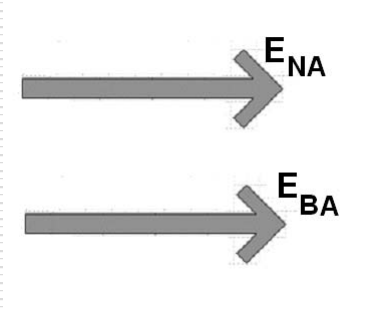
Vectoring Basics

Start With a Zero Reference Voltage.

- Wye – E_{NA}
- Delta – E_{BA}



Vectoring Basics

- Potential – Open Arrow.
- Current – Closed Arrow.
- Arrowhead Denotes Polarity.
- Current Enters the Polarity side of a Current Coil.
- Cannot have a C-Phase without first having A-Phase and B-Phase.
- The ONLY Current Coil that is ever reversed is B-Phase.
- B-Phase Current Coil Reverses when you Alter it.

  Half Coils and 'Z' Coils are considered Altered.
- All Meter Elements Have Forward Torque at Unity Power Factor.

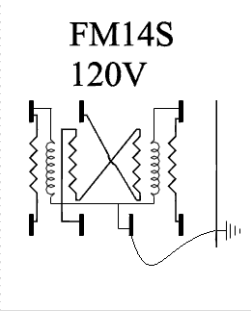
  Forward torque means less than 90 degrees between the Potential coil and the current coil vectors.

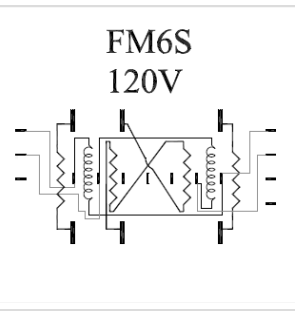
Sequence for Vectoring

- Learn and Memorize the Three Basic System Vector Diagrams.
- Learn and Memorize Meter Footprints.
- The Meter Footprints show the Potential Connections and Currents being measured. *Labeling the connections is helpful.*
- Apply the Rules Regarding Forward Torque and Which Current Coils may be Reversed.
- Draw the Meter Vectors.
- Create a hypothetical load.
- Do the Math.

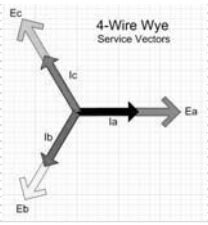
Two & 1/2 Element Meters

- Forms 14 & 6 (Conforming)

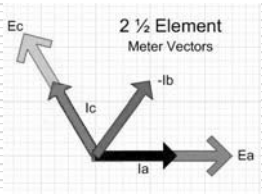




Form 6 and 14 vectors



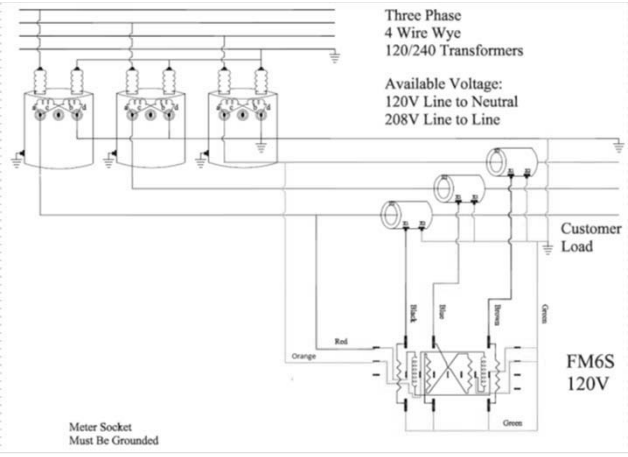
- System Vectors.



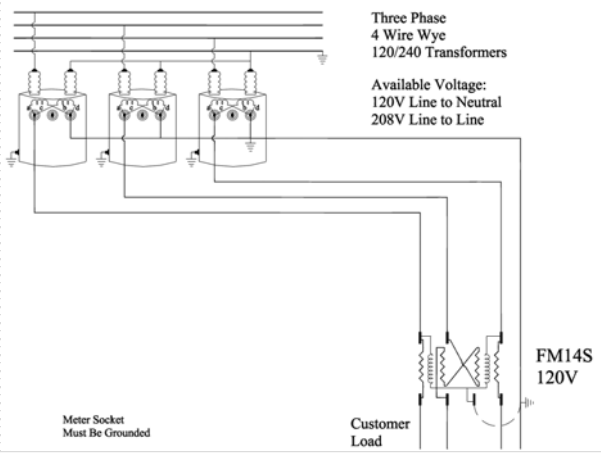
- Meter Vectors.

Non-conforming meter.

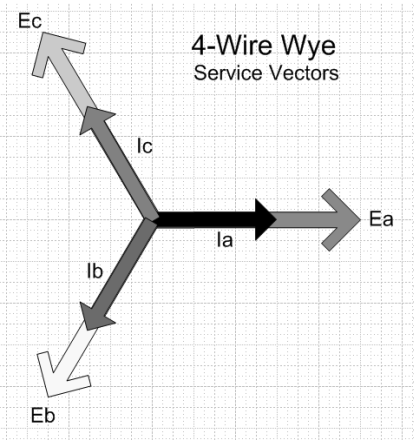
Form 6 as a 3Ø 4-Wire Meter

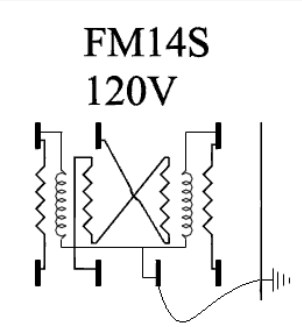


Form 14 as a 3Ø 4-Wire Meter

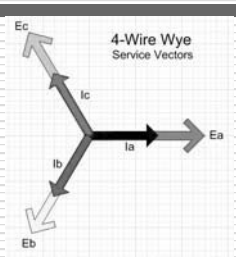


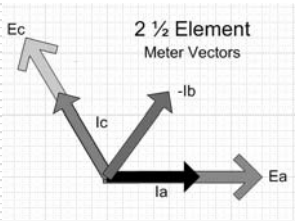
Form 14 as a 3Ø 4-Wire Meter

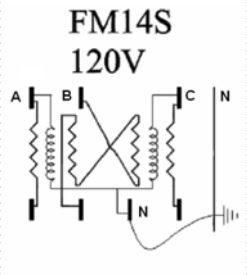




Form 14 as a 3Ø 4-Wire Meter



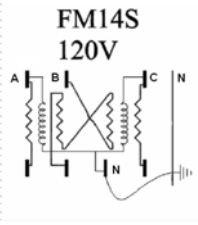


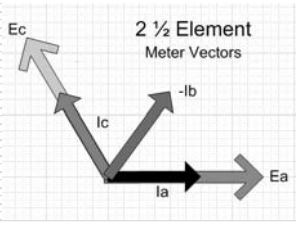


Drawing the Meter Vectors

- Apply the Rules Regarding Forward Torque and Which Current Coils may be Reversed.
- Draw the Meter Vectors.

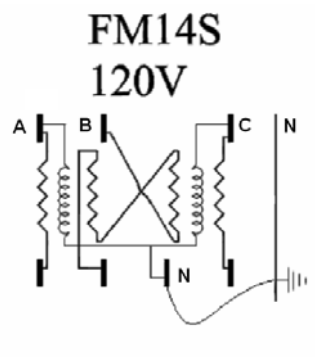
B-phase is a 'Z-coil', so Ib is reversed.

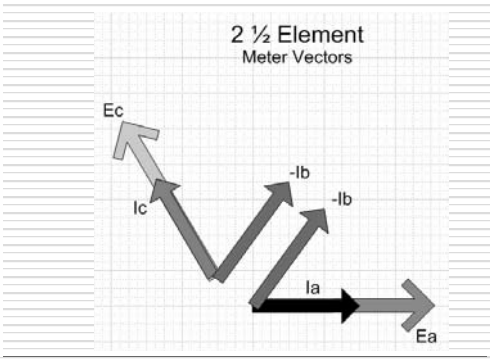




Drawing the Meter Vectors

Consider Ib. It's a 'Z-coil', so it is a double Coil.
-Ib interacts with Ea / Ia and -Ib interacts with Ec / Ic.



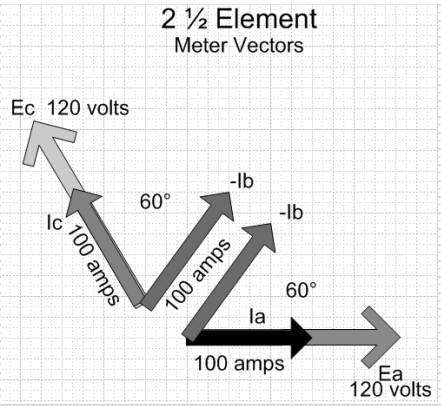


Create a Load

A Convenience Store with 36 kW of load
(For simplicity phases are evenly loaded and 1.0 pf)

36000 watts of 3-phase
36000 / (120 x 3) = 100 phase amps

Form 14 Vectors

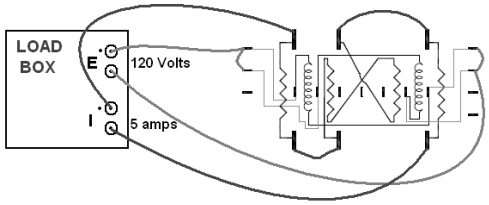


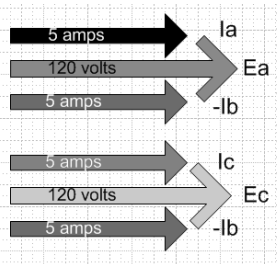
Total watts = 36000

'A' Element watts =
120 x 100 x cos 0º +
120 x 100 x cos 60º
= 18000 watts
'C' Element watts =
120 x 100 x cos 0º +
120 x 100 x cos 60º
= 18000 watts
Total: = 36000

Single-phase testing 2 ½ element meter

There's no angular displacement, so it tests like a 4-element meter.





Calculations

One element: 5 amps x 120 volts = 600 Watts.

Four elements: 5 x 120 x 4 = 2400 Watts.

You will know if it's connected properly because the watts will = ?

Unique Example

A Cap bank is switched according to MW load on a specific transformer. Some time in the past the Watt meter (2 ½ element) was wired using A-phase voltage, B-phase current and C-phase Voltage.

The multiplier for the meter includes an additional X 1.5 to correct for the lack of C-phase current (failed CT). How does this meter work?

Exercise

Given: 3-phase 30 amp 208 volt load
Unity power factor

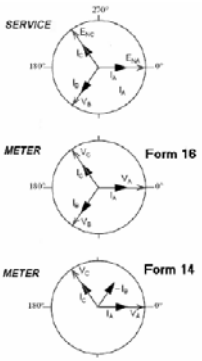
Straight Math:
3 X 120 X 30 **= 10,800 watts**

As The Meter Sees It:
(Form 14)

Element 'A'
120 X 30
+
120 X 30 X cos 60°
= 5400 watts

Element 'C'
120 X 30
+
120 X 30 X cos 60°
= 5400 watts

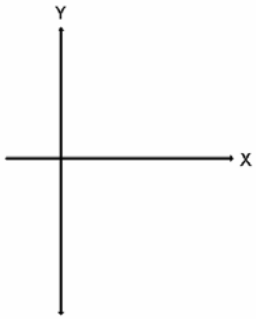
Total = 10,800 watts



Exercise

Try It

Given: 3-phase 30 amp 208 volt load
power factor = .866
(Cosine 30')



The End