode. This value will be set to zero each time a demand reset is performed.
Previous kW	The kW demand of the previous Test mode subinterval/ interval.
Input Pulse Count	The number of pulses that have been received since the last reset in Test mode. **Note:** The display will be updated with each input pulse.
Previous Interval # of Input Pulses	The number of pulses received during the last complete interval or subinterval in Test mode.
KWh	The energy accumulated in Test mode.
Present (Accumulating) kW	The calculated demand value as it increases from the start of a demand test interval to the end of the subinterval/ interval.
Time Remaining until Test Mode Timeout	The amount of time in minutes and seconds before the programmed Test mode timeout counter will expire.

Programming the Meter With a 200 Series Program

A CENTRON meter can be programmed using an existing Series 200 program. This procedure is a two-step process. First, export the 200 Series program you want to use to a CENTRON file format and then import that file into PC-PRO+ as follows:

1 Open the Program Editor.

2 Select **File** | **Export**.

The Export screen shown in Figure 5.5 is displayed.

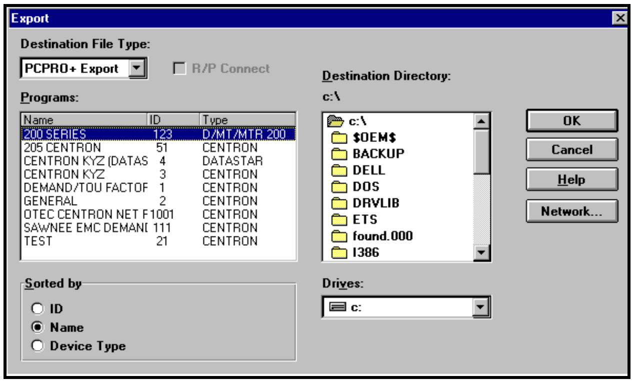

Figure 5.5 Program File Export

3 Select the 200 Series program to export from the list of available **Programs**.

4 Click **OK**.

The Program File Export Type screen is displayed.

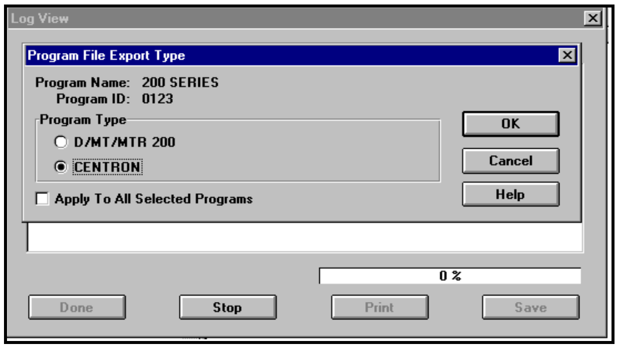

Figure 5.6 Program File Export Type

5 Select **CENTRON** export format as shown in Figure 5.6 above.

6 Click **OK**.

The file you selected in Figure 5.5 is converted to a CENTRON format. The program ID remains the same, but the file type becomes CENTRON.

7 Select **File | Import**.

The Import screen shown in Figure 5.7 is displayed.

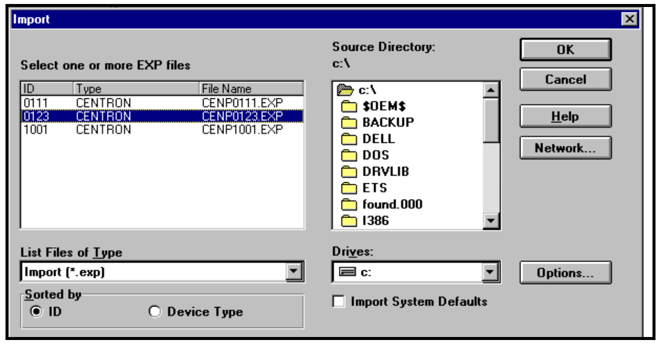

Figure 5.7 Import Screen

8 Select the CENTRON program to import from the list of available EXP files.

9 Click **OK**.

The program is loaded into the Program Editor. Edit as necessary before saving and using to program the meter.

Demand Reset

A demand reset can occur in both Normal and Alternate modes.

A demand reset can occur in two ways:

- Through the optical port using a compatible programming device
- With the standard push-button demand reset switch located on the face of the meter (see Figure 5.2)

When a demand reset is initiated, the following events occur:

- As an indication of a demand reset, the display flashes all eights for six seconds.
- The current maximum demand values are added to the corresponding Cumulative Demand values.
- A self-read is performed (if selected).
- All Maximum Demand values are reset to zero. All corresponding times and dates of maximum demands are cleared (C1ST and C1SL only).
- The number of demand resets is increased by one.
- The number of in-service days since the last reset is set to zero.
- The time and date of the last reset is updated (C1ST and C1SL only).
- The normal mode display resumes. Exception is when in test mode, the display resumes with next item in display list.

As a security feature, additional manual demand resets are prevented for 60 seconds following a demand reset.

When a demand reset is performed on a meter programmed for Block Demand, the current interval becomes the first interval in the next billing period. For Rolling Demand, all previously completed subintervals are zeroed. The current subinterval becomes the first subinterval in the next billing period. In Test mode, a demand reset will initialize the demand test interval.

Time-of-Use

TOU Schedules

The Time-of-Use capability is available on the C1ST and C1SL personality modules. It requires additional circuitry to store TOU schedule information and a battery for time-keeping purposes during power outages. Schedule information is programmed on a PC using the PC PRO+ software packages.

When using TOU functions on a meter, energy and demand registration are segregated into time blocks during the day. Each time block can be one of four rate periods. In addition to these four rate periods, a total rate is also available.

Calendar Schedule

The calendar schedule contains all daily and yearly information necessary to perform TOU metering. This schedule contains rate schedules, daily schedules, seasons, holidays, and daylight savings time dates. For information on the entry of these parameters into PC-PRO+, refer to the PC-PRO+ documentation.

Rate Schedules

Four independent rates are available for TOU registration-designated A, B, C, and D. Only one of these rates can be active at a time. The Total register is always active, regardless of the active rate period. The currently active rate is indicated by a flashing rate-specific annunciator.

Daily Schedules

Up to four daily schedules are available. Each schedule defines the beginning and ending time of each of the four available rate periods (A, B, C, and D). Up to 32 switch points per rate may be specified for each daily schedule.

Weekdays, Saturday, Sunday, and holidays can be assigned to one of the four daily schedules. Therefore, one to four daily schedules may be used in any combination with the days of the week.

Seasonal Schedules

A season is a period of continuous days during the year when a particular rate schedule is in effect. The year can be divided into a maximum of eight seasons. If multiple seasons are not used, the TOU schedule contains one year-round season. The Daily Schedules can be defined differently for each season. Up to eight Season Change dates are specified for each year in the Calendar Schedule.

Season changes occur at midnight of the Season Change date (where midnight corresponds to 00:00 hours) or can be programmed to occur at the first demand reset following the Programmed Season Change date.

Holiday Schedules

Up to twenty-two holidays can be designated per year in the Calendar schedule. One of the four Daily schedules is assigned to each of the Holidays in the Calendar Schedule.

Daylight Savings Time

Daylight Savings Time switch points occur at 2:00 A.M. on the first Sunday in April and the last Sunday in October. These dates are pre-assigned in the Calendar Schedule; however, they can be modified by the user. The user can also elect not to recognize Daylight Savings Time and operate the meter in standard time only.

Registers

Current Season Register

All energy and demand registers selected for the active season are considered current season registers. If a single rate schedule is applicable year-round, then only current season registers are used.

Last Season Registers

Last Season Registers are selected when two or more seasons are used during the year. For every Current Season Register there is a Last Season Register for the same quantity. Last Season Registers are designated LS in the programming software. Last Season Registers can also be selected for display in Normal and Alternate display modes.

Operation

At the end of a specified season, all Last Season Registers are updated with Current Season register data. The meter can be programmed to activate an automatic demand reset at a season change. A season change can be programmed to occur at midnight at the beginning of the programmed Season Change date or at the first demand reset following the Season Change date.

Season Change

The following events take place when an automatic demand reset occurs at season change:

- The Current Season energy registers are copied directly to the Last Season energy registers.
- The Current Season maximum demand registers are copied directly to the Last Season maximum demand registers and added to the cumulative demand registers.
- After the demand reset, the maximum demand registers are reset to zero. Both the cumulative and the continuous cumulative demand registers are copied to the Last Season cumulative and continuous cumulative demand registers, respectively.

If there is no demand reset at season change, all current season registers are directly copied to Last Season registers at season change but no current season registers are zeroed.

Load Profile Specifications

Capacity

The C1SL module provides 32k bytes of EEPROM for one channel of interval load profile data. The amount of installed EEPROM actually used for load profile recording is programmable from 1 to 32k bytes in one kbyte increments.

34 bytes of the 32k bytes is reserved for firmware and software parameters.

Bit Resolution

The mass memory is configured for 12 bit data resolution. Equivalent pulse count resolution per interval is as follows:

Bits = 12
Pulse Counts = 4096

Interval Lengths

The load profile records data on a block interval basis. The interval length is programmable: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 minutes. This interval length is independent of the interval length chosen for displayed demand quantities.

Power Outage

The C1SL module can flag an interval when a power outage exceeds a specified number of seconds. The power outage duration is programmable from 0 to 255 seconds.

Channel Configurations

The Load Profile register has one channel of interval load profile data. This channel corresponds to kWh. The pulse constant is programmable from 0.02 to 99,999 watthours per pulse in 0.01 increments. This pulse constant applies to secondary readings only. For example, a watthour pulse constant of 1.8 corresponds to 1.8 watthours per pulse.

Some example pulse weight calculations:

Example 1: Calculation of Pulse Weight

If the customer pulls a 240V, CL200, singlephase, Form 2S electromechanical meter from service, with the following:

Meter Kh = 7.2 watthours/disk revolution

Pulse Initiator = 4 pulses/disk, revolution

then this electromechanical meter has the following pulse weight (PW):

$$PW = \frac{Kh}{PDR} = \left(\frac{7.2 \text{ watt hours}}{\text{disk revolution}}\right) \Big/ \left(\frac{4 \text{ pulses}}{\text{disk revolution}}\right)$$

$$PW = \frac{1.8 \text{ watt hours}}{\text{pulse}}$$

If this meter is replaced by a Load Profile register of the same form number, voltage and current ratings, and if the utility wants the register to operate the same way, the pulse weight would be entered in the customer files as 1.8 watthours per pulse.

Example 2: Calculation of Pulse Weight

A Load Profile register on a singlephase, 240V, CL200, meter is programmed so that kWh is recorded into mass memory. The maximum 12-bit data resolution is desired for 15 minute intervals.

First, calculate the maximum watthour accumulation during 15 minutes intervals:

$$\text{Wh, Max} = 240\text{volts} \times 200\text{A} \times 1\text{phase} \times 0.25$$

$$\text{Wh, Max} = 12,000 \text{ watt hours}$$

The maximum number of pulses is 4095; therefore, the smallest pulse weight (PW) that can be used is:

$$\text{PW, Min} = \frac{12,000\text{Wh}}{4095\text{P}} = \frac{2.94\text{Wh}}{\text{Pulse}}$$

Data Storage

The Load Profile register stores data in mass memory at the end of each interval. This data stored is the pulse data for that interval. This process continues for each interval until sixty intervals have been recorded. The mass memory is grouped into segments of sixty intervals defined as a record or block. In addition to the profile data, each record contains the following information:

Time Tag		Specifies the month, day, and hour of the end of the data record (or block).
Power Outage		Status bit is set for each interval during which a power outage occurs (interval status).
Status Bits		There are four types of status bits written into each data block:
	Time Adjust	Status bit set along with power outage bit when time is adjusted with Load Profile running.
	Saturation	Status bit is set when the pulse count for any interval in the block exceeds 4,095 pulses.
	RAM Error	Status bit is set if any memory address within the record fails the memory check (block status).
	Field Test	Status bit is set if Test mode is activated during an interval.
Register Readings		A register reading is maintained in the data record to be used for data validation. This register reading is updated at the end of each interval.

Recording Duration

Use the following equation to determine the recording duration for the load profile register:

$$\text{Duration (days)} = \frac{M \times 1024}{107} \times \frac{I}{24}$$

M= Memory size in kilobytes

I = Interval Length in minutes

Truncate all decimals before multiplying by I/24.

Table 5.6 Recording Duration for 32Kb

Interval Length (min)	Recording Duration (days)
1	12.75
2	25.50
5	63.75
10	127.50
15	191.25
30	382.50
60	765.00

Optional Features

Electronic Detent

Programming electronic detent prevents received energy from accumulating in the delivered energy register. When detent is enabled, the received energy is accumulated in a separate register.

Expansion Port

A connector located on these personality modules provides the option of using expansion modules (when available), such as the R300CD board in conjunction with the C1SD, C1ST, and C1SL personality modules.

Security Codes

Register security can be provided with primary, secondary, and tertiary security codes that prevent unauthorized communication with CENTRON products. A Primary security code allows complete access to the meter. A Secondary security code allows full read access with limited write access to perform an automatic demand reset and to access the Alternate and Test modes. A tertiary security code allows read-only access. For more information about security codes, refer to the PC-PRO+ documentation.

Calculations

Energy

Calculation of energy is continuously incremented by multiplying the energy pulse weight by the measured energy. The energy pulse weight is calculated by the following formula:

$$\text{kWh Pulse Weight}\left(\frac{\text{kwh}}{\text{Pulse}}\right) = \text{Kh} \times 1000 = \text{Register Multiplier}$$

The energy in a given interval is the product of the number of pulses received during that interval times the pulse weight:

$$\text{Energy(kWh)} = \text{Number of Pulses} \times \left(\frac{\text{kWh}}{\text{Pulse}}\right)$$

Demand

Calculation of demand is always based on rolling or block intervals. Demand calculations use three constants; the watthour constant (Kh), the demand interval length, and the register multiplier.

The weight of an incoming pulse is determined according to the following formula:

$$\text{kW pulse weight}\left(\frac{\text{kw}}{\text{pulse}}\right) = \text{Kh}/1000 \times \text{Register Multiplier} \times 60/\text{Dem. Int. Length}$$

The demand in a given interval is the product of the number of pulses received during that interval times the pulse weight:

$$\text{Demand(kW)} = \text{Number of Pulses} \times \text{kW Pulse Weight}$$

The Demand value is continuously compared against the stored maximum value. If a demand value is greater than the corresponding maximum demand, it is saved as the new maximum demand. If the demand value is less than the corresponding maximum demand, it is discarded. At the beginning of an interval, the current interval demand is reset to zero and new demand values begin accumulating.

Demand Calculations

Block Interval Demand

Block demand corresponds to the number of subintervals being equal to one. At the end of every interval, the microprocessor compares the last completed block interval demand value to the demand value in memory. If the new value is greater than the stored value, the new demand value is stored as Maximum Demand. When a demand reset occurs, maximum demands are reset to zero and the current interval continues. C1SD will begin a new demand interval. New maximum demand values are calculated.

Rolling Interval Demand

For rolling interval demand, the programmed number of subintervals make up the demand interval. At the end of every subinterval, the microprocessor calculates a demand value based on the last full demand interval. When a demand reset occurs, all Maximum Demands are reset to zero along with all completed subintervals. The current subinterval continues (unless C1SD) accumulating data and the new maximum demand value(s) is (are) calculated for the next subinterval.

Cumulative Demand

When a demand reset is performed, Maximum Demand values are added to the existing corresponding Cumulative Demand values and written into memory as the new Cumulative Demand values. These values remain in storage until the next demand reset.

Continuous Cumulative Demand

Continuous Cumulative Demand is the sum of Maximum and Cumulative Demand at any time. The calculated interval demand is continuously compared to the previous Maximum Demand. If this demand is a new peak, it is stored as a Maximum Demand and adjusts the continuous cumulative register to reflect the new demand. A demand reset signal clears the Maximum Demand value, but does not affect the Continuous Cumulative reading.

Previous Interval Demand

Previous interval demand is the calculated demand from the most recently completed demand interval. When using rolling interval demand, this quantity is updated after each subinterval. Previous interval demand is not saved in non-volatile memory. When an interval is completed the demand value is transferred to the previous interval demand register for display. Upon power up or demand reset, the previous interval demand register is set to zero and is updated when the first subinterval is complete.

Present Interval Demand

The present interval demand value is the demand value at the present time normalized to the demand interval length. Present demand reports the calculated demand value as it increases from the start of a demand interval to the end of the interval. For rolling demand intervals, present demand reports the calculated demand value from the present subinterval as it is accumulating with the previous set of subintervals.

Power Procedures

Applying Power

Personality Modules are powered directly from line voltage via the board-to-board connector. These modules are energized when AC power is present. During power outages, the permanently installed lithium battery runs the clock circuit on C1ST and C1SL versions. The battery normally lasts for the life of the meter. However, in the unlikely event of a low battery notification, the battery or Register Module may need to be replaced.

DO NOT REMOVE THE ELECTRONICS' HOUSING WHILE THE METER IS POWERED. LINE LEVEL VOLTAGES ARE PRESENT ON THE CIRCUIT BOARD. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH. THE WARNING LABEL SHOULD ALWAYS BE VISIBLE ON THE HOUSING.

Battery Life (Load Profile & TOU)

The CENTRON TOU and Load Profile personality modules have a permanently soldered battery present on their circuit boards. This battery powers the clock when power is disconnected from the meter. The module program is transferred to EEPROM for recall when power is restored.

The battery life is longer for the CENTRON TOU and Load Profile modules than the J5 200 Series electromechanical hybrid meters. The capacity of the new battery is larger than equivalent older products, and the current consumption is reduced with new electronics technology.

In the process of determining this factor, battery life calculations are made assuming worst case conditions for both the battery capacity (at the lowest end of the manufacturer published initial limit) and the meter current consumption (assuming all the components are at the maximum side of their published tolerance).

The battery is also assumed to be operating at a self-discharge rate equal to a constant average temperature of 160°F. At this temperature the battery will lose 2% of its capacity per year (see dashed curve in Figure 5.8).

The design assumes that a significantly higher average temperature would increase the self-discharge and that a lower average temperature would lower the self-discharge.

The battery technology used is Lithium Thionyl Chloride. The battery life calculations use a safety factor that takes into account the increase in battery internal resistance as it approaches its end of life. This increase in internal resistance occurs before the battery voltage starts decreasing under open circuit conditions. This 80% limit for the maximum capacity usage is factored into the design.

Classical observation of the open circuit voltage would lead to an overly optimistic battery life and the likelihood of product failure before the detection circuit tripped. SchlumbergerSema believes this is a major improvement in design robustness to classical voltage detect circuitry and will avoid misleading diagnostics.

The curve in Figure 5.8 shows the CENTRON battery usage in amp-hours for the chosen scenario. The total time over the 15-year life of the product takes a battery carryover (no power applied) of 1 year (cumulative) and is shown as the initial year on the graph. In reality, it will likely be spread over the life of the product. Figure 5.8 shows there is significant margin available for the "on power operation" at 15 years, even at the 80% limit curve (historically, the low battery would be flagged at the battery capacity line). When 20% of the battery capacity remains, the internal resistance starts increasing exponentially, and the current characteristics of the battery degrades as can be seen from the chart.

With the assumption that the "low power mode" is used when the meter is not in field operation (entered from a three button reset), the current drain from the battery has the same value as the current drain under AC power which means an increase to the battery life.

Meters shipped from the factory unprogrammed or meters removed from the field and given a 3-button reset will not use battery carryover time.

A register displays the Low Battery error code (Er 000001) if the minutes-on-battery counter exceeds 525,600 minutes (1 year). The battery is no longer good when the Worst Case Battery Usage line crosses the 80% maximum usage line.

This means that the battery life for the CENTRON is a conservative estimate of 15 years with or without the 365 days (12 months) of continuous carryover.

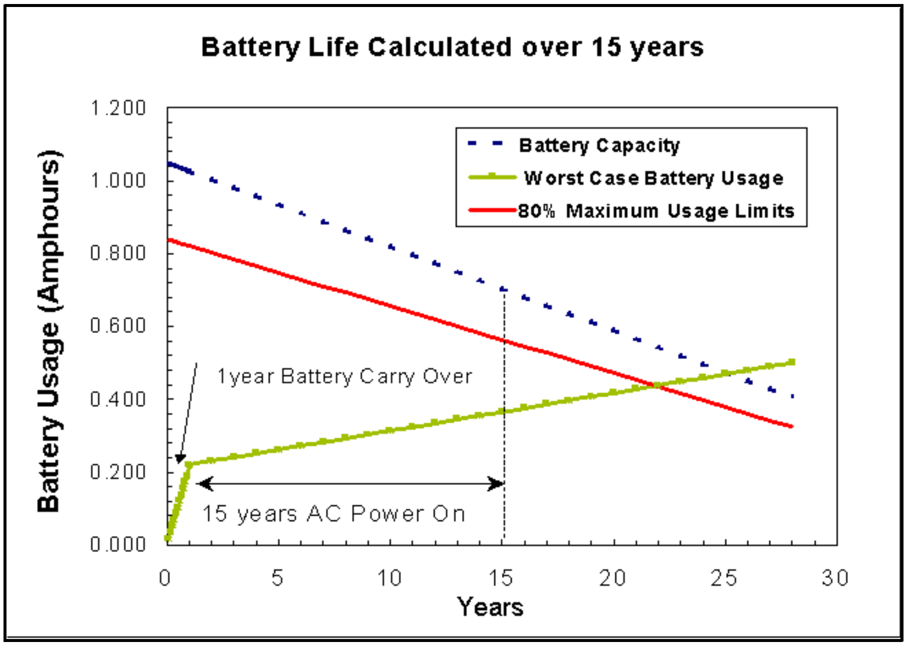

Figure 5.8 Battery Life Calculation

Three Button Reset

To perform a three button reset, follow these steps:

Performing a three button reset returns selected program parameters to a default state.

1 Remove power to meter.
2 Remove the meter cover.
3 Activate the magnetic reed switch using a small magnet positioned at the 10 o'clock point of the meter.
4 Depress the test mode button and the demand reset button.
5 Apply power to the meter while simultaneously performing steps 3 & 4.
6 Remove the magnet; release the test mode and demand reset buttons after 3 seconds.
7 The meter display should alternate between **CNTRON** and **Segment Test** if the reset is successful.
8 Replace the meter cover.

Option Boards

CENTRON R300CD Operation

The R300CD option provides two RF transmission messages for energy and demand readings. It is programmed with two unit ID's, one for identifying energy (kWh) related Standard Consumption Messages (SCMs), and one for demand (kW). The even ERT ID number will always correspond to the energy value, and the odd ID will always correspond to the demand value. Only the even ID number will be displayed on the meter nameplate, and the demand ID will be the next sequential number.

The R300CD transmits two different types of SCMs representing energy and demand. This is the only mode of operation used by the R300CD. R300CD option boards must be installed in a Time-of-Use (TOU) equipped (battery and full calendar clock capability) CENTRON. The R300CD will interrogate the TOU module once per minute and read the self read kWh and self read kW values. These values will typically change only once per billing period.

The kWh value broadcast in its SCM shall have six (6) significant digits. The R300CD converts the floating point BCD kW reading extracted from the CENTRON self read register to a fixed implied decimal with two digits of resolution to the right of the decimal point (.01 kW). The maximum kW measured is therefore restricted to 9999.99 kW.

Figure 5.9 on page 5-26 is a block diagram of R300CD hardware. R300CD hardware consists of two option boards: a control section and RF section. The control section communicates to the TOU module at rate of once per minute using the expansion port on the TOU module. The communication speed is fixed at 2400 baud in the control section and uses the SCS protocol. In each of the two SCMs described, the respective parameter reported is converted to a binary format for the RF transmission. No register information is saved in the R300CD option boards. In the instance of a power outage, the option board will update the kW and kWh values from the self read register upon power restoration.

The R300CD features the SchlumbergerSema patented method of tamper detection that senses both meter removal and inversion. The removal tamper (RTPR) increments a counter each time the meter is abruptly removed from a live meter socket. The tamper counter utilizes a tilt switch to detect when the meter is removed from the meter socket. The inversion tamper (ITPR) increments a separate counter each time the meter senses an inversion. The inversion tamper will be incremented when an inverted status is detected through a closed tilt switch upon power up. Each of these tamper indications are then transmitted through the radio frequency transmission.

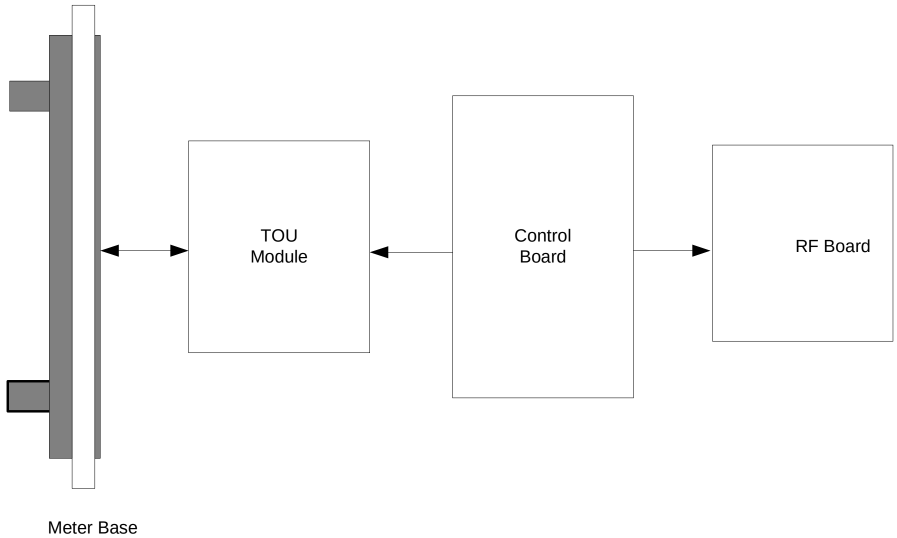

Figure 5.9 CENTRON TOU Personality Module with R300CD Option

Programming the R300CD Meter

In order for the R300CD meter to operate properly, you must set certain parameters. Incorrectly set parameters will result in improper operation of the R300CD.

The R300CD option boards use either a Load Profile (LP) or Time of Use (TOU) CENTRON personality module. In order for the R300CD to transmit it must have a kWh register.

For detailed programming instructions, see the PC-PRO+ documentation. Also refer to the *CENTRON R300CD Quick Install Guide*.

Chapter 6 Operation: C1SR Version

The SchlumbergerSema CENTRON C1SR is a one-way, unlicensed radio frequency (RF) personality module that attaches to the CENTRON meter base (See Figure 6.1). It offers a cost-effective solution for the endpoints in automatic and off-site meter reading applications. The CENTRON C1SR operates similar to the existing R300 module that is utilized by the J5 electromechanical meter.

Utilizing the 96-bit iTRON® Standard Consumption Message protocol (SCM), the C1SR provides the energy (kWh) consumption, module ID number, tamper indications, meter type, and error checking information in each radio frequency transmission. Within the 96-bit SCM, 26 bits are allocated to the module ID number for meter identification (also referred to as ERT ID number). As of October 15, 1999, all CENTRON C1SR meters utilize 26-bit identification numbers.

The C1SR uses frequency hopping and transmits within the unlicensed 910 to 920 MHz band on an average of once per second. In order to avoid interference from other devices, the transmission frequencies and time interval between transmission cycles are completely random in nature.

The C1SR is factory programmed with tuning information, module ID, tamper indicators (ITPR and RTPR), meter type, energy consumption, and scaling factor. The program and all register information are stored in non-volatile memory in the event of a power outage. Upon power restoration, all of the information in the non-volatile memory is restored to the appropriate registers.

Figure 6.1 C1SR

Physical Description

The C1SR personality module is constructed of a flame retardant printed circuit board material which supports the discrete, surface-mounted, and integrated circuit components. A microstrip etched on the circuit board serves as the RF antenna. The C1SR personality module easily snaps into the meter module mounting bracket. This module is then electronically attached to the metrology board via a board to board connector. The following information is sent to the personality module from the base metrology board:

- Line voltage
- Reference voltage
- Energy flow direction
- Energy pulse data
- Line frequency

The C1SR contains contacts on the module board, located at the 12 o'clock position behind the LCD, for resetting the energy register and tamper counters. This can be accomplished with the ZRO-C2A Resetter.

The C1SR uses a unique module identification number, provided by iTRON. This ID number is contained in each message transmission and is used by the handheld and billing system to determine meter identity and location. This ID number, which is contained on a bar-coded label, is placed on the LCD housing directly above the LCD display.

Registers

Display

The C1SR personality module is only available with a liquid crystal display, LCD. This module can be configured to display either four or five digits of energy consumption and will rollover at 100,000 kWh for both self-contained (Form 1S, 2S, 12S, 25S) and transformer rated meters (3S, 4S). The self-contained meters can be programmed to display normal kWh consumption (5X1 register configuration) or tens of kWh consumption (4X10 register configuration). If the C1SR is programmed for a 4x10 display, a “Mult by 10" label is placed on the module to the left of the LCD display. Thus, the actual energy consumption is obtained by multiplying the value on LCD display by 10.

The transformer rated meters can be programmed to display either a 5xTR or 4xTR. In order to determine the actual energy consumption, the display reading needs to be multiplied by the transformer ratio (TR). If the transformer ratio is 1, then the reading on the display is the actual energy consumption.

Regardless of the register configuration, the transmitted energy will always be in a 5x1 configuration.

The LCD display contains an electronic load indicator (or watt disk emulator). The load indicator is a single downward pointing triangle that flashes at a rate equal to the energy consumption. The indicator flashes ON for 1 Wh and OFF for 1 Wh. This effectively produces an equivalent Kh of 2.0. The LCD is automatically adjusted for contrast over the operating temperature range.

Electronic Detent

The C1SR module displays energy in increments of whole values of kWh. Standard operation for this module is to accumulate both forward and reverse energy flow in the positive direction. However, the C1SR personality module is available with an electronic detent that will cause the meter to ignore reverse energy flow. Therefore, if the meter is inverted, the registers will accumulate in the forward direction only, thus providing uni-directional operation. At the time of order, the C1SR module can be selected to have a detent register.

When the meter is undetented, both forward and reverse energy will be accumulated. Therefore, the electronic load indicator will flash at a rate equal to the energy consumption, regardless of the direction of the energy flow.

When the electronic detent is enabled, only forward energy flow will be accumulated. Thus, the single load indicator will not flash, nor will the meter accumulate when reverse energy flow is present.

Resetting Values

The ZRO-C2A Resetter zeros both the energy registers and tamper counters by direct connection to the C1SR module See also *The ZRO-C2A Handheld Meter Resetter for the CENTRON C1S and C1SR Operating Instructions*.

Transmission Scheme

A transmission cycle contains a wait period before and after each message burst and a period of random silent time. The silent time is determined by the scaling factor, which sets a minimum and maximum silent time between each transmission cycle.

The transmission frequencies (within the 910-920 MHz band), the frequency hopping pattern, and the time interval between transmission cycles are completely random in nature. This randomness provides a method for avoiding interference with transmissions from other devices. Figure 6.2 shows an example of the CENTRON C1SR transmission cycle containing one message burst.

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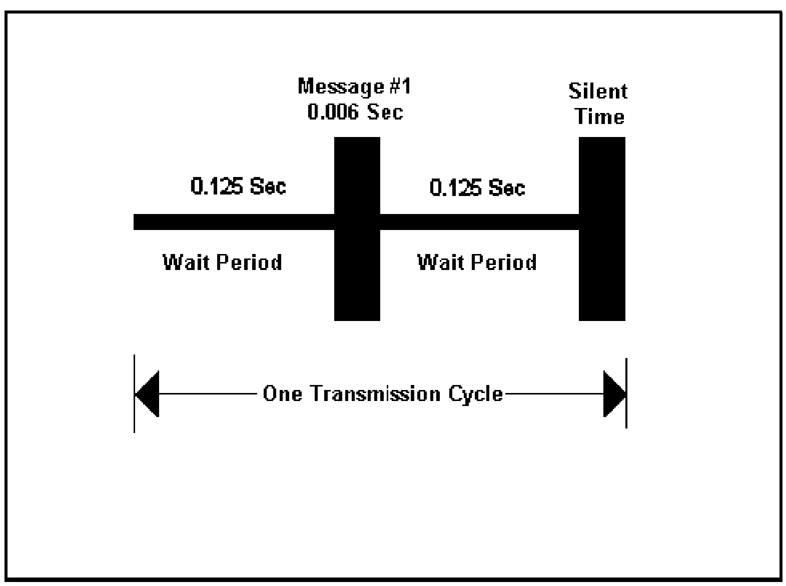

Figure 6.2 CENTRON C1SR Transmission Cycle

FCC Regulations

The C1SR communicates in the unlicensed, 910-920 MHz band governed by the US Code of Federal Regulations (CFR) Title 47, Part 15 Radio Frequency Devices, Sub Part C Paragraph 249 Intentional Radiator.

Changes or modifications not expressly approved by SchlumbergerSema Inc. could void the users authority to operate the equipment.

Tamper Detection

The CENTRON C1SR features the SchlumbergerSema patented method of tamper detection that senses both meter removal and meter inversion. The removal tamper (RTPR) increments a counter each time the meter is abruptly removed from a live meter socket. The tamper counter utilizes a tilt switch to detect when the meter is removed from a meter socket.

The inversion tamper (ITPR) increments a separate counter each time the meter senses reverse power flow caused by meter inversion. The metrology board senses reverse power flow and sends this status to the C1SR module. Although the C1SR increments an inversion counter when reverse power flow is detected, the meter, when undetented, will still accumulate the energy consumption in the positive direction. Each of these tamper indications, along with the kWh consumption, is then transmitted through the radio frequency transmission.

Testing the CENTRON C1SR Tamper Counter

In order to test the power removal counter, the meter must sense a shaken condition associated with a power outage.

1. Place the meter in a socket.
2. Apply power to the meter.
3. Remove the meter from the live socket.
4. Replace the meter in the socket.

   The meter has incremented the removal tamper counter.

The C1SR uses the power outage (the meter being removed from a live socket) in conjunction with the meter being shaken simultaneously to increment the power removal counter.

In order to test the inversion counter, the meter must sense reverse current flow.

1. Place the meter in the meter socket inverted (test LED pointing down).
2. Apply a load to the meter in the forward direction.

   The meter has incremented the inversion counter due to reverse energy flow through the meter.

The inversion counter increments when the meter senses reverse current flow. The metrology board senses reverse power flow and sends this status to the C1SR personality module. The C1SR then increments the counter and transmits the count.

As part of the 96-bit Standard Consumption Message, 4 bits are allocated for tamper indications, which include the power removal and meter inversion counters. The ReadOne Pro handheld reader converts the 4 bit binary number to its equivalent value between 0 and 15. Table 6.1 shows the removal and inversion information based on the reported tamper count. For example, a tamper count of 6 on the ReadOne Pro would translate as 1 meter removal and 2 meter inversions since the last read.

Table 6.1 ReadOne Pro Tamper Count

Binary	Tamper Count	Inversion	Removal
0000	0	0	0
0001	1	1	0
0010	2	2	0
0011	3	3	0
0100	4	0	1
0101	5	1	1
0110	6	2	1
0111	7	3	1
1000	8	0	2
1001	9	1	2
1010	10	2	2
1011	11	3	2
1100	12	0	3
1101	13	1	3
1110	14	2	3
1111	15	3	3

Retrofitting the C1SR Personality Module

The CENTRON R300 is a one-way radio frequency personality module that transmits within the unlicensed 910-920 MHz frequency band governed by the US Code of Federal Regulations (CFR) Title 47, Part 15 Radio Frequency Devices, Sub Part C Paragraph 249 Intentional Radiator. Any device operating within this unlicensed frequency band must contain an FCC Identification number. Therefore, the FCC ID Label included in the Retrofit Kits must be placed on the meter as shown in the illustrations below.

Changes or modifications not expressly approved by SchlumbergerSema could void the user's authority to operate the equipment.

To retrofit an existing meter with an R300 module, follow "Retrofitting with Personality Modules" on page 2-3 and attach FCC Label on the left side of the inner cover at the 9 o’clock position as illustrated in Figure 6.3.

Figure 6.3   FCC Label

Chapter 7 Operation: C1SC Version

The SchlumbergerSema C1SC is a one-way transmitter used for fixed network applications. The C1SC uses CellNet RF technology. The personality module transmits a formatted data packet consisting of the preamble, the utility billing ID, kWh information, and Cyclic Redundancy Checks (CRC) to ensure message integrity. The module also features built in power outage notification, reverse power flow detection, power restoration notification, and redundant transmissions. The C1SC uses spread spectrum to broadcast its message in the 902 to 928 MHz frequency range once every five minutes.

The C1SC is factory programmed to include the utility billing ID, LAN Address ID, and Register configuration. The utility billing ID is a value decided upon by the utility and CellNet. The LAN address is a value assigned by SchlumbergerSema, and programmed by SchlumbergerSema, to every meter within the network. LAN addresses and utility billing IDs are unique to each meter. SchlumbergerSema activates the LAN ID upon receipt of the meter association file from SchlumbergerSema.

After programming, the module is tested to verify the operating system parameters and FCC compliance. A final test is performed via RF to verify a correct LAN address meter ID number of digits and RF signal.

Figure 7.1 C1SC

Physical Description

The C1SC is constructed of a flame retardant, glass-filled printed circuit board material which supports the discrete, surface-mounted, and integrated circuitry components. A slot antenna etched on the circuit board serves as the RF antenna. The C1SC board snaps into the meter register mounting brackets to ease in the installation of the board. The LAN address barcode and interpretation is placed on the LCD housing for meter identification.

The C1SC personality module is attached to the metrology board using a board to board connector. The following information is passed from the metrology board to the C1SC:

- Line Voltage
- Reference Voltage
- Energy Flow direction
- Energy pulse data
- Line frequency

The C1SC has two additional labels called the meter change-out labels that are affixed to the bottom of the meter. The change out labels are identical and contain the AEP barcode information and a utility descriptor.

Transmission Scheme

The RF transmission is spread spectrum using Binary Phase Shift Keyed (BPSK) modulation. A chipping signal is used to spread the carrier and actual data is on-off-keyed (OOK). The modulator output drives the amplifier chain that provides a signal of approximately 100mW. The antenna is tuned for maximum efficiency at the carrier frequency.

Figure 7.2 shows how messages are typically transmitted. In the example, an interval packet made up of 18 intervals is transmitted every five minutes. Each interval contains a pulse count equivalent to the energy consumption for a 2.5 minute interval. The interval packet transmission represents a sliding 45 minute window of data.

Also shown in Figure 7.2, Interval packet 0 shows that the 2.5 minute interval is transmitted in one of the 18 packets of 2.5 minute information. Interval packet 1 is transmitted 5 minutes later and the selected 2.5 minute interval of data is now transmitted as the 16th packet (numbered 15). The following packet slides the information by two 2.5 minute intervals and continues for a total of nine transmissions. The information is then no longer in the sliding 45 minute window.

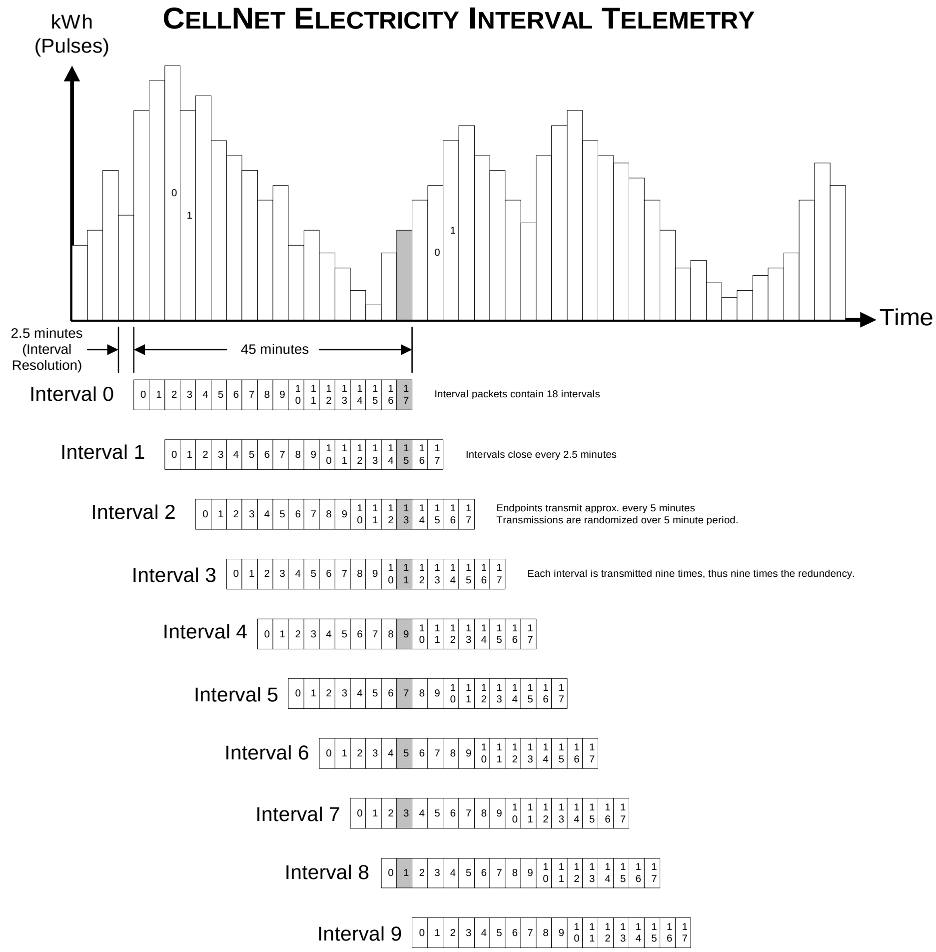

Figure 7.2 CellNet Telemetry

FCC Regulations

The C1SC communicates in the unlicensed 902-928 MHz band governed by the US Code of Federal Regulations (CFR) Title 47, Part 15, Subpart C, Paragraph 247. This device complies with Title 47, Part 15, Subpart C, Paragraph 247 of the FCC rules.

Display Functions

The LCD is configured for five digits of energy consumption and will rollover at 100,000 kWh. The LCD is automatically adjusted for contrast over the operating temperature range.

A watt disk emulator is located on the lower right hand corner of the display. The indicator consists of three triangles that light up sequentially left to right to indicate forward current flow. One full rotation of the three indicators is equivalent to 6 Watthours of energy.

Resetting Values

The C1SC can be reset using the CellNet Shooter device in conjunction with a computer.

Programming the C1SC/CN1SC

The CENTRON C1SC/CN1SC CellNet personality module programming port is located such that the CENTRON inner cover does not have to be removed when programming or testing the CellNet module.

In order to communicate with the CENTRON CellNet module, insert the programming slide into the hole in the inner cover of the CENTRON meter that is located at the 12 o'clock position (see Figure 7.3).

Figure 7.3 C1SC/CN1SC Programming Port Location

Chapter 8 Testing, Troubleshooting, and Maintenance

This section provides information and instructions to help you test and maintain the CENTRON meter. Topics covered include:

- Testing support features
- Energy testing
- Recommended testing procedures
- TOU schedule testing
- Field testing
- Troubleshooting (Fatal and non-fatal errors)
- Maintenance

Testing Support Features

Infrared Test LED

The CENTRON meter is equipped with an Infrared Test Light Emitting Diode (LED) where each pulse represents a fixed value of watthour measurement. The LED is located on the top of the meter as the meter is viewed from a typical installation (see Figure 8.1). The pulse weight represented by the LED pulses is 1.0 watthour per pulse (Kh=1.0).

Figure 8.1 LED Location

Pulse Detector

An optional pulse detector is available for the CENTRON meter. The pulse detector has an infrared pickup with 2 visible LEDs. When positioned over the CENTRON light pipe, it will produce a visible flash when an infrared pulse is received from the metrology. The right LED will flash once for each infrared Wh pulse while the left

LED will flash once for every 10Wh infrared pulses received. The left LED on the pulse detector is helpful when heavier loads are present on the system being examined. This can be used to verify that the metrology is measuring energy when installed and to conduct timing tests to determine the amount of load on meter. See Chapter 9 for the Pulse Detector part number.

Figure 8.2 Pulse Detector

Annunciators

Watthour Annunciators

C1SR meters (and some C1S versions) are equipped with LCD displays that utilize a single flashing triangular annunciator to show that power is being metered. The annunciator represents 1.0 watthour each time it turns on and 1.0 watthour each time it turns off for a total of 2.0 watthours.

On other CENTRON meters equipped with LCD's, there are 3 such annunciators which also show the direction of energy flow (C1S, C1SC, C1SD, C1ST, C1SL). The triangles will scroll left to right for positive (line to load) energy flow, and right to left for negative energy flow.

The Kh value of the single triangle is twice the Kh of the LED and, therefore, 2.0 watthours per pulse. On the three triangle units the Kh of each triangle is further multiplied by 3 as each triangle is turned on and off in sequence, resulting on a Kh of 6.0.

TOU Rate Annunciators

The CENTRON meter is equipped with 5 Time-of-Use annunciators on the LCD (see Figure 8.3). Located on the right side of the display, the annunciator A, B, C, D, or TOTAL flashes when the applicable rate is active and is enabled to display their respective values. (Available on the C1ST and C1SL.)

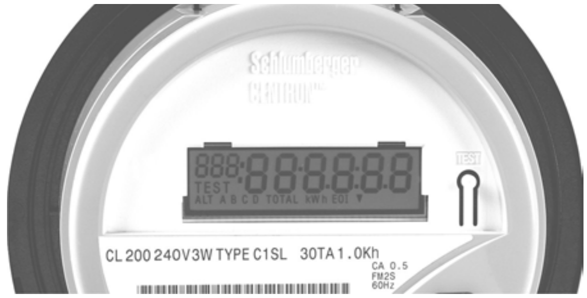

Figure 8.3 TOU Rate Annunciators

Test Mode Annunciator

The CENTRON meter is equipped with a Test Mode LCD annunciator located in the left portion of the display. This annunciator is enabled when Test Mode is activated. The word TEST appears on the display and flashes at a steady rate when test mode is activated. (Available on the C1SD, C1ST, and C1SL.)

Testing with the Infrared Test LED

The CENTRON meter is equipped with an Infrared Test LED (Light Emitting Diode) which is located on the top of the meter at the 12 o'clock position.

The pulse weight represented by the LED pulses is always 1.0 watt-hour per pulse. Since the Kh value for the meter is 1.0, make sure the test board is programmed to accept this Kh value.

# OF PULSES REQUIRED ON TEST BOARDS			
	1S & 2S CL200	**120V 3S, 240V 3S, 240V 4S**	**12S & 25S, 2S CL 320**
Full Load	10	7	15
Light Load	10	6	7
Power Factor	10	7	12

1 pulse = 1 Watt-hour as compared to 1 pulse = 7.2 Watt-hours in Electromechanical meters.

To obtain test uncertainties of 0.01% (plus the uncertainties of the test equipment), use a minimum of 30 pulses.With a constant load applied (real or phantom), the LED pulses are compared to the output of a high accuracy watthour standard. This is accomplished using a compatible optical pickup and a comparator.

Follow these steps to test the Wh LED:

1 Apply a constant delivered watts load (Wapp) to the meter.

2 Verify that the LED pulses properly either by counting the pulses or using a comparator to compare the pulses from the meter under test to the standard. To determine the number of pulses per second, use the following equation:

$$\text{Number of Pulses per sec} = \text{Wapp} \times \frac{1\text{hr}}{3600} \times 1\text{Kh}$$

Testing Using the Disk Emulation Annunciator

The CENTRON meter is capable of visually being tested by using the Watt Disk Emulation Annunciator.

Recommended Energy Testing Procedures

Testing solid-state meters on test boards that were designed primarily for electromechanical meters may give unexpected results. Erroneous readings have been known to occur on “light load” tests when the test sequence calls for said light load test to follow immediately after the full load test. The problem is caused by improper “jogging” and can be avoided by sequencing the test in order of applied power such that the lowest power is tested first. This problem does not exist on modern test boards with the latest test software.

AEP Test Codes

Table 8.1 shows the AEP Test Codes.

Table 8.1 AEP Test Codes

Meter Specification	Code
CL100 120V 2W 1 Phase Type C1S 15TA 1.0Kh FM1S 60Hz	2B
CL200 240V 3W 1 Phase Type C1S 30TA 1.0Kh FM2S 60Hz	1N
CL320 240V 3W 1 Phase Type C1S 50TA 1.0Kh FM2S 60Hz	2J
CL20 240V 2W 1 Phase Type C1S 2.5TA 1.0Kh FM3S 60Hz	2F
CL20 120V 2W 1 Phase Type C1S 2.5TA 1.0Kh FM3S 60Hz	2E
CL20 240V 3W 1 Phase Type C1S 2.5TA 1.0Kh FM4S 60Hz	2G
CL200 120V 3W 2 Phase Type CN1S 30TA 1.0Kh FM12S 60Hz	2H
CL200 120V 3W 2 Phase Type CN1S 30TA 1.0Kh FM25S 60Hz	2I

Field Testing

Field testing of the CENTRON meter may be accomplished with conventional methods using either the infrared test LED or the disk emulation annunciator (when supplied). For details on the operation of the annunciator, see Page 8-2.

Required Hardware

The typical field test setup consists of a phantom load, portable standard, and an infrared test pulse adapter with a counter or snap switch assembly. CENTRON meters purchased without a test link will require a more sophisticated loading circuit.

Troubleshooting

Error Codes (R300)

Non-Fatal Error

Cause	Effect	Indication
Checksum Error of the Energy Register	Stops RF transmission but continues energy accumulation and will be cleared after a power cycle.	The LCD will display the annunciator, a downward pointing arrow, in the lower right hand corner.

Fatal Error

Cause	Effect	Indication
Unsuccessful writing to or reading from EEPROM memory.	All metering and RF functions are halted. Return the module to the factory for repair.	The LCD will display the word Error in the area normally used for energy accumulation.
Metrology error.	All metering and RF functions are halted. Return the meter and module to the factory for repair.	The LCD will display the word Error in the area normally used for energy accumulation.

Error Codes (Demand, TOU, and Load Profile)

The firmware performs error checks to confirm proper register operation. Table 8.2 lists possible errors and associated error codes.

Table 8.2 Error Codes

Error	Error Code	Error Type
Low Battery	Er 000001	Non-fatal
EEPROM	Er 000010	Fatal
Reverse Direction	Er 007000	Non-fatal
Clock	Er 010000	Non-fatal
Full Scale Overflow	Er 100000	Non-fatal
TOU Error	Er 020000	Non-fatal
Load Profile Error	Er 030000	Non-fatal
Metrology Error	Er 000004	Fatal

Fatal errors cause the display to lock on the error code. If multiple fatal errors occur, the one that was detected first will be the error code that locks on the display.

Non-fatal errors can be programmed to scroll during the one second display off-time or lock on the register display. If multiple non-fatal errors occur, the meter will display a combined error message. For example, if a low battery error and a clock error exist, the error display will read ER 010001. In this case, if one of the errors had been programmed to lock, and the other error had been programmed to scroll, the display will lock on the combined error message.

Activating the Alternate Mode Magnetic Reed Switch allows the Normal Mode Display Sequence to scroll one time during a locked non-fatal error. At the end of the display sequence, the error message locks onto the display again.

Non-Fatal Error Codes

Table 8.3 Non-Fatal Error Codes

Code	Error	Possible Causes
Er 000001	Low Battery Error	Number of minutes on the battery has exceeded one year-replace module—checked on power up and once per second.
	Discussion: A low battery check is performed once every second. If a low battery level is detected during this procedure, error code Er 000001 is displayed in Normal mode. This error can be programmed to continuously scroll during the one second display off-time or lock on the register display. A low battery continues to function; however, its reliability decreases over time. If a low battery level error occurs during normal operation, TOU and Mass Memory will continue to operate until an outage occurs. If a low battery level is detected upon programming or upon restoration of power after an outage, ER 000001 will display. Total registers remain functional during a Low Battery Condition; however, TOU (rates A, B, C, D) registers and load profile will not accumulate.	
Er 007000	Reverse Direction Error	Reverse Direction Error Indicator—Clear on demand reset or reprogram register; checked continuously.
	Discussion: A Reverse Direction error exists when the register detects 10 Wh in the reverse direction. Reverse Direction detection is a selected feature during programming. If a Reverse Direction error occurs, Er 007000 is displayed during the one second off-time in Normal mode. The Reverse Direction error will clear when a demand reset is performed.	
Er 010000	Clock Error	Clock Error—Reprogram register and check for proper operation; checked upon programming and once per second
	Discussion: A Clock error exists when a clock parameter is determined to be out of range. If this error occurs, Er 010000 is displayed in Normal mode. This error is programmable to continuously scroll during the one second display off-time or lock on the register display. If a Clock error occurs, the Load Profile and TOU operations will be discontinued until the meter is reprogrammed. The error will then clear, and the meter will resume normal operation.	
Er 020000	TOU Error	TOU Error—Reprogram register and check for proper operation; checked upon programming and once per second
	Discussion: A TOU error occurs when the TOU calendar is out of range. TOU is disabled.	
Er 030000	Load Profile Error	Load Profile Error—Reprogram register and check for proper operation; checked upon programming and once per second

Table 8.3 Non-Fatal Error Codes

Code	Error	Possible Causes
	Discussion: A Load Profile error occurs when the Load Profile parameter is out of range or inactive.	
Er 100000	Full Scale Overflow Error	Programmed Full Scale Value exceeded—Check programmed Full-Scale value and meter installation for proper sizing of equipment; checked continuously.
	Discussion: A Full Scale overflow error exists when the calculated demand at an EOI exceeds the register Full Scale value. The register Full Scale value is selected during programming. If an overflow occurs, the error code Er 100000 is displayed in Normal mode. This error is programmable to display during the one second display off-time or lock on the register display. The Full Scale overflow error displays when the overflow occurred. The Maximum Demand register continues to accumulate and display kW as long as the format limitations are not exceeded. When a demand reset is performed, the correct Max kW value will be added to the cumulative registers and the error code will no longer be displayed. If a Full Scale overflow occurs, check the installation to ensure that the current metering capability has not been exceeded. A Full Scale overflow in no way affects the existing billing data.	

Fatal Error Codes

Table 8.4 Fatal Error Codes

Code	Error	Possible Causes
Er 000004	Metrology Error	(Available in firmware revisions 10.27 and above.) Defective component in the base metrology causing invalid energy pulse signal.
	Discussion: The direction of energy flow signal is monitored for rate of change. If the rate of change exceeds 14 Hz, the metrology error is triggered. Under this condition the base metrology has become defective and the energy pulse signal being sent from metrology to the D/T/L module is no longer valid. Base metrology should be replaced in the event of this error.	
Er 000010	EEPROM Error	Energy value checksum failure; EEPROM failure—reprogram module and check for proper operation. If error still does not clear, replace module; checked upon programming and at power up.
	Discussion: If the module has an EEPROM error, the error code ER 000010 will be continuously displayed. If this error occurs, program the module and check for proper operation. If the error continues to exist, replace the module.	

Inspecting and Troubleshooting—General

Due to the modular architecture of the CENTRON meter, modules of similar voltage (120V or 240V) may be interchanged. Therefore, the personality module of the CENTRON you are troubleshooting can be placed on a known working base to verify proper operation of the personality module. Likewise, a known working personality module may be placed on the base of a meter to verify proper operation of the meter.

This section provides a list of the most likely problems that you may encounter, along with possible causes and solutions.

Blank Display

Cause	Solution
Power Not Applied to Meter	Apply power.
LCD/LCD Driver Failure	Replace Register Circuit Board.
Loose Power Supply Connection	Remove and re-seat board-to-board connector.

Time and Date Wrong (TOU or Load Profile Only)

Cause	Solution
Time/Date Wrong in PC or Handheld device	Verify and update time/date in programming device and download new time and date to register. See appropriate software manual for more detailed directions.
Wrong Line Frequency	Verify proper line frequency is selected in Setup routine in programming software. Select proper frequency and reconfigure meter.
Battery Failure During Power Outage	Replace module.
Daylight Savings Time not Programmed Correctly	Verify DST is selected in program. Reconfigure meter with correct program.
Timekeeping circuitry component failure	Replace module.

No Accumulation of kWh or kW

Cause	Solution
Demand Delay Selected	kW will not immediately accumulate after a power outage if CLPU (Demand Delay) has been selected. Accumulation will begin immediately after Demand Delay has expired. Verify register program and reconfigure meter.
Module was left in Test mode	Accumulation of kW or kWh will not take place while register is in Test mode. Exit Test mode and verify proper accumulation begins.
Module Not Receiving Pulses	Verify that meter is accumulating energy by testing infrared test LED.
Time-of-Use Schedule programmed incorrectly	Verify TOU schedule contains continuous 24-hour periods for all weekdays, weekends, or holidays. All 24-hour periods throughout every year must be accounted for within the TOU schedule.

Cause	Solution
Component Failure	Replace module.

Software Cannot Communicate with Module

Cause	Solution
Optical Probe Cable Assembly Failure	Check cable with known register that communicates. Check cable against known cable that is functioning. Also check batteries in cable assembly.
Com Port in PC is Set Wrong	Verify proper Com Port number has been selected in the programming software. If the wrong Com Port is selected, communications will not occur.
Security code in Module	If security codes have been downloaded to the register, the programming device must have the proper code to make connection to the module. Verify security codes in the programming software.
Probe Not Connected Properly	Verify Optical Probe lines up properly over the optical connector. Re-install cover for proper alignment. Verify PC or handheld and cable are securely connected and attached to the correct Com Port.
Optical Connector Failure	Replace cover assembly.
Electronics Failure	Replace module.
Incorrect Baud Rate	Optical port can be programmed to operate at 4800 or 9600 baud. Factory default baud rate is 4800.

Reed Switch Does Not Activate the Alternate Mode

Cause	Solution
Magnetic Field is too Weak	Place magnet closer to switch or use stronger magnet.
Reed Switch Failure	Replace module.
Alternate Mode Items Not Selected	Re-program meter with items to be displayed in Alternate mode.

Reset Mechanism Does Not Initiate Demand Reset

Cause	Solution
Reset Mechanism Does Not Initiate Demand Reset	Re-install or Replace cover assembly.
Reset Has Occurred Within Last 60 Seconds	Manual demand reset cannot occur within 60 seconds of the previous demand reset. Wait 60 seconds and perform a second Demand Reset.
Reset Button Is Defective	Replace module.

Demand Reset Cannot be Initiated Through PC or Handheld

Cause	Solution
Communication Cannot Be Established	See Programming Problems.

Test Mode Switch Does Not Place Module in Test Mode

Cause	Solution
Switch Not Fully Depressed	Verify that the test mode pushbutton has been completely depressed.
Switch or Electronic Failure	Replace module.
Test Mode Items Not Selected	Re-program module with items to be displayed in Test mode.

Inspecting and Troubleshooting—C1S LCD and C1SR

Blank Display

Cause	Solution
Power not applied to the meter	Apply power.
Loose power supply connection	Remove and re-seat board to board connector.
LCD/LCD Driver failure	Replace Register circuit board. **Note**: Energy reading and tamper flags may be uploaded with the ZRO-C2A.

Chapter 9 Specifications and Drawings

Specifications

C1S

Table 9.1 C1S Specification

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
100	120	2	1S	CLOCK	5X1	980300000-000	980310000-000
100	120	2	1S	CLOCK	4X10	980320000-000	980330000-000
100	120	2	1S	CYCLO	5X1	980340000-000	980350000-000
100	120	2	1S	CYCLO	4X10	980360000-000	980370000-000
100	120	2	1S	LCD w/Segment Check	5X1	980380000-000	980390000-000
100	120	2	1S	LCD w/o Segment Check	5X1	984540000-000	984550000-000
100	120	2	1S	LCD w/Segment Check	4X10	980400000-000	980410000-000
200	240	3	2S	CLOCK	5x1	980000000-000	980010000-000
200	240	3	2S	CLOCK	4X10	980020000-000	980030000-000
200	240	3	2S	CYCLO	5X1	980040000-000	980050000-000
200	240	3	2S	CYCLO	4X10	980060000-000	980070000-000
200	240	3	2S	LCD w/Segment Check	5X1	980080000-000	980090000-000
200	240	3	2S	LCD w/o Segment Check	5X1	984090000-000	984100000-000
200	240	3	2S	LCD w/Segment Check	4X10	980100000-000	980110000-000
320	240	3	2S	CLOCK	5x1	981140000-000	981150000-000
320	240	3	2S	CLOCK	4X10	981160000-000	981170000-000
320	240	3	2S	CYCLO	5X1	981180000-000	981190000-000
320	240	3	2S	CYCLO	4X10	981200000-000	981210000-000

Table 9.1 C1S Specification

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
320	240	3	2S	LCD w/Segment Check	5X1	981220000-000	981230000-000
320	240	3	2S	LCD w/o Segment Check	5X1	983950000-000	983960000-000
320	240	3	2S	LCD w/Segment Check	4X10	981240000-000	981250000-000
20	120	2	3S	CLOCK	5xTR	980540000-000	980550000-000
20	120	2	3S	CLOCK	4X10	980560000-000	980570000-000
20	120	2	3S	CYCLO	5XTR	980580000-000	980590000-000
20	120	2	3S	CYCLO	4XTR	980600000-000	980610000-000
20	120	2	3S	LCD w/Segment Check	5XTR	980620000-000	980630000-000
20	120	2	3S	LCD w/o Segment Check	5XTR	985590000-000	985600000-000
20	120	2	3S	LCD w/Segment Check	4XTR	980640000-000	980650000-000
20	240	2	3S	CLOCK	5xTR	980660000-000	980670000-000
20	240	2	3S	CLOCK	4XTR	980680000-000	980690000-000
20	240	2	3S	CYCLO	5XTR	980700000-000	980710000-000
20	240	2	3S	CYCLO	4XTR	980720000-000	980730000-000
20	240	2	3S	LCD w/Segment Check	5XTR	980740000-000	980750000-000
20	240	2	3S	LCD w/o Segment Check	5XTR	985610000-000	985620000-000
20	240	2	3S	LCD w/Segment Check	4XTR	980760000-000	980770000-000
20	240	3	4S	CLOCK	5xTR	980780000-000	980790000-000
20	240	3	4S	CLOCK	4XTR	980800000-000	980810000-000
20	240	3	4S	CYCLO	5XTR	980820000-000	980830000-000
20	240	3	4S	CYCLO	4XTR	980840000-000	980850000-000
20	240	3	4S	LCD w/Segment Check	5XTR	980860000-000	980870000-000
20	240	3	4S	LCD w/o Segment Check	5XTR	985630000-000	985640000-000
20	240	3	4S	LCD w/Segment Check	4XTR	980880000-000	980890000-000
200	120	3	12S	CLOCK	5x1	980900000-000	980910000-000
200	120	3	12S	CLOCK	4X10	980920000-000	980930000-000
200	120	3	12S	CYCLO	5X1	980940000-000	980950000-000

Table 9.1 C1S Specification

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
200	120	3	12S	CYCLO	4X10	980960000-000	980970000-000
200	120	3	12S	LCD w/Segment Check	5X1	980980000-000	980990000-000
200	120	3	12S	LCD w/Segment Check	5X1	983930000-000	983940000-000
200	120	3	12S	LCD w/Segment Check	4X10	981000000-000	981010000-000
200	120	3	25S	CLOCK	5x1	981020000-000	981030000-000
200	120	3	25S	CLOCK	4X10	981040000-000	981050000-000
200	120	3	25S	CYCLO	5X1	981060000-000	981070000-000
200	120	3	25S	CYCLO	4X10	981080000-000	981090000-000
200	120	3	25S	LCD w/Segment Check	5X1	981100000-000	981110000-000
200	120	3	25S	LCD w/o Segment Check	5X1	985650000-000	985660000-000
200	120	3	25S	LCD w/Segment Check	4X10	981120000-000	981130000-000

C1SR

Table 9.2 C1SR Specifications

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
100	120	2	1S	R300	5X1	981500000-000	981510000-000
100	120	2	1S	R300	4X10	981520000-000	981530000-000
200	240	3	2S	R300	5X1	980120000-000	980130000-000
200	240	3	2S	R300	4X10	980140000-000	980150000-000
320	240	3	2S	R300	5X1	981740000-000	981750000-000
320	240	3	2S	R300	4X10	981760000-000	981770000-000
20	120	2	3S	R300	5XTR	981540000-000	981550000-000
20	120	2	3S	R300	4XTR	981560000-000	981570000-000
20	240	2	3S	R300	5XTR	981580000-000	981590000-000
20	240	2	3S	R300	4XTR	981600000-000	981610000-000
20	240	3	4S	R300	5XTR	981620000-000	981630000-000

Table 9.2 C1SR Specifications

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
20	240	3	4S	R300	4XTR	981640000-000	981650000-000
200	120	3	12S	R300	5X1	981660000-000	981670000-000
200	120	3	12S	R300	4X10	981680000-000	981690000-000
200	120	3	25S	R300	5X1	981700000-000	981710000-000
200	120	3	25S	R300	4X10	981720000-000	981730000-000

C1SC

Table 9.3 C1SC Specifications

Class	Volts	Wire	Form	Register	Digits/ Mult	Specification Number	
						Glass	Poly
100	120	2	1S	CellNet	5X1	980420000-000	980430000-000
200	240	3	2S	CellNet	5X1	980160000-000	980170000-000
20	120	2	3S	CellNet	5XTR	981260000-000	981270000-000
20	240	2	3S	CellNet	5XTR	981300000-000	981310000-000
20	240	3	4S	CellNet	5XTR	981340000-000	981350000-000
200	120	3	12S	CellNet	5X1	981380000-000	981390000-000
200	120	3	25S	CellNet	5X1	981420000-000	981430000-000
320	240	3	2S	CellNet	5X1	981480000-000	981470000-000

C1SD

Table 9.4 C1SD Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
100	120	2	1S	Demand	POLY	981780000-000
200	240	3	2S	Demand	POLY	980200000-000

Table 9.4 C1SD Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
320	240	3	2S	Demand	POLY	981840000-000
20	120	2	3S	Demand	POLY	981790000-000
20	240	2	3S	Demand	POLY	981800000-000
20	240	3	4S	Demand	POLY	981810000-000
200	120	3	12S	Demand	POLY	981820000-000
200	120	3	25S	Demand	POLY	981830000-000

C1ST

Table 9.5 C1ST Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
100	120	2	1S	TOU	POLY	981850000-000
200	240	3	2S	TOU	POLY	980210000-000
320	240	3	2S	TOU	POLY	981910000-000
20	120	2	3S	TOU	POLY	981860000-000
20	240	2	3S	TOU	POLY	981870000-000
20	240	3	4S	TOU	POLY	981880000-000
200	120	3	12S	TOU	POLY	981890000-000
200	120	3	25S	TOU	POLY	981900000-000

R300CD

Table 9.6 R300CD Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
100	120	2	1S	TOU with R300CD	POLY	982900000-000
200	240	3	2S	TOU with R300CD	POLY	98291000-000
320	240	3	2S	TOU with R300CD	POLY	983010000-000
20	120	3	3S	TOU with R300CD	POLY	983140000-000
20	240	2	3S	TOU with R300CD	POLY	983150000-000
20	240	3	4S	TOU with R300CD	POLY	983160000-000
200	120	3	12S	TOU with R300CD	POLY	983170000-000
200	120	3	25S	TOU with R300CD	POLY	983600000-000

C1SL

Table 9.7 C1SL Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
100	120	2	1S	Load Profile	POLY	981920000-000
200	240	3	2S	Load Profile	POLY	980220000-000
320	240	3	2S	Load Profile	POLY	981980000-000
20	120	2	3S	Load Profile	POLY	981930000-000
20	240	2	3S	Load Profile	POLY	981940000-000

Table 9.7 C1SL Specifications

Class	Volts	Wire	Form	Register	Cover	Specification Number
20	240	3	4S	Load Profile	POLY	981950000-000
200	120	3	12S	Load Profile	POLY	981960000-000
200	120	3	2S5	Load Profile	POLY	981970000-000

Drawings

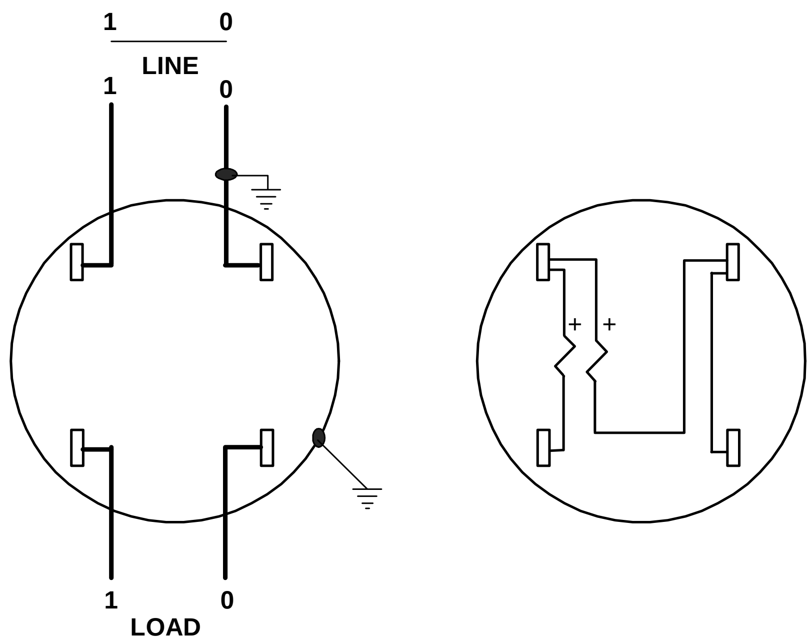

Figure 9.1 Form 1S Wiring Diagram

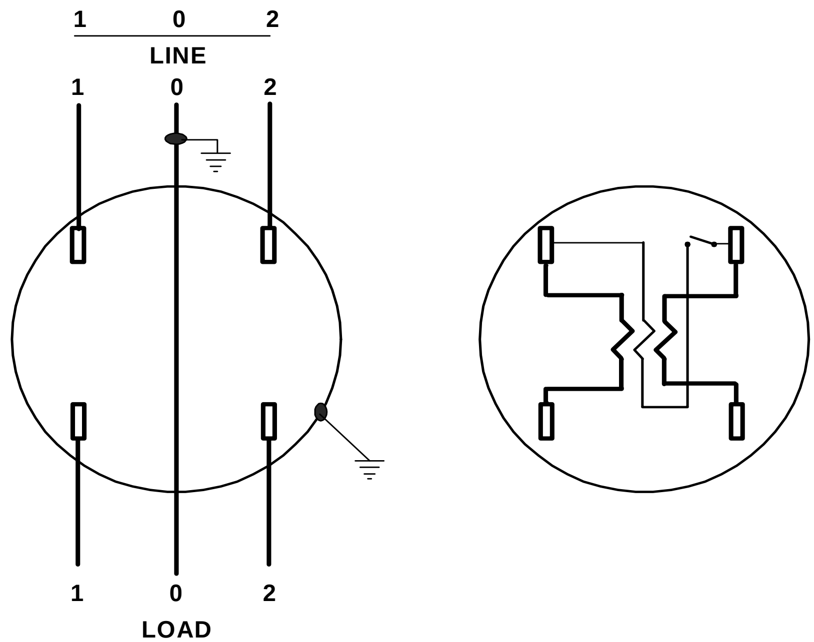

Figure 9.2 Form 2S Wiring Diagram

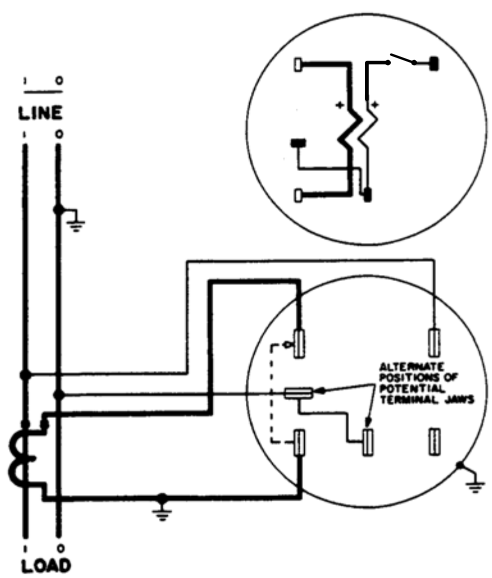

Figure 9.3 Form 3S Wiring Diagram

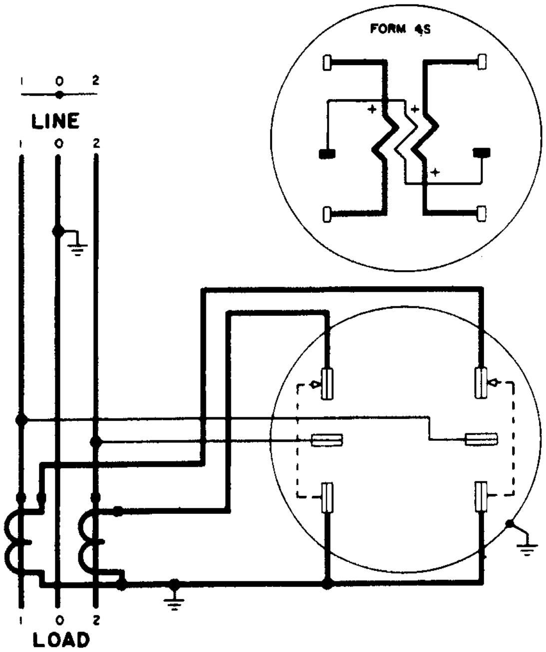

Figure 9.4 Form 4S Wiring Diagram

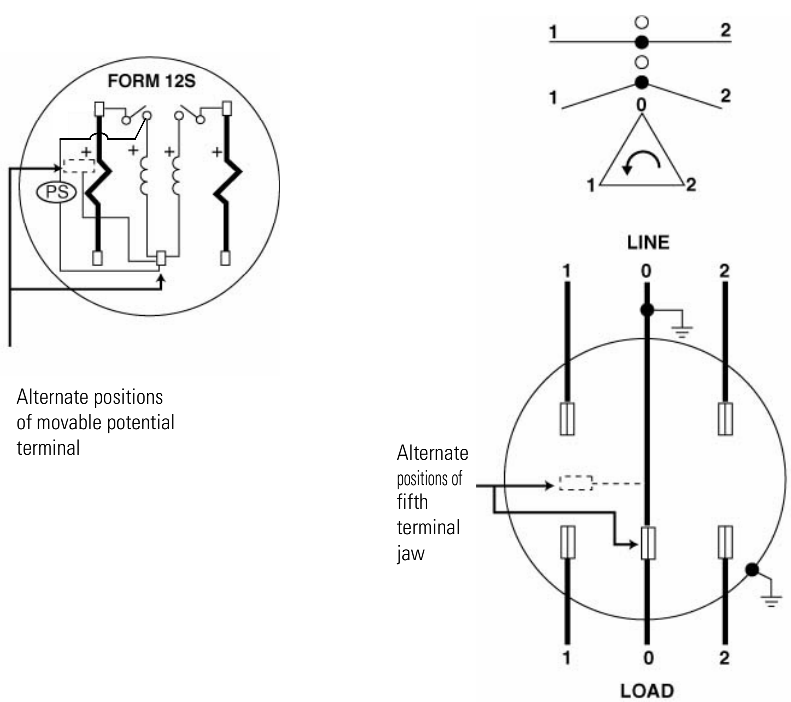

Figure 9.5 Form 12S Wiring Diagram

Notes:

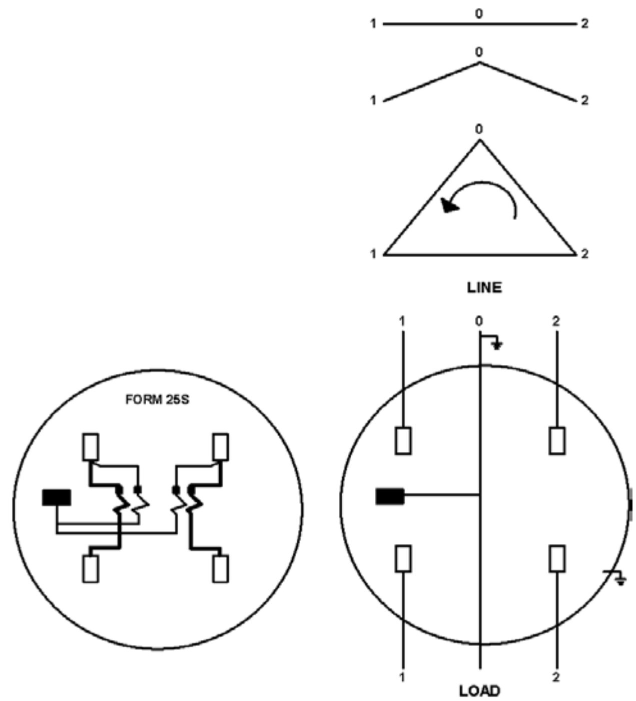

Figure 9.6 Form 25S Wiring Diagram

GLOSSARY

Term	Description
annunciator	A Liquid Crystal Display (LCD) label that is displayed to identify a particular quantity being displayed
baud	Unit of data transmission signalling speed, roughly analogous to bits per second (bps)
display duration	The programmed number of seconds that a quantity is displayed on the LCD before it is replaced with the next quantity in the display sequence
EEPROM	Electrically Erasable Programmable Read Only Memory. A memory chip that can only be erased by an electrical signal (retains data during a power outage)
EPROM	Erasable Programmable Read Only Memory. Similar to EEPROM except it requires ultraviolet light to be erased
electronic detent	An algorithm in firmware which restricts the device to metering energy flow only to the customer (unidirectional metering)
firmware	Computer programs stored in non-volatile memory chips (ROMs, PROMs, EPROMs, EEPROMs, etc.)
fixed decimal	A display format that always retains the same number of digits to the right of the decimal point
floating decimal	A display format that allows a maximum number of digits to the right of the decimal, but can display any number of digits to the right of the decimal equal to or less than that number specified
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
magnetic reed switch	A mechanical switch consisting of a thin metal contact which is closed by an external magnetic field
nonvolatile memory	See EEPROM
RS-232	A communication media whereby information is transmitted through a serial bit stream

Notes:

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