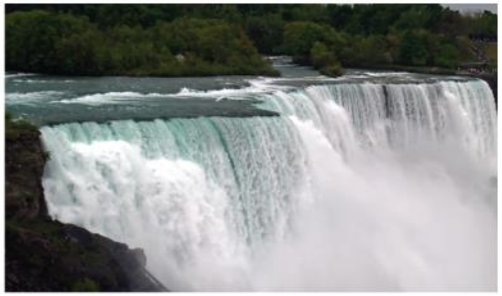


Introduction to Poly-Phase Metering

Terry Gaiser

sensus

The Measure of the Future

Safety First!

Safety Reminder

- Safety is a full-time job that requires the hard work and full attention of every meter employee.

- Safety procedures, if followed, will enable personnel to work without injury to themselves or others and without damage to property.

Safety Reminder

- Simply issuing safety procedures or rules does not guarantee safe work practices or produce good safety records.

- Meter employees must learn the safety rules of their company, apply them daily, and become safety-minded.

Safety Reminder

- Meter personnel owe it to themselves, their families, and their company to do each step of every job in a safe manner.
- Careful planning of every job is essential and nothing should be taken for granted.
- The meter employee must take responsibility for his/her own safety.
- Constant awareness of safety, coupled with training, experience, and knowledge of what to do and how to do it, will prevent most accidents.

Safety Reminder

- The importance of working safely cannot be over-emphasized - Remember, there is no job so important that it cannot be done in a safe manner.

The Measure of the Future

Why Use Poly-Phase Meters?

Why Use Poly-Phase Meters?

- Three-phase power distribution is the most common method used by electric power companies to distribute power. Primarily used to power large, commercial loads and large motors.

- Three-phase power is generally more economical because it uses less conductor material to transmit electric power than equivalent single-phase systems at the same voltage.

Why Use Poly-Phase Meters?

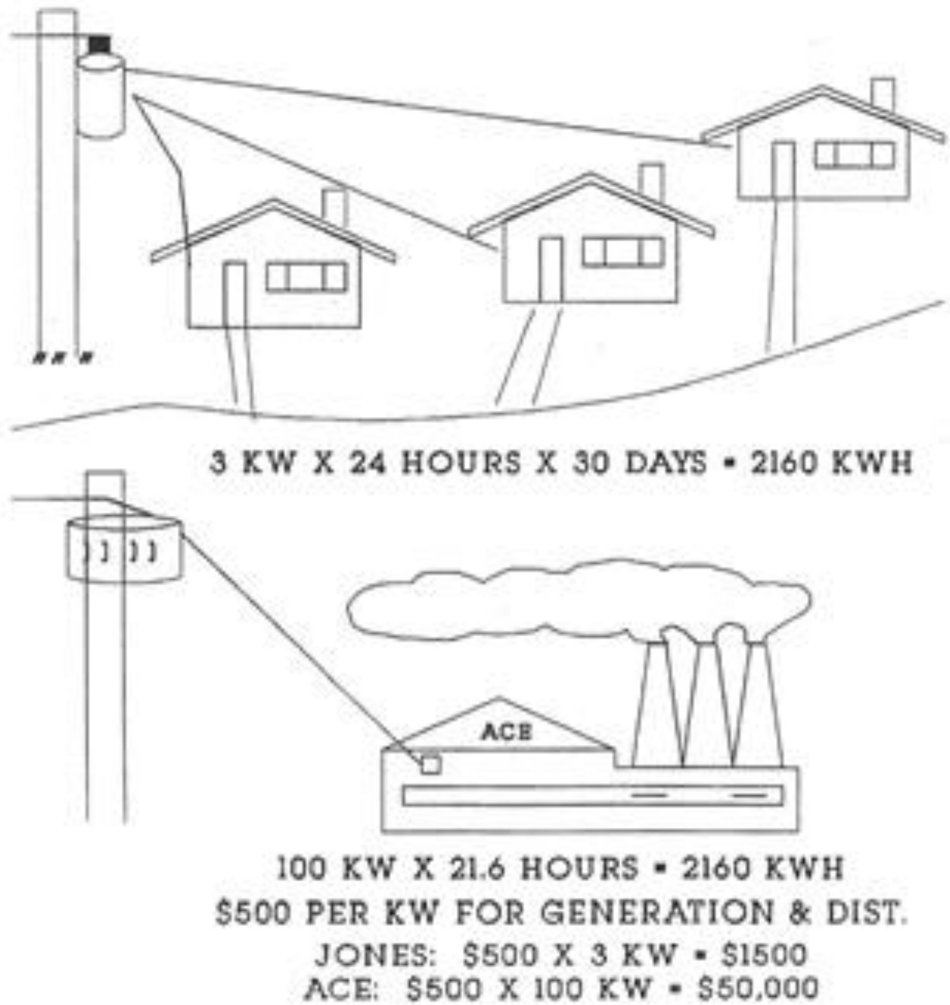
- Three-phase systems can produce a magnetic field that rotates in a specified direction, which simplifies the design of electric motors and eliminates the need for phase shifting transformers.

- A three-phase motor is more complex and potentially more costly than a single-phase motor of the same voltage class and rating.

- Equipment can be connected in a Delta configuration eliminating the need of a neutral conductor.

Poly-Phase Services – Why am I paying more for it?

Example:



Poly-Phase Metering Today

- Most U.S. electric meter manufacturers supply meters with maximum currents (meter class amps) of 100, 200 and 320 amperes for direct connection to the electrical services. These meters are referred to as self-contained meters.

- Most electric meter manufacturers also supply meters with maximum currents of 10 and 20 amperes for use with instrument transformers. These meters are referred to as transformer rated meters.

Poly-Phase Metering Today

- In electro-mechanical meters, voltage indicating lamps or LEDs are used. Typically, these are installed on transformer-rated meters to indicate if the transformer has failed,

- Most meter manufacturers furnish their solid-state meters with potential indicators on the meter display that confirm the presence of individual phase voltages.

Poly-Phase Metering Today

- In addition, many electronic meters now provide a number of additional measurements, security, instrumentation and power quality functions.
- Most commercial meters are made in both “A”, (bottom-connected), and “S”, (socket) type bases. Type “A” are normally connected to the Line and Load by means of a test block installed at the site.
- The use of the “S” base metering is quickly becoming the industry standard.

Poly-Phase Metering Today

- Socket base meter advantages include quick and easy insertion and removal of the meter in a compact meter socket and with full Class 200 or 320 amp capacity.

- The socket can be furnished with a manual or an automatic bypass to short the secondary of the any external current transformers, or allow removing or changing the meter without interrupting the customer's service.

Poly-Phase Metering Today

- Multi-stator Classes 10 and 20 meters are available in both A Base and S base configurations.

- They are available for switchboard use in semi-flush or surface-mounted cases, with or without draw-out features.

- Draw out cases provide a means to test the meter in place, or to withdraw it safely from the case without danger of opening the current-transformer secondary circuits

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The Measure of the Future

Watthour Meter Basics

Domestic US Meter Manufacturers

- Aclara - General Electric
- Landis + Gyr – Siemens – Landis @ Gyr – Duncan
- Itron – Schlumberger – Sangamo
- Honeywell - Elster – ABB – Westinghouse
- Sensus

Metering Terminology

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The Measure of the Future

Metering Terminology

Metering Terminology

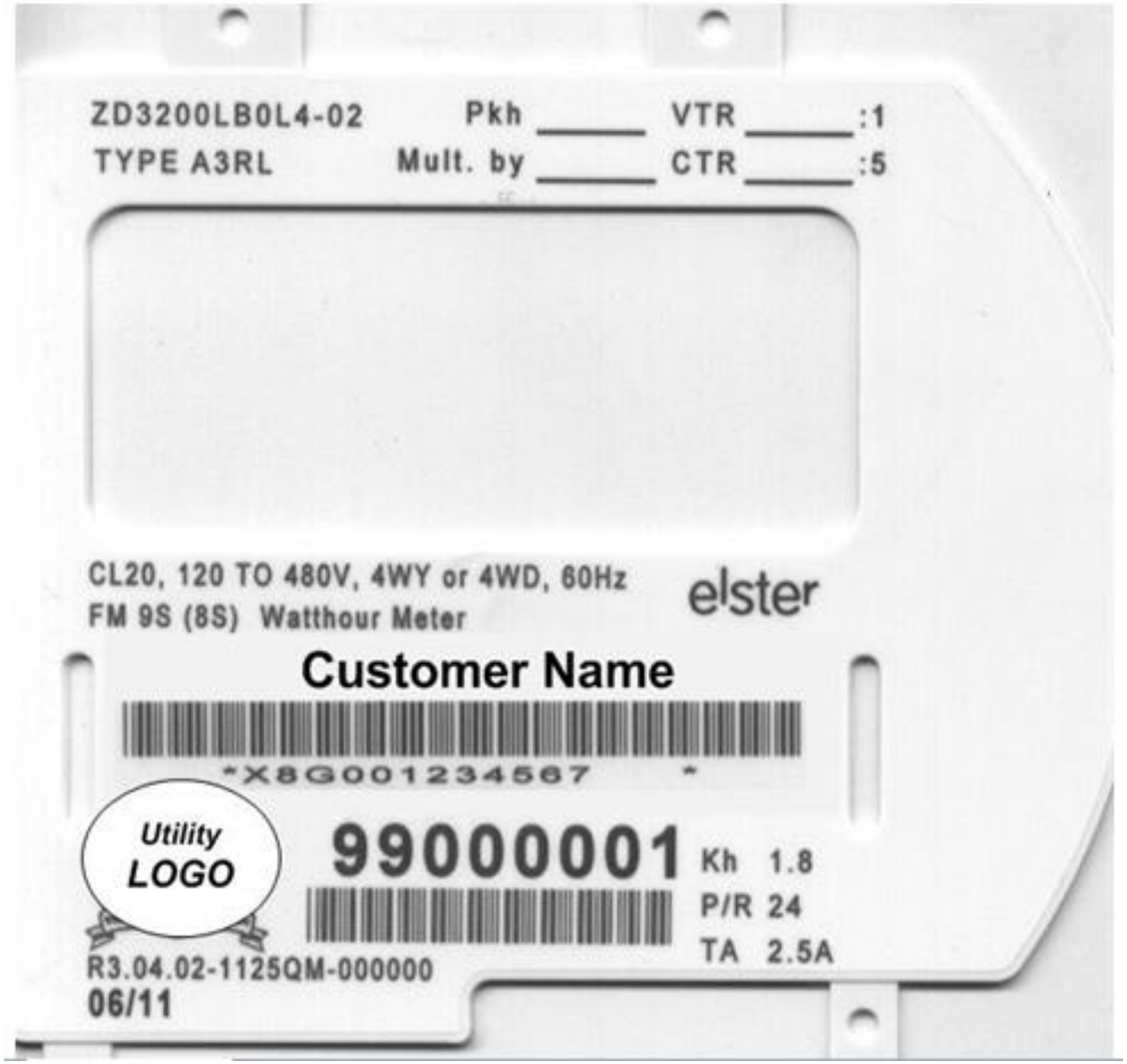
- **Single-Phase –** A meter with one watt meter or one “element”. Also referred to as a 1-phase meter. Often synonymous with residential metering.

- **Poly-Phase –** A meter with more then one watt metering “element”. Also referred to as a 3-phase meter. Poly-phase meters come with 2, 2 ½ and 3 elements (watt meters) in a single package. Often synonymous with commercial & industrial metering.

- **Stators –** Old term from electro-mechanical meters that is synonymous with elements. Example: A 3-stator meter has 3 elements or 3 watt-meters

Meter Nameplate

Example:



Metering Terminology (continued)

- **Form Number –** Number conforming with the internal connection diagram included in the ANSI C12.10 standard - Meters with the same form number have identical internal connections. Abbreviated as “Fm”

- **Form Letter –** Letter following form number indicating the socket/terminal configuration of the meter.

- **S – Socket Based –** Large number of meters in service are S-base
- **A – Adapter Base** (integral screw terminals for service wiring)
- **K – Bolt-in 480 amp meter –** Only Landis+Gyr offers K-base meters

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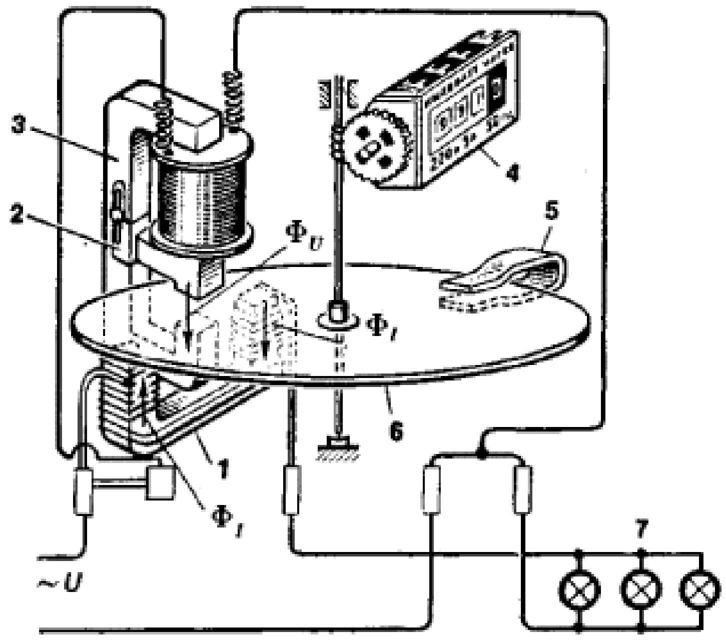
Common Meter Forms

Meter Form	Service Voltages	Service Type & Wires	Class
1S	120V	1-PH 2W	CL100
2S	240V	1-PH 3W	CL200 or CL320
3S	120V or 240V	1-PH 2W	CL10 or CL20
4S	240V	1-PH 3W	CL20
5S(35S or 45S)	120/240V or 240/480V	1-PH 3W	CL20
	120/208V	3W Network	
	120V or 240V	3W or 4W Delta	
6S(36S) or 29S	120/208V or 277/480V	4W Wye	CL20
8/9S	120/208V or 277/480V	4W Wye	CL20
	120/240V or 240/480V	4W Delta	
12S/25S	120/240V or 240/480V	1-PH 3W	CL200 or CL320
	120/208V	3W Network	
	120/240V or 240/480V	3W Delta	
14/15/16S	120/208V or 277/480V	4W Wye	CL200 or CL320
	120/240V or 240/480V	4W Delta	

Kh

- **Kh =** The watthour constant of any meter and is the amount of energy, expressed in watthours, delivered to or consumed by a load necessary to cause the disk to make one complete revolution.



Metering Terminology (continued)

- **Kh (or Disk Constant) –** watt-hours metered by each disk revolution or theoretical disk revolution
- **PKh (Primary metering Kh) =** Kh x VTR x CTR
- **Example:** Form 9S Kh=1.8 and 7200:120 VTR and 600:5 CTR
- **PKh =** 1.8 x 60 x 120 = 12,960 watt-hours
- **Kt or Kfactor –** watt-hours metered by each pulse recorded on a solid-state meter.

Metering Terminology (continued)

- **Self-Contained –** Meter is connected directly to the load being measured. Abbreviated by letters “SC”

- Current and voltage transformers are not required with self-contained meters – the meter is directly connected to the service conductors. The full line voltage is applied to the meter and the entire current flows through the meter.

Metering Terminology (continued)

- **Transformer-Rated –** Meter measures scaled down representation of the load. Scaling accomplished by use of external current transformers (CTs) and optional voltage transformers (VT or PTs). Abbreviated by letters "TR"

- All transformer rated meters require current transformers. In the case where the service voltage exceeds 480 volts, voltage transformers are also required. Current transformers are used when the current exceeds 200 amps (exceptions are Class 320 and 480 amp K-Base services). Many companies also require that voltage transformers be used on all 480 volt services.

Metering Terminology (continued)

- **Class –** Maximum continuous current the meter is capable of handling. Abbreviated by letters “CL”

- **Common Meter Class Ratings:**

- **CL 100 -** 100 Amps – Self-Contained
- **CL 200 -** 200 Amps – Self-Contained
- **CL 320 -** 320 Amps – Self-Contained
- **CL 10 -** 10 Amps – Transformer-Rated
- **CL 20 -** 20 Amps – Transformer-Rated

Metering Terminology (continued)

- **Test Amps –** Current in amps that the meter is tested for “Full Load (FL)” accuracy. Abbreviated by letters “TA” Also referred to as the rated current. TA = 15% of class amps for self-contained, 25% of class amps for transformer rated.
- **Example:** Form 2S CL200 meter TA=30 Amps (200 x 15%)
- **TA 0.5 -** CL2 meter tested at 0.5 Amps
- **TA 2.5 -** CL10 or CL20 meter tested at 2.5 Amps
- **TA 15 -** CL100 meter tested at 15 Amps
- **TA 30 -** CL200/CL320 meter tested at 30 Amps
- **TA 50 -** CL320/CL480 meter tested at 50 Amps
- **Light Load –** Current in amps that the meter is tested for low current accuracy. Typically 10% of TA. Abbreviated by letters “LL”
- **Example: LL =** 3 Amps on a meter with a TA 30 Amps

Metering Terminology (continued)

- **Service Voltage –** Line-to-neutral or line-to-line voltage at the meter service. Often referred to as meter nameplate voltage.
- **Example:**
- Residential meters typically have 120V or 240V service voltages
- Modern solid-state 3-phase meters have 120-480V service voltages
- **Service Wiring –** Number of wires from the distribution transformer and phase relationship. Abbreviated as “#W”
- **Example:**
- 1-Phase 2W or 3W
- 3-Phase 3W wye (network) or 3W delta
- 3-Phase 4W wye or 4W delta

Metering Terminology (continued)

- **Primary Metering** uses transformers to reduce the voltage and current to values a meter can measure. This is common on large commercial and industrial customers. Meters can only directly measure up to 480 amps and 480 volts. Primary metering requires "multipliers" to correctly scale the energy used.
- **VTR –** Voltage Transformer Ratio
- **Example:** 7200:120 VT results in a VTR of 60 (scale 7200V to 120V)

- **CTR –** Current Transformer Ratio
- **Example:** 600:5 CT results in a CTR of 120 (scale 600 amps to 5 amps)

- These ratios are commonly known as your meter multiplier

Electrical Quantities – definitions

- **Current –** The rate of flow of electrons in an electric circuit. One ampere of current is flowing when one coulomb of electrons (being 6.28 x 10 to the 18th power electrons) is flowing past a given point in one second. The unit of measure of current is the ampere and is measured by an amp-meter. Current is analogous to the flow of water in a water system.

- **Voltage (EMF) –** The electrical pressure that will cause or tends to cause current to flow in an electrical circuit. The unit of measure of voltage is the volt and is measured by a volt-meter. Voltage is analogous to water pressure in a water system.

Electrical Quantities – terminology

- **Resistance –** The property of an electric circuit that opposes current flow. In a DC circuit, the unit of measure is the ohm and is measured by an ohm-meter.

- **Power –** The rate of which electrical energy is delivered to or consumed by a load, and in a DC circuit, power is equal to current multiplied by the voltage (P=IE). The unit of measure of power is the watt and is measured by a watt-meter.

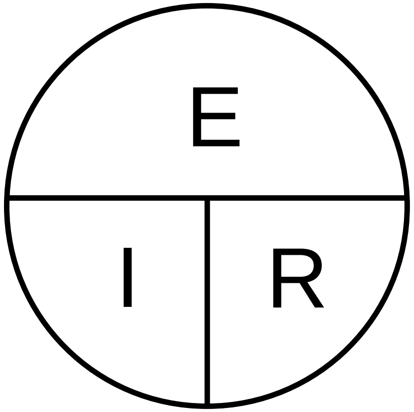
- **Energy –** The total amount of electrical work done over a period of time and is equal to power multiplied by time. The unit of measure of energy is the watthour and is measured by a watthour meter.

Electrical Quantities

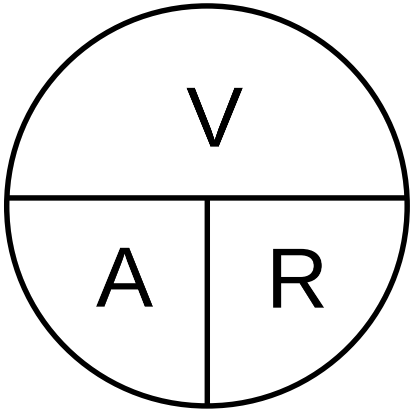
- **Power:** The rate of doing work
- One horsepower is equivalent to 745.7 watts**.**
- **Power (Watts) =** Voltage X Current X Cosine
- Power generated in the stator assembly is the driving force that spins the disk.
- **Energy:** The capacity for doing work
- The work done by one watt acting for one hour
- **Energy =** Power X Time
- The counteractive flux field generated by the damping magnet (drag magnet) introduces time control to the disk
- Note: In solid-state meters, the disk is not present, but the end measurements are still the same.

Ohm's Law

- In a DC circuit, the current (I) is directly proportional to the voltage (E) and inversely proportional to the resistance (R).
- Volts, Amps, and Ohms (resistance) have a unique relationship…If you know 2 of the 3 quantities, you can calculate the 3rd:
- **Volts =** Amps x Ohms **(E = IxR)**
- **Amps =** Volts / Ohms **(I = E/R)**
- **Ohms =** Volts / Amps **(R = E/I)**

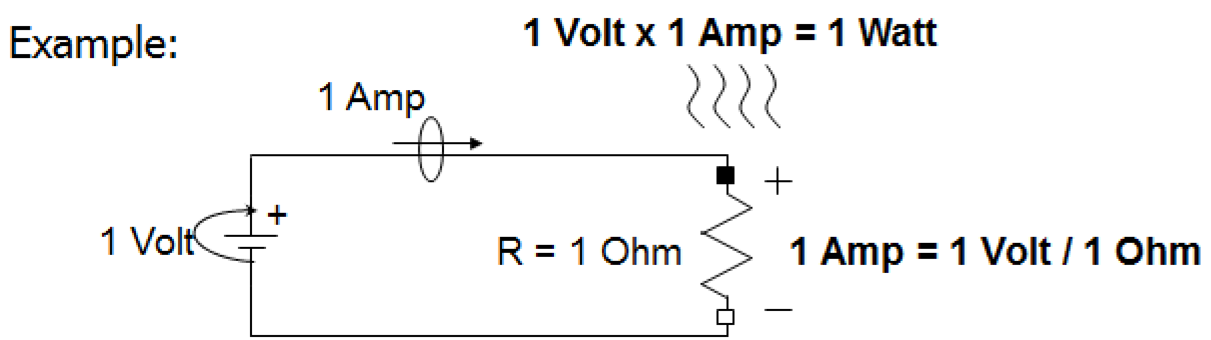


- Historically, Ohms law and engineering
- Textbooks use:
- I = Amps
- E = Volts



Power in DC Systems

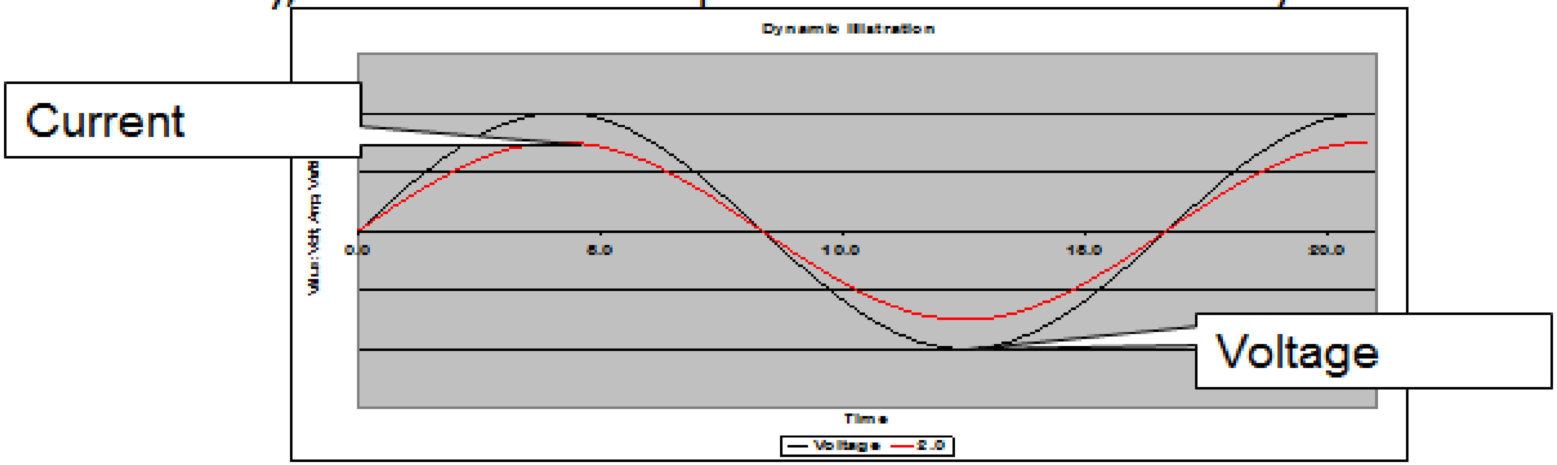
- **Electric Power (1 Volt x 1 Amp) converted to Heat (1 Watt)**
- **In Direct Current (DC) systems:** Watts = Volt x Amps (VA)
- **Ohms Law:** Amps = Volts / Resistance (ohms)



Power in AC Systems

Power in AC Systems

+The previous examples are all based on DC power. Ohms law doesn't change in AC (alternating current) systems, but watts is calculated differently, and volts and amps are measured differently.



Volts and Amps in AC systems are measured with RMS meters where:

RMS ⇒ Root Mean Square ⇒ Square Root of average of Squares

Calculated from digital samples:

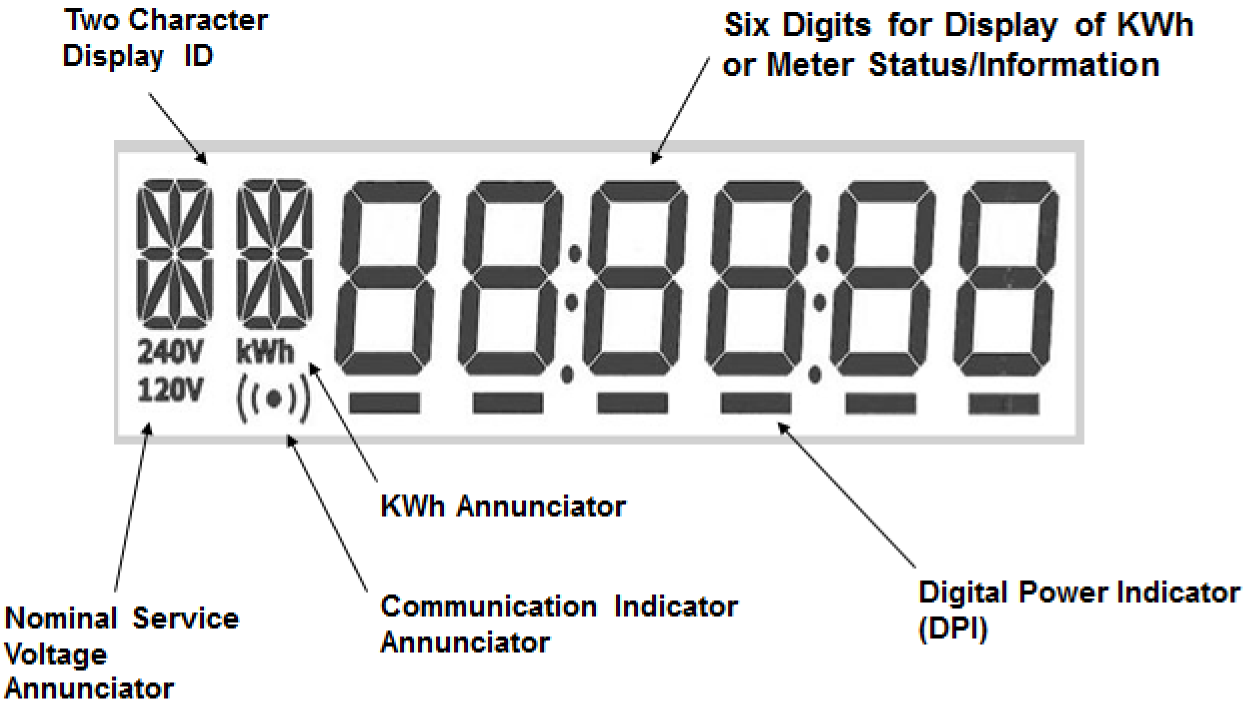
$$RMS = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + \ldots v_n^2}{N}}$$

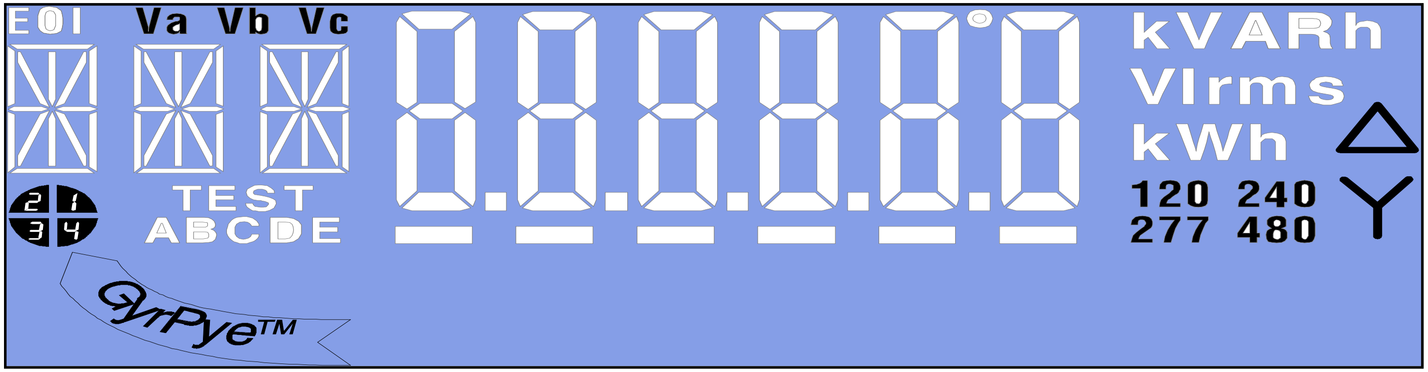
3 Phase Power Formula

- **The constant for 3 Phase Power is the square root of 3 or 1.73**
- **Watts (Power) =** Volts x Amps x 1.73 x cosine of angle theta (power factor) divide by 1000 to obtain kW

- **Horse Power -** 1 hp =746 watts
- **Horse Power (3 Phase) =** (Volts x Amps x 1.73 x Power Factor) divided by 746 = horsepower
- The common symbol for 3 Phase is a 3 then an oval with a horizontal bar through it (Greek symbol of Theta)

Solid State Meter Displays





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The Measure of the Future

Metering Instrument Transformers

Metering Transformers (CT’s)

JKW - 5

JAK - 0

JCR - 0C

Metering Transformers (VT's or PT's)

Instrument Transformers

- **Instrument Transformers perform two primary functions:**

- A) They transform the line current or voltage to values suitable for standard instruments which normally operate on 5 amps and 120 volts.

- B) They isolate the instruments and meters from line voltage. To make this protection complete for both instruments and operators, the secondary circuit should be grounded.

Current Transformers (CT's)

- <u>**Types of Current Transformers**</u>

- **A) Window Type**: This type has a secondary winding completely insulated and permanently assembled on the core, but has no primary winding. This type of construction is commonly used on 600 volt class current transformers.
- **B) Bar Type**: Same as the window type except a primary bar is inserted into the window opening. This bar can be permanently fixed into its position or be removable.
- **C) Wound (wound-primary) Type**: This type has the primary and secondary windings completely insulated and permanently assembled on the core. The primary is usually a multi-turn winding.

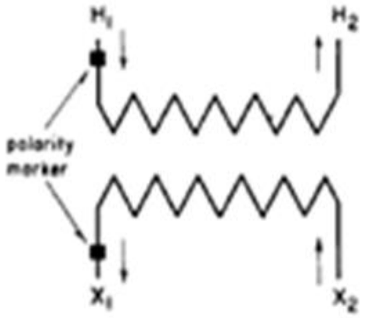
Instrument Transformers

- Transformers that are used in the delivery of power (watts or VA) are referred to as instrument transformers.
- Instrument transformers are used for scaling down high AC voltage or current for use with metering and relays.
- These transformers are commonly referred to as VT (voltage transformer) or CT (current transformer).

Instrument Transformers

- According to the figure below, when current is flowing toward the transformer in the marked primary lead, it is flowing away from the transformer in the marked secondary lead

- Arrows indicate instantaneous relative direction of currents in the windings.



Instrument Transformers

- With instrument transformer metering, the polarity of the VT and CT transformers must match the corresponding polarity of the meters voltage and current inputs.

- Failure to match transformer and meter polarity can result in negative power measurement on single phase services and substantial under registration of 50% - 66% on a poly-phase meter.

Instrument Transformers - Caution

- **<u>Safety Caution:</u>** Always short a current transformer’s secondary winding before removing a meter. Use provided test switches to short out a current transformer <u>before</u> removing an electricity meter. Failure to do so will result in extremely high voltage that can damage the transformer and harm personnel.

- **<u>Safety Caution:</u>** Never short a voltage transformer’s secondary winding. Shorting a voltage transformer’s secondary winding can damage the transformer.

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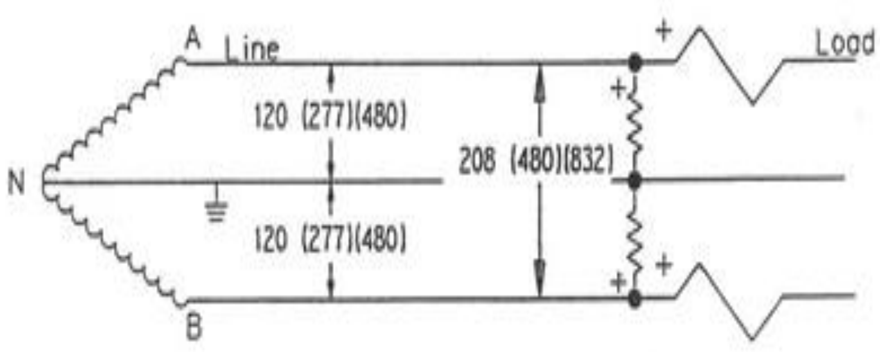
Proven Solutions

Types of Services

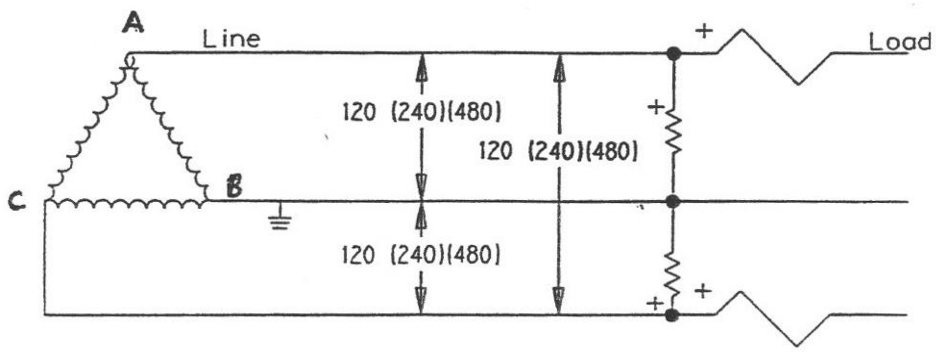
Type of Service

- Poly-phase service
- Three phase three-wire network
- 120/208 Volts
- 277/480 Volts



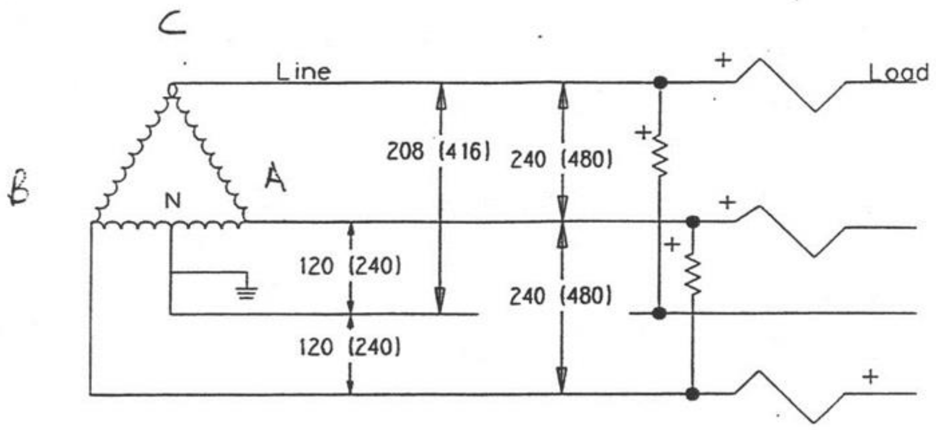
Type of Service

- Poly-phase service
- Three phase three-wire (Delta) – one phase may, or may not be grounded
- 120 Volts
- 240 Volts
- 480 Volts



Type of Service

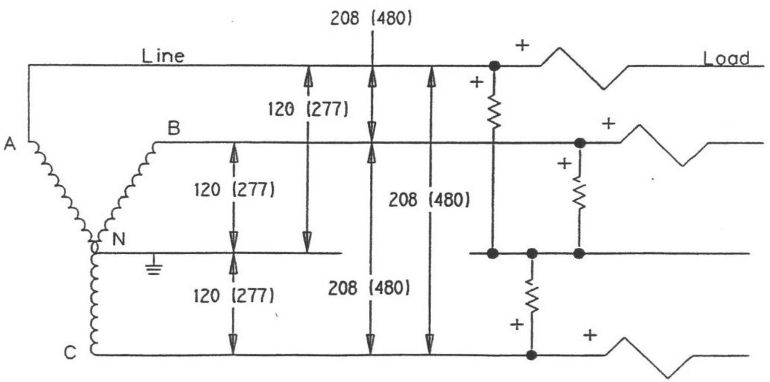
- Poly-phase service
- Three phase four-wire delta
- 120/240/208 Volt-Meter voltage is 240 Volts
- 240/480/416 Volt-Meter voltage is 480 Volts



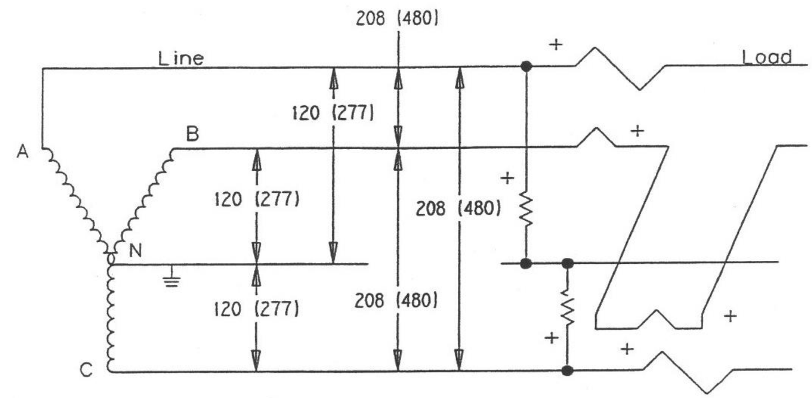
(c) Three-Phase, Four-Wire Delta

Type of Service

- Poly-phase service
- Three phase four-wire wye
- 120/208 Volt-Meter voltage is 120 Volts
- 277/480 Volt-Meter voltage is 277 Volts



Three phase four-wire wye – 2.5 element "Z" meter



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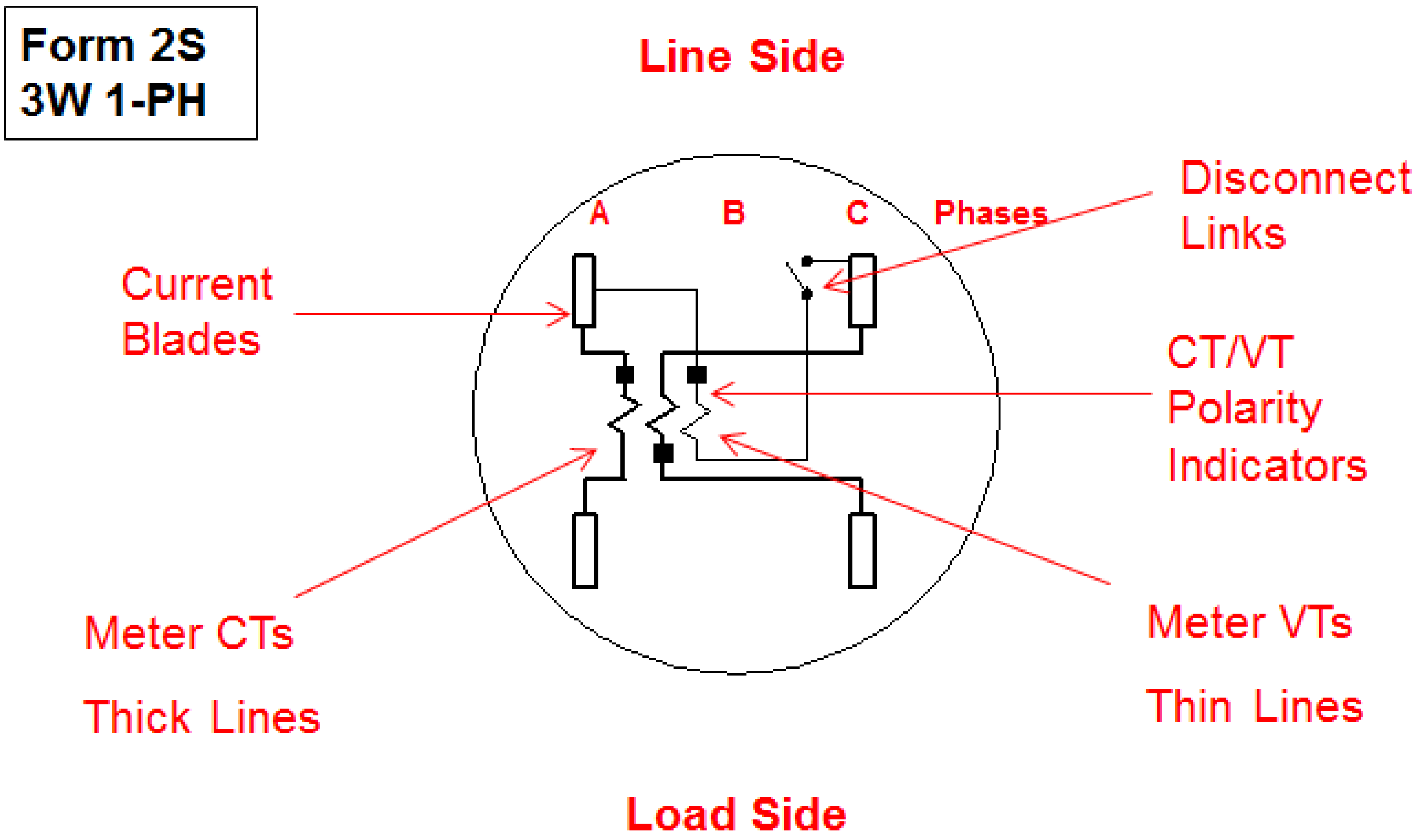
The Measure of the Future

Meter Diagrams

Meter Schematic Symbols



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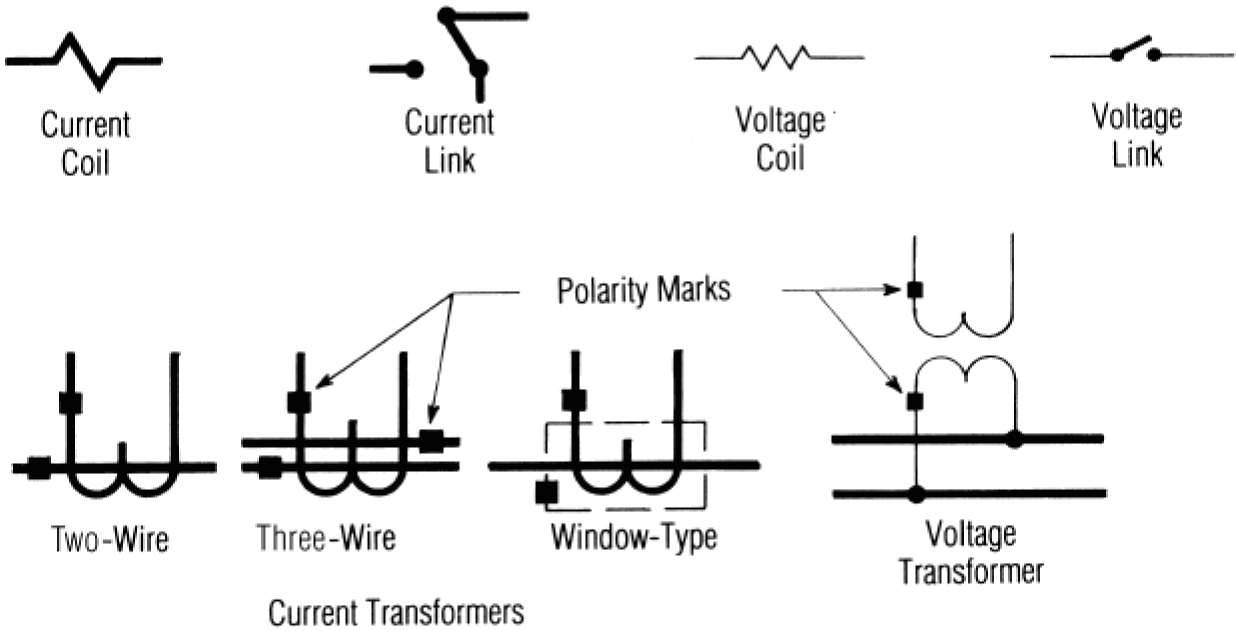
Meter Circuit Schematic Symbols



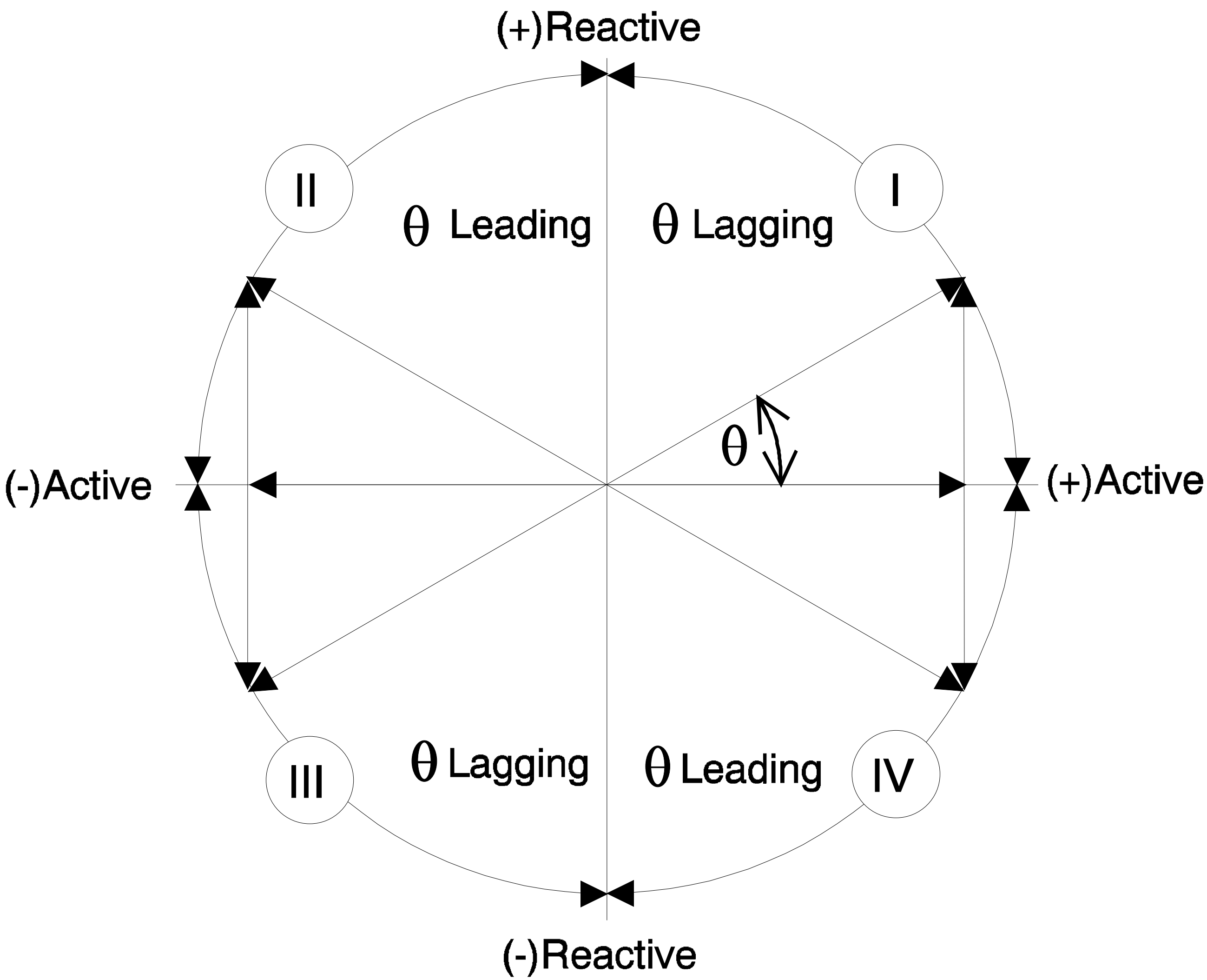
Understanding Meter Diagrams

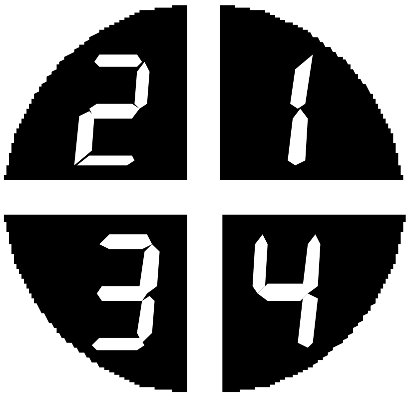
- Meter diagrams are a pictorial method of describing meter circuits. They allow personnel to visualize a meter and its service.

- Each symbol of a meter diagram has a particular meaning and once a reader becomes more familiar with meter diagram symbols, they can interpret more complex meter diagrams such as poly-phase meters.

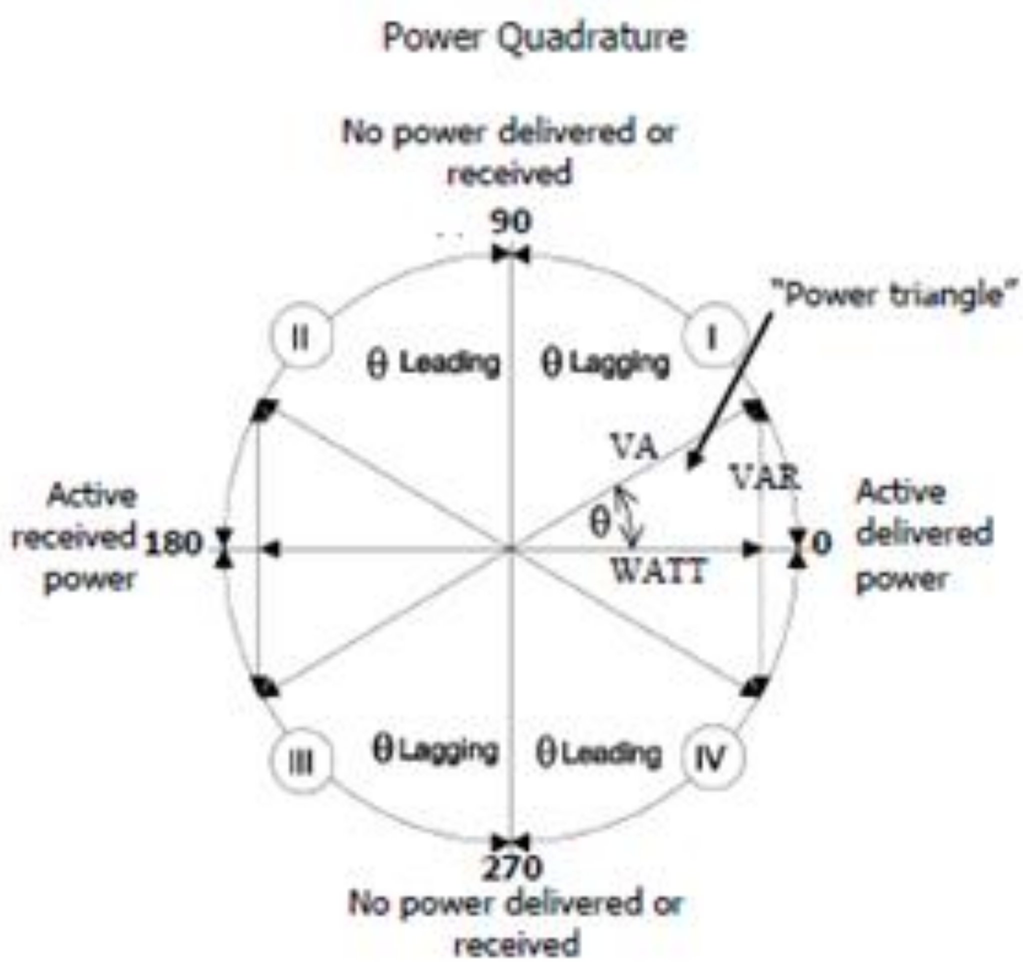
- In the following examples, all S-based meters (socket based) have the line side wiring connected to the top of the meter, and the load side wiring exiting from the bottom of the meter.

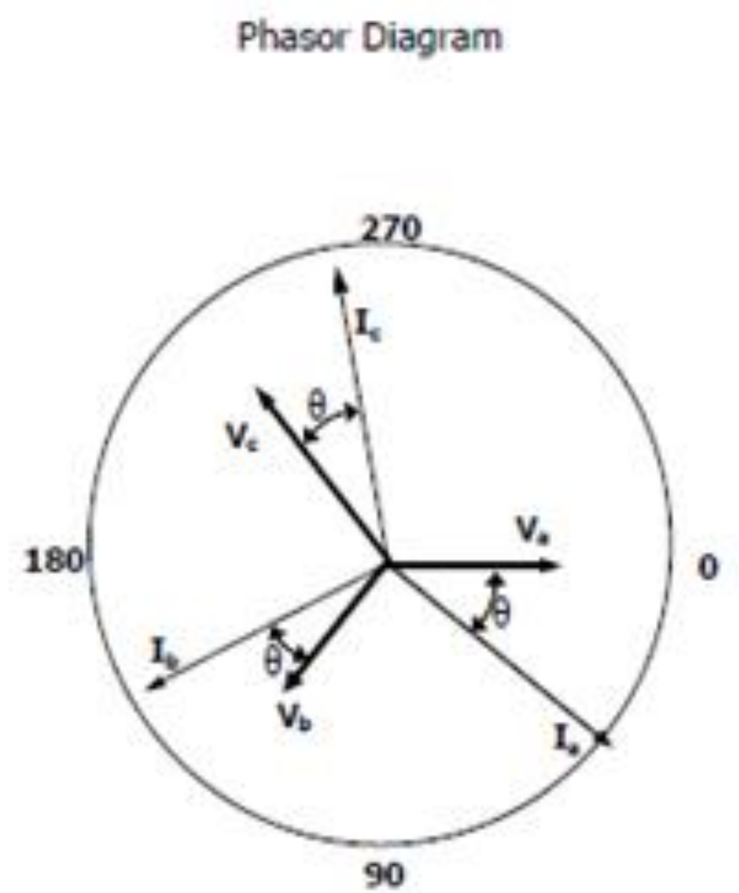
Power Quadrants





Phasor Diagrams vs. Power Quadrants





Phasor Diagrams vs. Power Quadrants

- There is often some confusion about phasor diagrams – these diagrams are NOT Power Quadrature diagrams. Power Quadrature diagrams show the actual direction of power flow (received vs. delivered) and the relation of watts and reactive volt-amperes.

- Phasor diagrams show the ideal angles of current and voltage from the perspective of the meter using phase A voltage as a reference angle.

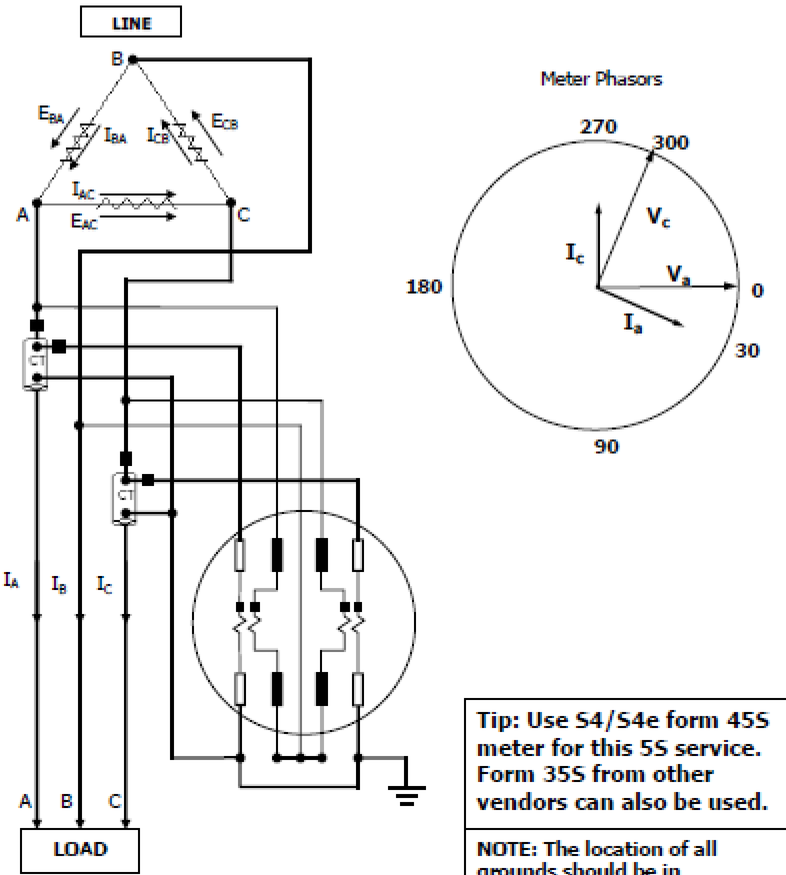
Phasor Diagrams vs. Power Quadrants

- When voltage and current do not have the same angle in a Phasor diagram, it does not mean that the current is “leading” or “lagging”. Rather, it shows the angle that the meter should expect to see for each phase.

- In order to have leading or lagging current, the current would have to lead or lag these *expected* angles.

Form 5S – 2 element, 3 wire Delta

11.1 5S - Wiring 1 - 2-element, 3-wire Delta, A-B-C phase rotation

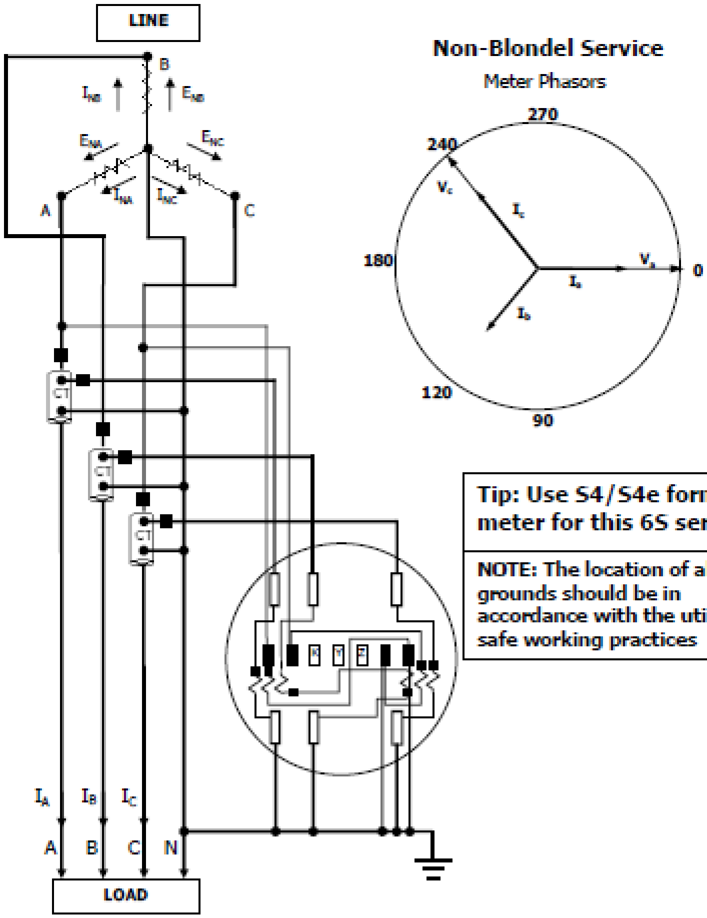


Tip: Use S4/S4e form 45S meter for this 5S service. Form 35S from other vendors can also be used.

NOTE: The location of all grounds should be in accordance with the utilities safe working practices

Form 6S – 2.5 element, 4 wire Delta

13. 6S, 2½-element, 4-wire Wye, A-B-C, phase rotation

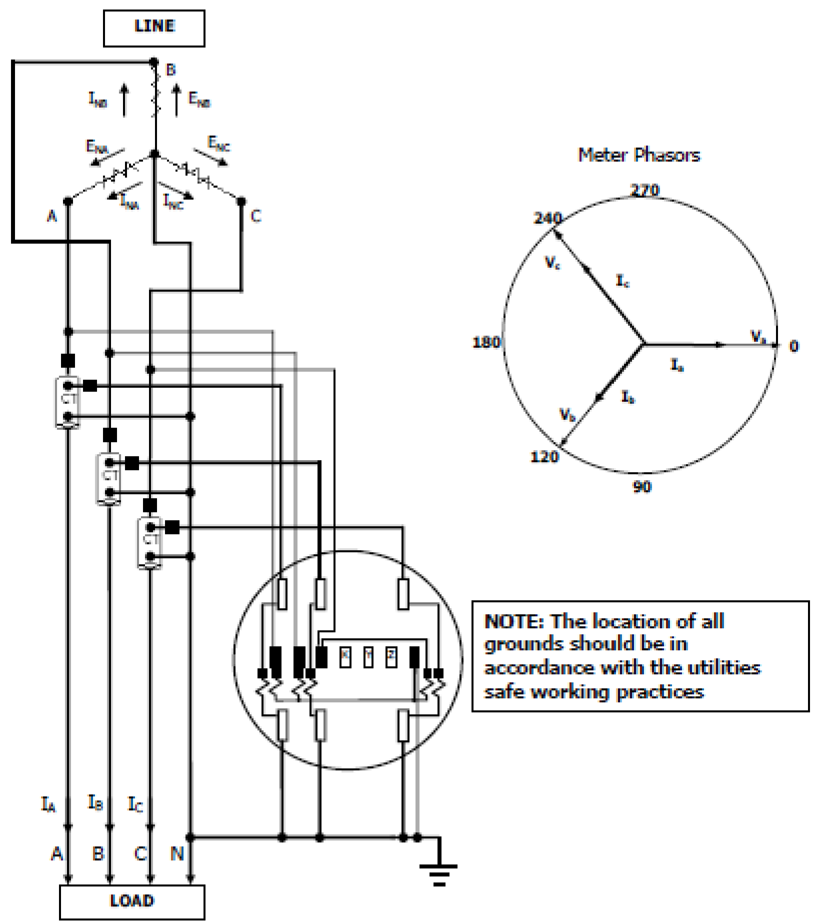


Tip: Use S4/S4e form 36S meter for this 6S service

NOTE: The location of all grounds should be in accordance with the utilities safe working practices

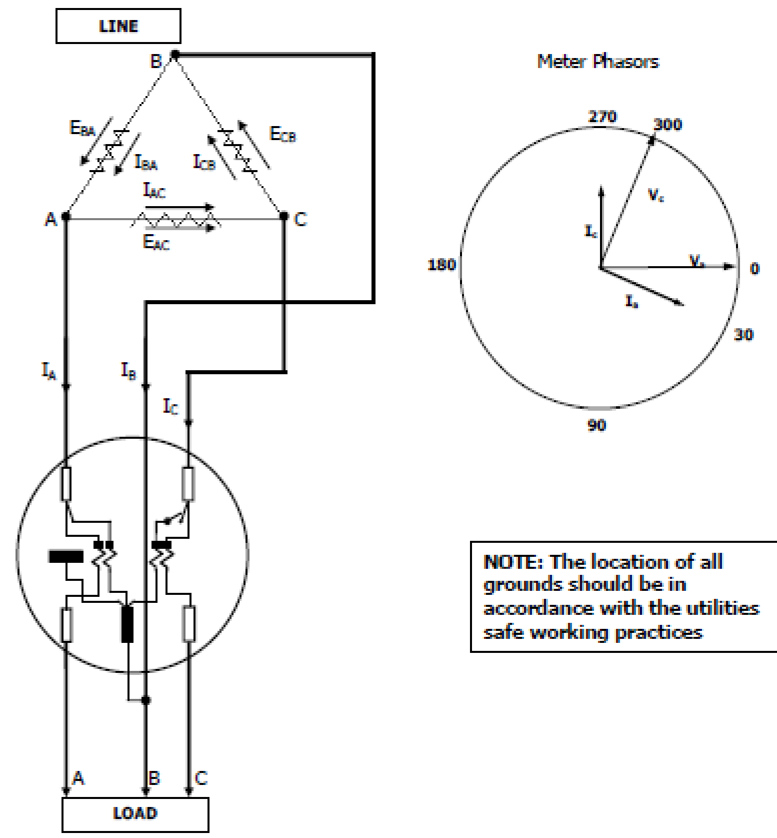
Form 9S – 3 element, 4 wire Wye

17.2 9S - 3-element, 4-wire Wye, A-B-C phase rotation



Form 12S – 2 element, 3 wire Delta

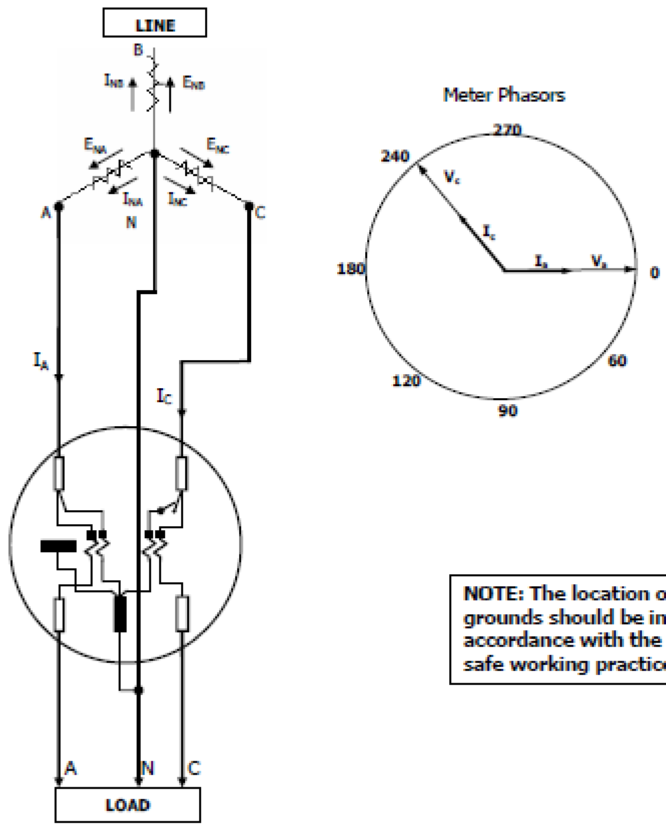
21.1 12S - 2-element, 3-wire Delta, A-B-C phase rotation



NOTE: The location of all grounds should be in accordance with the utilities safe working practices

Form 12S – 2 element, 3 wire Wye

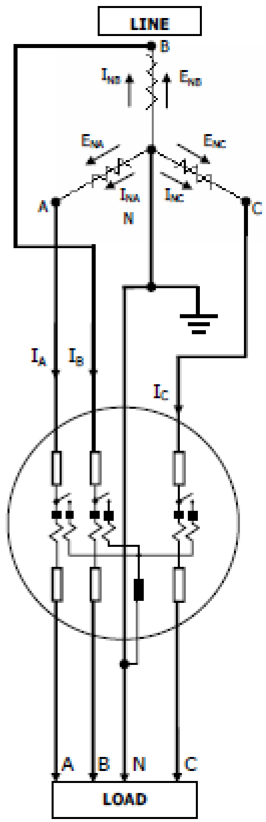
21.2 12S - 2-element, 3-wire Wye, A-B-C phase rotation



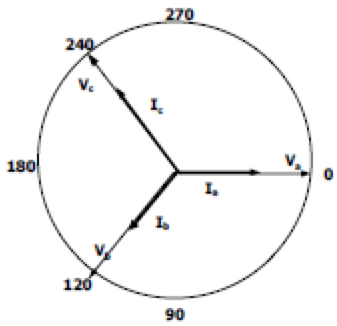
NOTE: The location of all grounds should be in accordance with the utilities safe working practices

Form 16S – 3 element, 4 wire Wye

28.2 16S - 3-element, 4-wire Wye, A-B-C phase rotation



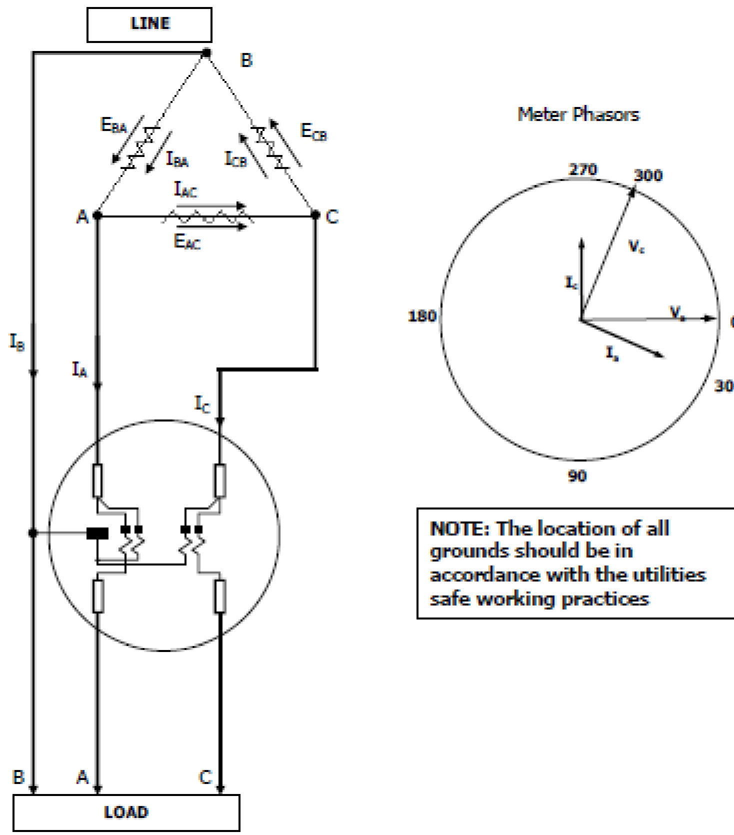
Meter Phasors



NOTE: The location of all grounds should be in accordance with the utilities safe working practices

Form 25S – 2 element, 3 wire Delta

32.1 25S - 2-element, 3-wire Delta, A-B-C phase rotation



NOTE: The location of all grounds should be in accordance with the utilities safe working practices

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The Measure of the Future

Demand Metering

Demand Metering

- **Demand –** The rate at which energy is consumed (Normally measured in kilowatts).
- **Present Demand –** The average kilowatts used in the current interval.
- **Maximum Demand –** The highest demand measured during a time based interval or billing period.
- **Demand Interval –** A user configurable period of time during which max demand is calculated. Ex. 5,15, 30, 60 minutes

Demand Metering

- **Block Interval –** A method for calculating demand by arithmetically averaging the meter registration over a regularly repeated time interval. At the end of the interval, the demand calculation begins for the next interval.

- **Rolling Interval –** A method for calculating demand by arithmetically averaging the meter registration over a regular time interval. The interval remains continuous and therefore, the present demand is the average demand used in the last sub-interval.

Demand Registers

- <u>**Mechanical Demand Registers**</u>

- **Sweep Hand Demand Register –** A register which displays the kilowatt demand through the use of a sweep hand (pointer) on a semi-circular scale.

- **Clock Readout Demand Register –** A register which displays the kilowatt demand on a dial arrangement with pointers, similar to a pointer-type register.

Demand Registers

- <u>**Electronic Demand Registers**</u>

- **Generic Electronic Registers –** A register which measures, accumulates, stores, and displays an electrical quantity (kW/kWh)

- **Time-of-Use Register –** A register which measures, accumulates, stores, and displays an electrical quantity for various predetermined time periods. “TOU” registers may also have load-profile capabilities.

- **Multifunction Register –** A register which measures, accumulates, stores, and displays in excess to one electrical quantity (kW, kVAR, kQ, volts, amps, etc.) Registers are programmable to calculate consumption by time shift or RMS methods.

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The Measure of the Future

Utility Rates

Meter Programming Software

- Aclara (General Electric) (MeterMate)
- Landis + Gyr (1132 Prog/Com)
- Itron (PC-PRO+)
- Honeywell (Elster) (MeterCat)
- Sensus – Uses poly-phase meters from Elster and GE

Utility Rates

- **<u>Straight Kwh billing</u>**

- Most residential electric bills are based on a total usage or kWh (kilowatt hour) charge. The cost of each kilowatt hour consumed varies drastically across the country.

- **kWh x charge = Billing amount**

Utility Rates

- **<u>Demand</u>**

- In the commercial and industrial energy market, energy charges are more likely to be based on Energy (kWh) and peak demand (kW).

- When billing on demand, it is typical for the kWh charge to be lowered and the bill adjusted with a maximum demand charge. For example, the usage or kWh may be charged at 2.5 cents per kWh and the demand charge at $7.36 per kW demand.

- **(kWh x charge) + (kW x charge) = Billing amount**

Utility Rates

- **<u>kWh demand and power factor adjustment</u>**

- A standard kWh meter does not measure the power that is used where the voltage and amperage are shifted out of phase. Because of the reactive properties of electric motors and equipment common to the commercial and industrial customer, and the variability of the type of load from one consumer to another, it is common for a reactive meter to be installed in addition to a kWh meter.

- **(kWh x charge) + (kW x charge/ average power factor) = Billing amount**

Utility Rates

- **<u>Time of use (TOU)</u>**
- Time of use billing is similar the other methods but the rate is not the same for all periods of consumption. Time of use billing methods were developed to allow a energy provider to level their total system load and to operate more efficiently.
- In time of use, the utility offers lower cost energy during periods of the day when they have excess power available that is not being consumed and higher cost power for the times that the electric demand is high.
- **(On peak kWh x charge) + (On peak demand x charge) + (Off peak kWh x charge) + (Off peak demand x charge) = Billing amount**

Utility Rates

- **Dynamic or Real Time Pricing (RTP)**

- Real time pricing is a newer method of billing energy cost that is based on time of use. In this method, the utility projects the load expected 24 hours in advance and sets the rates based on a program expected to level out the usage. A customer must incorporate an active program of analysis and real time control of consumption to take advantage of these programs.

- **Energy and demand charge for each hour = Billing amount**

SENSUS

The Measure of the Future

Poly-Phase Meter of Today

Solid State Poly-Phase Meter of Today

- ANSI approved
- Consumption and Instantaneous Quantities (Watts and Vars)
- Per Phase Quantities
- Delivered and Received Metering (Four Quadrant Metering)
- Net Metering
- AC or DC Auxiliary Power options
- Demand/TOU plus Power Factor
- Multi-channel Load Profile Recording
- Power Quality & Event Monitoring
- Direct Access Meter through communication options
- Transformer, Line & Instrument Transformer Loss Compensation

Solid State Poly-Phase Meter of Today

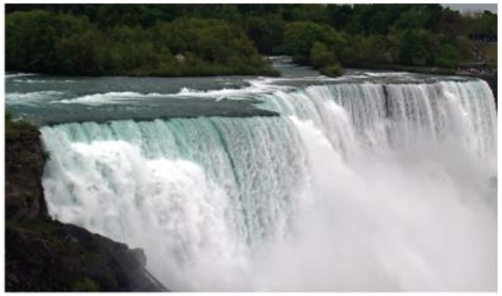
- Build a meter concept - Customer's investment protected
- Software upgrade: kWh to Active Demand/TOU to Reactive Demand/TOU
- Demand or TOU
- Output relay flexibility – example: 4 out, 2 in
- Communication Options: AMI module (RF, PLC, Cellular), Modem, RS232, RS485, Ethernet
- Real-time Rate activation
- Flash memory that allows upgrades and feature enhancements
- Upgradeable Meter Firmware

Summary

- It is important to understand electric meter theory and both general and manufacturer specific meter terminology
- It is essential to understand what is being metered in order to accurately measure differing loads, voltages, and power factors.
- It is critical to understand the values being metered – user defined values through meter program creation.

Summary

- Remember, there is no job so important that it cannot be done in a safe manner.
- In the past, the electric meter only provided a kWh reading that in turn generated a bill.
- Now and in the future, the electric meter will continue to provide increasing value to the utility and the end customer by providing accurate, detailed, and timely data.
- Questions? Comments? Discussion?

Thank You!