PEL Phase Order Indicator Blinking Red
How to Determine WHY indicator is blinking.

The PEL family of Power and Energy Loggers have a “Phase Order” light on their front panel. This indicator lights up and blinks red when the PEL indicates a potential issue with the phase order. There may be times when the Phase Order indicator is blinking red but you are certain that all of your voltage and current inputs are connected to your electrical network correctly.

Many users have recorded successful campaigns with this indicator blinking. The actual conditions of the network you are monitoring may be causing this and there is nothing you can do to remedy it. This document should help you understand the nature of the indicator and the reasoning behind it.

This document will describe how to determine what is causing the Phase Order indicator to blink red.

The PEL analyzes various angles between the current, voltage and power. The angles measured, and their relationship to each other, will trigger the indicator light. It may not be obvious why the Phase Order light is lit.

Required Items:

- The Voltage (V1,V2,V3,N) and Current (I1,I2,I3) inputs are connected *correctly* to the electrical network
- Connecting to the PEL via the DataView® Control Panel or through the Android App
- Viewing the Phasor Diagram using the Real-time view in the Control Panel/App
- Knowing which Electrical Hook-up is programmed into the PEL (3-phase 4-wire Y, 3-phase 3-wire Delta, etc….)
- Annex tables (at the end of this document), extracted from the PEL user manual.

Once you have the above information, then you are ready to determine the reason behind the indicator.

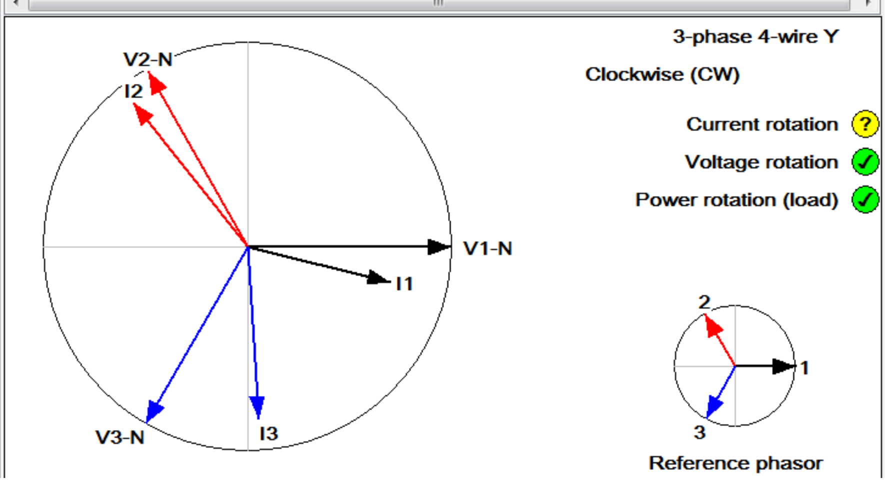
Example Phasor Diagram with “Phase Order” indicator blinking red.

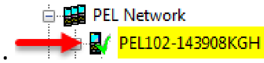
In the real-time example below, the Phasor Diagram on a PEL where the red “Phase Order” indicator is blinking. Observing this view is needed to find the root cause of the indicator. Follow the steps outlined below.

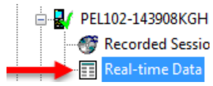
Real-time Data

RMS | Power

Phase							
φ (V2-N;V1-N Phase Angle)	119.9°	φ (V3-1;V2-3 Phase Angle)	120.6°	φ (I2;I1 Phase Angle)	142.6°	φ (I1;V1-N Phase Angle)	-13.9°
φ (V3-N;V2-N Phase Angle)	119.8°	φ (V1-2;V3-1 Phase Angle)	120.2°	φ (I3;I2 Phase Angle)	145.2°	φ (I2;V2-N Phase Angle)	8.7°
φ (V1-N;V3-N Phase Angle)	120.3°	φ (V2-3;V1-2 Phase Angle)	119.2°	φ (I1;I3 Phase Angle)	72.2°	φ (I3;V3-N Phase Angle)	34.1°



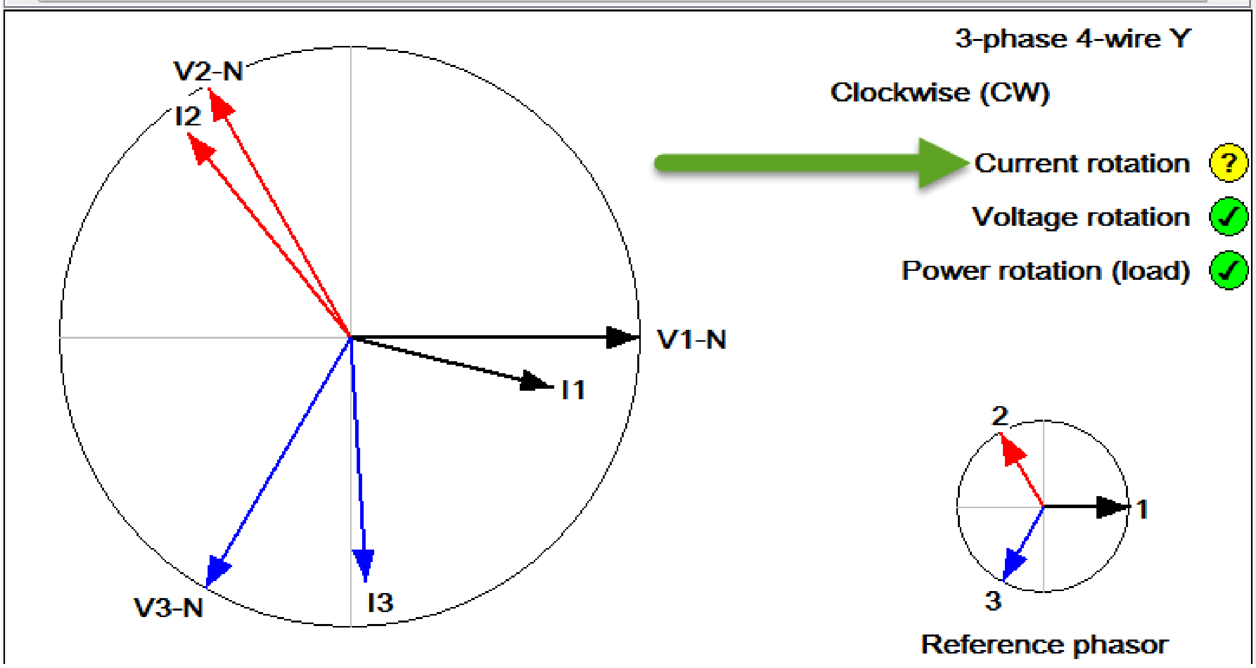
Open PEL Control Panel, select the PEL under “Pel Network”. 

1) Click on “Real-time data” 

2) Click on the Phasor Diagram icon to display the below screen. 

3) The angles that are triggering the Phase Order indicator will be displayed as either a Yellow **?** or a Red **X**. Our example has a Yellow **?** next to “Current Rotation”. This indicates that the reason lies within the Current Rotation angles associated with a 3-phase 4-wire Y electrical network.

Phase							
φ (V2-N;V1-N Phase Angle)	119.9°	φ (V3-1;V2-3 Phase Angle)	120.6°	φ (I2;I1 Phase Angle)	142.6°	φ (I1;V1-N Phase Angle)	-13.9°
φ (V3-N;V2-N Phase Angle)	119.8°	φ (V1-2;V3-1 Phase Angle)	120.2°	φ (I3;I2 Phase Angle)	145.2°	φ (I2;V2-N Phase Angle)	8.7°
φ (V1-N;V3-N Phase Angle)	120.3°	φ (V2-3;V1-2 Phase Angle)	119.2°	φ (I1;I3 Phase Angle)	72.2°	φ (I3;V3-N Phase Angle)	34.1°



4) Looking at the current rotation angles, we see the following angles:

φ (I2;I1 Phase Angle)	142.6°
φ (I3;I2 Phase Angle)	145.2°
φ (I1;I3 Phase Angle)	72.2°

These angles show the relative vector for each leg of current, and their relationship to each other.

5) Refer to the Annex table "A.5.1 – Current Phase Order". There are 3 charts showing the Electrical Hookup and the phase angles that are acceptable for proper Phase Order. Since Current Rotation is the cause of the indicator, we need the Current Phase Order chart.

In this example, the Electrical Hookup is "3-phase 4-wire Y" and the acceptable angles are show below:

A.5.1 Current Phase Order

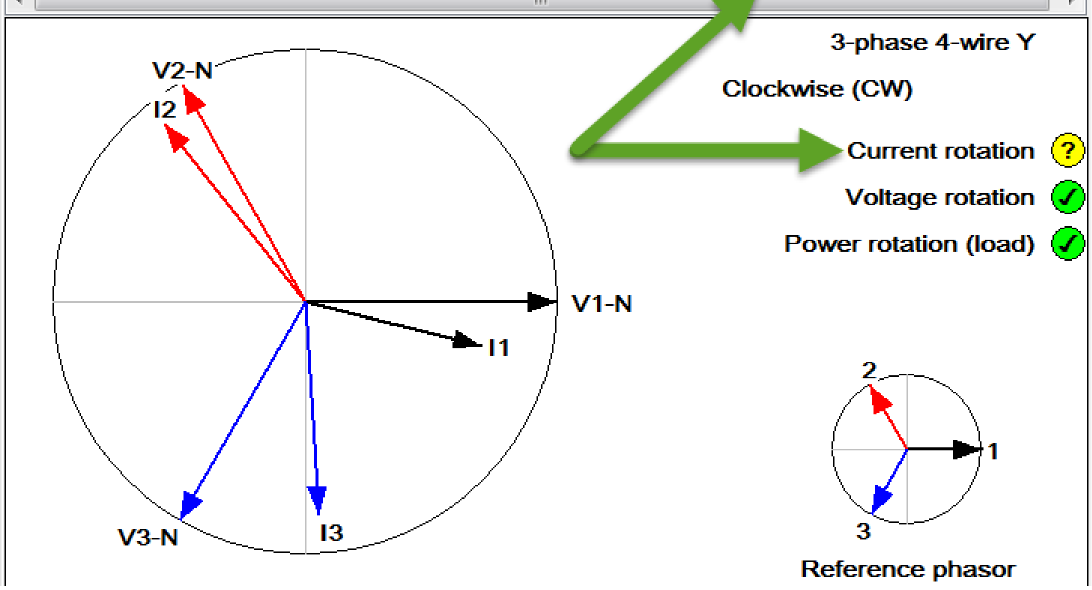
Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	No	
Split phase (1-Phase 3-Wire)	1P -3W	Yes	(I2, I1) = 180° ± 30°
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes	ϕ (I1, I3) = 120° ± 30° No I2 current sensors
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	No	
3-Phase 4-Wire Y	3P-4WY	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Y balanced	3P-4WYB	No	
3-Phase 4-Wire Y 2½	3P-4WY2	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°

6) If we look at the "3-Phase 4-Wire Y" row (highlighted yellow), we see that angles between (I1,I3), (I3,I2), and (I2,I1) all need to be at 120° ±30° (circled red). Therefore, the acceptable angles are 150° to 90° for the Current Phase Order to be considered good. When the angles are within these limits, then the Phase Order Indicator will not blink red.

7) If we look back to our Phasor Diagram, we can see that the angle of (I1,I3) is at 72.2° (circled red). This angle of 72.2° is outside of the normal acceptable range of 120° ±30° (150° to 90°) as defined by the chart.

Phase

φ (V2-N;V1-N Phase Angle)	119.9°	φ (V3-1;V2-3 Phase Angle)	120.6°	φ (I2;I1 Phase Angle)	142.6°	φ (I1;V1-N Phase Angle)	-13.9°
φ (V3-N;V2-N Phase Angle)	119.8°	φ (V1-2;V3-1 Phase Angle)	120.2°	φ (I3;I2 Phase Angle)	145.2°	φ (I2;V2-N Phase Angle)	8.7°
φ (V1-N;V3-N Phase Angle)	120.3°	φ (V2-3;V1-2 Phase Angle)	119.2°	φ (I1;I3 Phase Angle)	72.2°	φ (I3;V3-N Phase Angle)	34.1°



8) The PEL then concludes that the Current Angle between I1 and I3 is outside of acceptable range and this will light up the Phase Order indicator by blinking red.

9) There may be multiple areas and multiple angles that are causing the issue. Please analyze all angles from the category that has a Yellow **?** or a Red **X**.

10) Repeat above process if the fault lies with Voltage Rotation/“Voltage Phase Order” (Annex A.5.2) or with Power Rotation/”Current vs Voltage Phase Order“ (Annex.5.3)

There can be many valid reasons why these angles are outside of our defined limits. These varied reasons can be caused by the native behavior of the electrical network the PEL is monitoring.

For example, the state of the current and whether it is Lagging, Leading or In-Phase with the voltage. If you have a strong Inductive load on your system, the current will lag behind your voltage. If you have a strong Capacitive load, the current will lead the voltage. If your load is purely Resistive, the current will be in-phase with your voltage. If the current leads or lags the voltage by a large margin, then the PEL may interpret this as a Phase Order error.

Low levels of current that have a high harmonic content may also trigger the Phase Order indicator.

I hope you found this useful in determining why your Phase Order indicator is blinking red.

If you have any further questions, feel free to contact AEMC Technical Support at 1-800-343-1391 x351 or via email to techsupport@aemc.com .

Thank you.

ANNEXES

A.5.1 Current Phase Order

Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	No	
Split phase (1-Phase 3-Wire)	1P -3W	Yes	ϕ (I2, I1) = 180° ± 30°
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes	ϕ (I1, I3) = 120° ± 30° No I2 current sensors
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	No	
3-Phase 4-Wire Y	3P-4WY	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Y balanced	3P-4WYB	No	
3-Phase 4-Wire Y 2½	3P-4WY2	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Δ	3P-4WΔ	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Open-Δ	3P-4WOΔ		
DC 2-Wire	DC-2W	No	
DC 3-Wire	DC-3W	No	
DC 4-Wire	DC-4W	No	

A.5.2 Voltage Phase Order

<table>
<tr><th>Distribution System</th><th>Abbreviation</th><th>Current Phase Order</th><th>Comments</th></tr>
<tr><td>Single phase
(1-Phase 2-Wire)</td><td>1P-2W</td><td>No</td><td></td></tr>
<tr><td>Split phase
(1-Phase 3-Wire)</td><td>1P -3W</td><td>Yes</td><td>ϕ (V2, V1) = 180° ± 10°</td></tr>
<tr><td>3-Phase 3-Wire Δ
[2 current sensors]</td><td>3P-3WΔ2</td><td rowspan="6">Yes (on U)</td><td rowspan="6">[ϕ (U12, U31), ϕ (U31, U23), ϕ (U23, U12)] = 120° ± 10°</td></tr>
<tr><td>3-Phase 3-Wire Open-Δ
[2 current sensors]</td><td>3P-3WO2</td></tr>
<tr><td>3-Phase 3-Wire Y
[2 current sensors]</td><td>3P-3WY2</td></tr>
<tr><td>3-Phase 3-Wire Δ</td><td>3P-3WΔ3</td></tr>
<tr><td>3-Phase 3-Wire Open-Δ</td><td>3P-3WO3</td></tr>
<tr><td>3-Phase 3-Wire Y</td><td>3P-3WY3</td></tr>
<tr><td>3-Phase 3-Wire Δ
balanced</td><td>3P-3WΔB</td><td>No</td><td></td></tr>
<tr><td>3-Phase 4-Wire Y</td><td>3P-4WY</td><td>Yes (on V)</td><td>[ϕ (V1, V3), ϕ (V3, V2), ϕ (V2, V1)] = 120° ± 10°</td></tr>
<tr><td>3-Phase 4-Wire Y
balanced</td><td>3P-4WYB</td><td>No</td><td></td></tr>
<tr><td>3-Phase 4-Wire Y 2½</td><td>3P-4WY2</td><td>Yes (on V)</td><td>ϕ (V1, V3) = 120° ± 10°
No V2</td></tr>
<tr><td>3-Phase 4-Wire Δ</td><td>3P-4WΔ</td><td rowspan="2">Yes (on U)</td><td rowspan="2">ϕ (V1, V3) = 180° ± 10°
[ϕ (U12, U31), ϕ (U31, U23), ϕ (U23, U12)] = 120° ± 10°</td></tr>
<tr><td>3-Phase 4-Wire Open-Δ</td><td>3P-4WOΔ</td></tr>
<tr><td>DC 2-Wire</td><td>DC-2W</td><td>No</td><td></td></tr>
<tr><td>DC 3-Wire</td><td>DC-3W</td><td>No</td><td></td></tr>
<tr><td>DC 4-Wire</td><td>DC-4W</td><td>No</td><td></td></tr>
</table>

A.5.3 Current vs Voltage Phase Order

Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	Yes	ϕ (I1, V1) = 0° ± 60° for load ϕ (I1, V1) = 180° ± 60° for source
Split phase (1-Phase 3-Wire)	1P -3W	Yes	[ϕ (I1, V1), ϕ (I2, V2)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I2, V2)] = 180° ± 60° for source
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes	[ϕ (I1, U12), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I3, U31)] = 210° ± 60° for source No I2 current sensor
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3	Yes	[ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 210° ± 60° for source
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	Yes	ϕ (I3, U12) = 90° ± 60° for load ϕ (I3, U12) = 270° ± 60° for source
3-Phase 4-Wire Y	3P-4WY	Yes	[ϕ (I1, V1), ϕ (I2, V2), ϕ (I3, V3)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I2, V2), ϕ (I3, V3)] = 180° ± 60° for source
3-Phase 4-Wire Y balanced	3P-4WYB	Yes	ϕ (I1, V1) = 0° ± 60° for load ϕ (I1, V1) = 180° ± 60° for source
3-Phase 4-Wire Y 2½	3P-4WY2	Yes	[ϕ (I1, V1), ϕ (I3, V3)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I3, V3)] = 180° ± 60° for source No V2
3-Phase 4-Wire Δ	3P-4WΔ	Yes	[ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 210° ± 60° for source
3-Phase 4-Wire Open-Δ	3P-4WOΔ		
DC 2-Wire	DC-2W	No	
DC 3-Wire	DC-3W	No	
DC 4-Wire	DC-4W	No	