

Adopt new Article 2.2.
CALIFORNIA CODE OF REGULATIONS
TITLE 4
DIVISION 9, CHAPTER 1

Article 2.2. Electric Watthour Meters

4027. A. Application.

A.1. This code applies to electronic and mechanical electrical energy submeters used as commercial measuring devices.

A.2. See also General Code requirements in Article 1, Sections 4000, 4001, 4002, and Section 1.10. General Code.

A.3. Code sections and subsections with an (EM) notation apply to electronic meters only. Code sections and subsections with a (MM) notation apply to mechanical meters only. Code sections and subsections without (EM) or (MM) notation apply to both meter types.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

4027.1. Definitions.

Accuracy Class. A performance specification for instrument transformers which expresses the maximum deviation from the true value of a measured quantity. (Instrument Transformer Accuracy Class) example: a 0.2 accuracy class transformer would be more accurate than a 0.3 accuracy class transformer.

Alternating Current (AC). An electric current that reverses direction in a circuit at regular intervals.

Ampere. The practical unit of electric current. It is the quantity of current caused to flow by a potential difference of one volt through a resistance of one ohm. One ampere is one coulomb of charge per second.

Audit Trail. An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device.

Balanced Load. Balanced load is used to indicate equal currents in all phases and relatively equal voltages between phases and between each phase and neutral (if one exists), with approximately equal watts in each phase of the load.

Basic Lightning Impulse Insulation Level (BIL). A specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse.

Burden (B). The impedance of the circuit connected to the instrument transformer's secondary winding.

Coulomb. The meter-kilogram-second unit of electric charge equal in magnitude to the charge of 6.24×10^{18} electrons; charge transported through a conductor by a current of one ampere flowing for one second.

Creep. A continuous apparent measurement of energy in a meter with operating voltage applied and no power consumed.

Current. The rate of the electron flow past any one point in the circuit. The unit of measurement is coulombs per second or amperes.

Electronic Meter (EM). An electric watthour meter that does not have a rotor. The meter incorporates instrument transformer(s) for determining the tenant's electrical usage.

Element. A combination of a voltage-sensing unit and a current-sensing unit, which provides an output proportional to the quantities measured.

Form Designation (FM). (MM) An alphanumeric designation denoting the circuit arrangement for which the meter is applicable and its specific terminal arrangement. The same designation is applicable to equivalent meters for all manufacturers.

Hertz (Hz). Frequency or cycles per second. One cycle of an alternating current or voltage is one complete set of positive and negative values of the current or voltage.

Instrument Transformer. A transformer that reproduces in its secondary circuit, in a definite and known proportion, the voltage, or current of its primary circuit, with the phase relation preserved. Sometimes these devices may be referred to as VTs (Voltage Transformers) or CTs (Current Transformers).

Instrument Transformer-Rated Meter. A metering system with terminals arranged for connection to the secondary windings of external instrument transformers.

Instrument Transformer Ratio. The stated ratio of the primary circuit current or voltage compared to the secondary circuit current or voltage.

Kilowatt (kW). A unit of power equal to 1,000 watts.

Kilowatthour (kWh). 1,000 watthours.

Line Service. The service conductors connecting the master meter to the submeter.

Load Service. The service conductors connecting the submeter to the tenant's electrical load.

Master Meter. An electric watthour meter owned, maintained and used for commercial billing purposes by the serving utility. All the electrical energy served to a submetered service system is recorded by the master meter.

Mechanical Meter (MM). A watthour meter with a rotor.

Meter Class (CL). The manufacturer's designated maximum amperes a meter can measure continuously without damage or exceeding limits of accuracy.

Meter. An electric watthour meter.

Metrological Components. Elements or features of a measurement instrument or system that perform the measurement process or that may affect the final quantity determination or resulting price determinations. This includes accessories that can affect the validity of transactions based upon the measurement process. The measurement process includes determination of quantities; the transmission, processing, storage, or other corrections or adjustments of measurement data or values; and the display or recording of measurement values or other derived values such as price or worth or charges.

Ohm. Practical unit of electrical resistance, which allows one ampere to flow when the impressed potential is one volt.

Percent Registration. Percent registration is calculated as follows:

$$\text{Percent Registration} = \frac{\text{Wh measured by METER}}{\text{Wh measured by STANDARD}} \times 100$$

Percent Error. Percent Error = Percent Registration – 100

Power Factor. The ratio of the active power to the apparent power.

Primary Watthour Constant (PK_h) (MM). The meter K_h multiplied by the product of the current and/or voltage transformer ratio(s):

$$PK_h = K_h (\text{Current Transformer Ratio} \times \text{Voltage Transformer Ratio})$$

Register Ratio (R_r) (MM). The number of revolutions of the gear meshing with the worm or pinion on the rotor shaft per complete rotation of the fastest (most sensitive) wheel or dial pointer.

Revolution Equivalent. The number of watthours represented by one increment (pulse period) of serial data.

Serving Utility. The utility distribution company that sells electrical energy to the owner of the submeter system.

Stator (MM). The unit which provides the driving torque in a watthour meter. It contains a voltage coil, one or more current coils, and the necessary steel to provide the required magnetic paths.

Submeter. A meter furnished, owned, installed, and maintained, by the customer who is served through a utility owned master meter.

Tenant. The person or persons served electrical energy from a submetered service system.

Test Amperes (TA). The manufacturer's specified full load test amperage.

Test Block. Device that facilitates safe meter testing by disconnecting the meter from the circuit without interrupting the service to the tenant.

Thermal Overload Protector. A circuit breaker or fuse that automatically limits the maximum current in a circuit.

Volt. The practical unit of electromotive force. One volt will cause one ampere to flow when impressed across a resistance of one ohm.

Voltage Transformer. A device which provides a secondary voltage which is a precise fraction of the primary voltage.

Watt. The practical unit of electrical power. In an alternating-current circuit (AC), the power in watts is volts times amperes multiplied by the circuit power factor.

Wattour (Wh). The practical unit of electrical energy, which is expended in one hour when the average load during the hour is one watt.

Wattour Constant (K_h). The expression of the relationship between the energy applied to the meter and one rotor revolution, or output indication, expressed as wattours per revolution or, wattours per output indication.

Wattour Meter. An electricity metering system comprised of components functioning together that measures and registers the integral, with respect to time, of the active power of the circuit in which it is connected. This power integral is the energy delivered to the circuit during the interval over which the integration extends. The unit in which this integral is measured is usually the kilowattour.

Wattour Test Constant (K_t) (EM). The expression of the relationship between the energy applied to the meter system and corresponding occurrence of one test output indication expressed as wattours per test output indication.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code.
Reference: Section 12107, Business and Professions Code.

4027.2. S. Specifications.

S.1. Metrological Components. A meter system shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy. Components shall be designed to prevent undetected access to adjustment mechanisms and terminal blocks by providing for application of a physical security seal or an Audit Trail.

S.2. Terminals. The terminals of the meter shall be arranged so that the possibility of short circuits while removing or replacing the cover, making connections, or adjusting the meter, is minimized.

S.3. Enclosures. Manufactured enclosures supplied with meters shall be designed so that all terminals, connectors, indicators, switches, instrument transformers, and jumpers necessary to conduct a field test are readily accessible for the purposes of connecting test equipment and observing the active meter readings and/or test constant output indications.

(Nonretroactive as of January 1, 2004)

S.4. Provision for Sealing.

S.4.1. Sealing. Provisions shall be made for applying a security seal in a manner that requires the seal to be broken, or for other approved means of providing security (e.g. audit trail available at the time of inspection), before an adjustment can be made that affects the metrological integrity of the meter. The audit trail shall use the format set forth in Table S.4.1.

<u>Table S.4.1. Categories of Device and Methods of Sealing</u>	
<u>Categories of Device</u>	<u>Method of Sealing</u>
<u>Category 1: No remote configuration capability.</u>	<u>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</u>
<u>Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</u>	<u>An event logger is required in the device; it shall include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information shall be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. <u>Note: Does not require 1000 changes to be stored for each parameter.</u></u>

S.5. Meter Identification and Marking Requirements. The following identification and marking requirements are in addition to the requirements of Section 1.10. G-S.1.

Each meter shall have the following information legibly marked on the nameplate or register, if applicable.

- (a) Manufacturer's name or trademark, type designation, and nonrepetitive serial number.
- (b) AC voltage rating.
- (c) Test amperes (TA).
- (d) Meter class (CL).
- (e) Watthour or rotor constant (K_h).
- (f) (MM) Register ratio (R_r) and multiplier (if greater than one).
- (g) Frequency rating (Hz).
- (h) Number of meter stator(s) or element(s).

- (j) Watthour meter or other descriptive term.
- (j) (MM) Number of wires (W).
- (k) (MM) Form designation (FM).
- (l) (EM) Watthour test constant (K_t).

Instrument transformer-rated meters shall contain the following additional information:

- (m) Instrument transformer ratio or transformer model number.
- (n) (MM) Primary watthour constant (PK_h).
- (o) Temperature Limits, if narrower than and within -20°C to $+50^{\circ}\text{C}$ (-4°F to 122°F).
(Nonretroactive as of January 1, 2004)

S.6. Abbreviations and Symbols. The following abbreviations or symbols may appear on a meter, instrument transformer, or indicator.

- (a) FM = Form
- (b) CL = Class
- (c) V = Volts
- (d) Hz = Hertz, Frequency or Cycles Per Second
- (e) TA = Test Amperes
- (f) K_h = (MM) Watthour Constant Per Rotor Revolution or Pulse
- (g) PK_h = Primary Watthour Constant
- (h) R_r = Register Ratio
- (i) CTR = Current Transformer Ratio
- (j) VTR or PTR = Voltage or Potential Transformer Ratio
- (k) MULT BY = Multiply By
- (l) W = Wire (example: 240V 3W)
- (m) Y = WYE Power Supply
- (n) ANSI = American National Standards Institute
- (o) B = Burden
- (p) BIL = Basic Lightning Impulse Insulation Factor
- (q) K_t = (EM) Watthour Test Constant
- (r) AC = Alternating Current (i.e. VAC)
- (s) Wh = Watthour
- (t) kWh = Kilowatthour
- (u) Δ = Delta Power Supply

S.7. Instrument Transformer.

S.7.1. Identification. Each instrument transformer that is non-integral with the meter shall have a permanent identification label identifying the following:

- (a) Manufacturer's name, type designation, and nonrepetitive serial number
- (b) True ratio, primary versus secondary, ampere or voltage values
- (c) Accuracy class
- (d) Burden designation (B)
- (e) Basic lightning impulse insulation level (BIL)
- (f) Rated Frequency (HZ)

Note: If evident by the method of integration that instrument transformers are not intended to be detachable or replaceable, the required information may be located on the meter. (Nonretroactive as of January 1, 2004)

S.7.2. Accuracy Class. An instrument transformer that is not an integral part of the meter and is used for revenue metering shall be rated 0.3 accuracy class or more accurate for the burden of a particular meter type. If a meter system requires an instrument transformer more accurate than 0.3 accuracy class, the limitations shall be stated on the meter.

(Nonretroactive as of January 1, 2004)

S.7.3. Polarity Marking. A permanent mark indicating proper installation orientation is required on the instrument transformer when the accuracy of the meter is affected.

S.8. (MM) Meter Register. A meter register shall clearly indicate the number of kilowatthours measured by the meter. The register ratio shall be indicated on the front of the registers that are not an integral part of the meter nameplate. Means shall be provided for the tenant to read the meter register.

S.9. (EM) Meter Watthour Display.

S.9.1. All submeters in a service system shall have an individual customer display on or at the meter and the minimum value shall not exceed 1 kilowatt hour.

(Nonretroactive as of January 1, 2004)

S.9.2. All submeter systems shall be capable of displaying in 10 watthour test constant (K_t) output indications or less, but not less than 1.9 watthour test constant (K_t) output indications.

Means for displaying watthour test constant (K_t) output indications include but are not limited to: decimal point, contrasting display colors, shorting link, or a means for visual flashing pulse counts.

(Nonretroactive as of January 1, 2004)

S.9.3. The minimum display value (unit of measure) shall be conspicuously identified on or near the customer display.

(Nonretroactive as of January 1, 2004)

S.9.4. A segmented digital display shall have an easily accessible provision for checking that all segments are operational.

(Nonretroactive as of January 1, 2004)

S.9.5. If the display is not on continuously, it shall be accumulated continuously so that real-time measurement is displayed during activation.

(Nonretroactive as of January 1, 2004)

S.10. Multiple Meter Indicating Elements. An indicating or combination indicating-recording element coupled to two or more meter systems shall be provided with means to prohibit display of information from any meter system not selected, and shall be provided with automatic means to indicate clearly and definitely which meter system is associated with the indication.

S.11. (EM) Meter-Control Program. The program shall be an integral part of the meter's firmware read-only memory that cannot be changed in its operating environment.

S.12. (EM) Data Storage and Retrieval.

- (a) Watthour data accumulated and displayed on the indicator shall be permanent and accessible.
- (b) Values displayed or stored in memory shall not be affected by electrical, mechanical or temperature variations, radio-frequency interference, power failure, or any other environmental influences to the extent that accuracy is impaired.
- (c) Memory and/or display shall be recallable for the life of the meter. A replaceable battery shall not be used for this purpose.

S.13. Temperature Range for Metering Components. Meters shall be accurate and correct over the temperature range of -20 °C to +50 °C (-4 °F to 122 °F). If the meter and/or components are not capable of meeting these requirements the installations shall be limited to temperature limits stated on the meter.
(Nonretroactive as of January 1, 2004)

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code.
Reference: Section 12107, Business and Professions Code.

4027.3. N. Notes.

N.1. Meter Creep Test. A meter creep test shall be conducted by applying rated voltage to the meter under test and no load applied.

N.2. Meter Starting Load. A meter starting load test shall be conducted by applying rated voltage and 0.5-ampere load.

N.3. Meter Test Constant Output Indications (EM). Full and light load tests shall consist of 8 or more watthour test constant (K_t) output indications of the test standard and at least 1 watthour test constant (K_t) output indication of the meter under test. Test standards that read out directly in watthours shall meet the watthour equivalent of 8 or more watthour test constant (K_t) output indications.

N.4. Meter and System Test Loads.

- (a) (MM) Mechanical self-contained meters shall be balanced load tested, and may be single element tested, for meter accuracy at full and light loads.
- (b) (MM) Instrument transformer rated systems shall be single element tested, and may be balanced load tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the current transformer(s).
- (c) (EM) Instrument transformer(s) rated systems shall be single element tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the instrument transformer(s).
- (d) The reference voltage phases (A, B, or C) at the meter shall be the same phase

as the load.

N.5. Test of a Meter System.

- (a) Each meter submitted for test shall be a complete system. For example: a meter body and any necessary instrument transformer(s), indicator(s), system software, etc., required to make up a complete system.
- (b) The test load applied for a full load test shall be the marked test amperes (TA) on the nameplate of the meter under test.
- (c) The test load applied for a light load test shall be 10% of the marked (TA) test amperes on the nameplate of the meter under test.
- (d) The test load applied for a full load test of a meter for a 0.5 power factor setting shall be the marked (TA) test amperes of the nameplate of the meter under test.
- (e) The test load applied for a light load test of a meter for a 0.5 power factor setting shall be conducted at 20% of the (TA) test amperes of the meter.
- (f) All tests shall be made at the rated voltage $\pm 10\%$ and $\pm 3\%$ of the (TA) test amperes applied to the device under test.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

4027.4. T. Tolerances.

T.1. Meters with Instrument Transformer(s). Where instrument transformers are used, the provisions of this section shall apply to the metering equipment as a whole.

T.2. Meter Creep Test.

T.2.1. (EM) The meter indicator or display shall not change by more than 1 least significant digit with the voltage circuit(s) energized and current circuit(s) not energized for a duration of 1 hour using the watt-hour test constant (K_t) output indications.

T.2.2. (MM) A meter rotor shall rotate no more than 1 complete revolution in 10 minutes with the meter voltage circuit(s) energized and the current circuit(s) not energized.

T.3. Meter Starting Load Test.

T.3.1. (EM) The watt-hour test constant (K_t) output indication shall continue to advance when a load of 0.5 amperes is applied.

T.3.2. (MM) The meter rotor shall rotate continuously when a load of 0.5 amperes is applied.

T.4. Application to Underregistration and to Overregistration. The following prescribed tolerances shall be applied to errors of underregistration and errors of overregistration.

T.4.1. Tolerance Values. Maintenance and acceptance tolerances for electric watt-hour meters shall be as follows for full and light load tests:

- (a) Maintenance tolerance shall be 2 percent for full and light loads.
- (b) Acceptance tolerance shall be 1 percent for full and light loads.

Acceptance tolerances shall be applied to new and repaired meters before they have been placed in service and meters undergoing type approval.

T.4.2. Power Factor Tests. Power factor tests shall be conducted at 0.5 power factor setting:

- (a) Maintenance tolerance shall be 2 percent for full and light loads.
- (b) Acceptance tolerance shall be 1 percent for full and light loads.

NOTE: 0.5 power factor light load tests shall be conducted at 20 percent of the Test Amperes (TA).

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

4027.5. UR. User Requirements.

UR.1. Selection Requirements.

UR.1.1. Meter Class. The meter class shall equal or exceed the total capacity in amperes of the thermal overload protectors of the tenant.

UR.1.2. Suitability of Equipment. A meter shall be suitable for use on its electrical system. A 3-wire two-phase load which is connected to a 120-208 volt network service shall be metered by a two-stator or two-element meter.

A meter shall accurately measure all loads 5 percent or greater of the electrical service capacity of the tenant. Service capacity shall be determined by the master thermal overload protectors to the tenants' service or by the rated capacity of an electrical cord or plug used to provide power from the service panel to the tenant.

UR.1.3. Instrument Transformer Ratio. The instrument transformer shall be correctly matched to the meter indicator and multiplier.

UR.2. Installation Requirements.

UR.2.1. Regulation Conflicts. If any provision of this section (UR.2. Installation Requirements) is less stringent than that required of a similar installation by the serving utility, the installation shall be in accordance with those requirements of the serving utility.

UR.2.2. Meter Test Facilities. All meters shall be provided with the same test facilities that are required of a similar meter by the serving utility.

UR.2.3. (MM) Test Blocks. All three-phase self-contained meter installations shall be equipped with test blocks, which are approved by the serving utility, for safe meter testing.

UR.2.4. (MM) Test Switches. Meter installations that are equipped with current or potential transformers, or both, shall have test switches installed, which are approved by the serving utility, for safe meter testing.

UR.2.5. (MM) Circuit Closing Devices. All self-contained meter installations that cannot accept a short interruption of the electrical service, for the purpose of testing the meter, shall be equipped with a manual circuit closing device as approved by the serving utility. Automatic circuit closing devices shall not be used on any meter installation.

UR.2.6. Thermal Overload Protectors. The main circuit breaker or main switch, fuses, and their auxiliary equipment shall be installed in the load service near its entrance as supplied to the tenant. It is intended to constitute the main control and means of cut-off for the supply to the tenant.

UR.2.7. Metering System Grounds. A metal cased meter and its corresponding thermal overload protector enclosure shall be properly grounded.

UR.2.8. Line Service at Test Site. Line voltage(s) and neutral shall be readily available and accessible at the field test site for the purpose of energizing test equipment.

UR.2.9. Location of Meter. Each meter shall be accessible by an unobstructed entrance or passageway not less than 24 inches (61 cm) wide and 78 inches (198 cm) high. An unobstructed standing space of at least 30 inches (76 cm) wide, 36 inches (91 cm) deep and 78 inches (198 cm) high shall be maintained in front of the meter to allow for installation and reading of the meter. An unobstructed space shall be provided for connecting test equipment and testing the meter.

UR.2.10. Accessibility.

UR.2.10.1. Meter and Meter Component Installation Heights. Meter, meter components, instrument transformers, and meter terminal connectors necessary to conduct a field test, shall be located not more than 75 inches (190 cm) and not less than 30 inches (76 cm) above the ground or standing surface measured to the bottom of each such component.

UR.2.10.2. Meter Component Access.

- a) All terminals, connectors, indicators, displays, switches, instrument transformers, and jumpers necessary to conduct a field test shall be installed so they are readily accessible for the purpose of connecting test equipment and observing active meter readings and/or test constant output indications.

Any live parts, terminals, or connectors, operating at service voltage, necessary to conduct a field test, shall be adequately spaced and accessible so that shorting is unlikely when connecting or disconnecting test equipment.

b) Instrument transformers shall be installed in an appropriate sealable enclosure designed for housing instrument transformers. Such enclosure shall be located not more than 15 feet (4.5 m) in distance from the associated meter element(s) and shall be readily available for connecting meter test equipment and viewing the watt-hour test constant output indication. (Nonretroactive as of January 1, 2004).

UR.2.10.3. Exemption. Submeter installations serving only watercraft are exempt from the provisions of UR. 2.10.1. and UR.2.10.2. Owners shall, when requested by the sealer, deliver the meter and all components necessary for testing to a location designated by the sealer. If the sealer determines a field test is necessary to determine proper installation and operation, it shall be the meter owner's responsibility to provide qualified personnel or equipment as necessary to permit the sealer to test the meter.

UR.2.11. Metered Circuits (Load Service). All electricity used by a tenant shall be taken exclusively from the load service of the tenant's meter. This service and its associated meter shall accurately measure the tenant's load and be capable of being used only at the discretion of the tenant.

UR.2.12. Unmetered Circuits (Line Service). The tenant's electrical circuit shall not be taken from the line terminals of the meter, meter socket, or line service. The owner of the submeter system may utilize this service.

UR.2.13. Dedicated Tenant Service. A meter shall serve only the space, lot, building, room, suite, stall, slip, or premise occupied by the tenant.

UR.2.14. Tenant Premise Identification. Tenant premise identification shall be clearly and permanently shown on or at the meter, and on all separate components of a meter system, including, but not limited to, instrument transformer(s), modem(s), and transmitter(s) if equipped. Remote indications and all printed indications shall be readily identifiable and readily associated with the tenant's premise. Printed indications shall also include time and date information.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.