

APPLICATION NOTE

**UTILIZING ACUVIM 3 FOR TRANSFORMER AND LINE LOSS COMPENSATION**

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**1. PURPOSE**

Transformers and line losses are an inherent part of electrical power delivery and become increasingly significant when meters are installed away from the contractual billing or reference point because electrical losses are location-dependent, and a meter only measures at the location it is installed, not upstream or downstream. In many revenue and billing-oriented metering scenarios, the physical location of a power meter does not coincide with the point at which energy consumption is commercially accounted for. Meters are often installed at accessible or protected locations such as upstream or downstream, while energy billing is defined at a different point in the electrical system, typically at the load or delivery boundary.

The transformer and line loss compensation function in the Acuvim 3 is intended to support billing-related energy accounting by applying calculation-based adjustments rather than the physical meter installation location. The correction is based on user-defined transformer and feeder parameters, which are used to estimate current-dependent copper and resistive losses along the defined electrical path and apply corresponding adjustments to the reported power and energy values. By applying a configurable electrical model of the intervening transformer and transmission line, the meter estimates and adjusts billed energy to more closely represent the energy delivered at the contractual reference point rather than the energy measured at the meter installation location. This approach supports improved billing alignment and revenue reconciliation in radial, single-source systems where the electrical path between the meter and billing point is clearly defined, subject to the accuracy of the configured system parameters. Loss compensation does not reduce physical system losses and is not intended as a general energy management or internal allocation tool. The purpose is to provide billing-grade correction of measured energy when the meter cannot be installed directly at the billing point.

**2. TYPICAL INSTALLATION SCENARIOS**

**Meter Location:** Defines the physical point in the electrical system where voltage and current are measured. This corresponds to the actual installation point of the meter, and all measured electrical values are referenced to this physical installation point.

**Billing Location:** Defines the electrical point at which power and energy values are accounted for billing or commercial purposes. This location represents the reference billing point (BP) used for revenue metering, settlement, or billing purposes and may differ from the meter’s physical installation location.

When the billing location differs from the meter location, the meter applies transformer and line loss compensation as a calculation-based

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adjustment to reference reported energy values to the defined billing location.

Figure 1 shows the diagram of the billing and metering points.

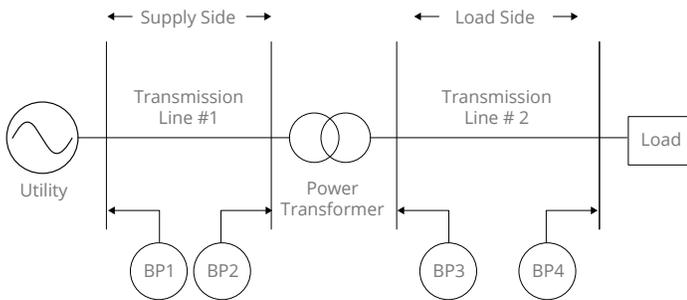


Figure 1 Meter and Billing Positions

- Source End (BP1)** – Upstream supply point.
- Transformer Primary Side (BP2)** – High-voltage side of the transformer.
- Transformer Secondary Side (BP3)** – Low-voltage side of the transformer.
- Load End (BP4)** – Downstream load reference.

For example, in a typical industrial service, the revenue meter may be installed at the customer’s main low-voltage switchboard (BP4) for accessibility and safety, downstream of the service transformer and feeder conductors. However, the utility service agreement may define the billing reference point at the upstream utility delivery point (BP1) on the high-voltage side. In this case, the meter measures energy after the transformer when high-voltage feeder, and low-voltage feeder losses have already occurred. To align the measured energy with the contractual billing point, loss compensation is applied to add estimated line and transformer losses using a configured electrical model, providing a model-based representation of energy at BP1 for radial, single-source systems.

Table 1 shows the addition and subtraction of line and transformer loss compensation.

Table 1 Transformer and Line Loss Compensation

Billing Position	Meter Position	Effect on Calculated Power
BP1		No change
BP2	BP1	T_line #1 losses subtracted
BP3		T_line #1 and transformer losses subtracted
BP4		T_line #1, T_line #2 and transformer losses subtracted
BP1		T_line #1 losses added
BP2	BP2	No change
BP3		Transformer losses subtracted
BP4		T_line #2 and transformer losses subtracted

BP1		T_line #1 and transformer losses added
BP2	BP3	Transformer losses added
BP3		No change
BP4		T_line #2 losses subtracted
BP1		T_line #1, T_line #2 and transformer losses added
BP2	BP4	T_line #2 and transformer losses added
BP3		T_line #2 losses added
BP4		No change

### 3. STEPS TO VIEW AND SET TRANSFORMER/LINE-LOSS COMPENSATION

#### 3.1 Meter Location, Transmission Line and Transformer Configuration

From the Web Interface, follow the steps mentioned below to set the Acuvim 3 location and configure the transmission line and transformer parameters.

1. Click on **Settings** from the main menu.

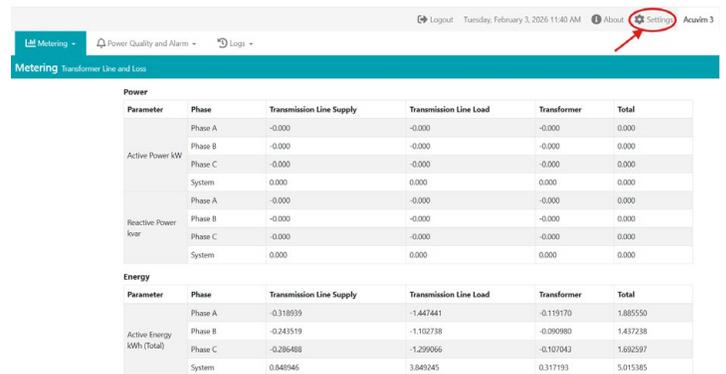


Figure 2 Navigating to Settings

2. Select **Revenue and Energy** from the tab menu.

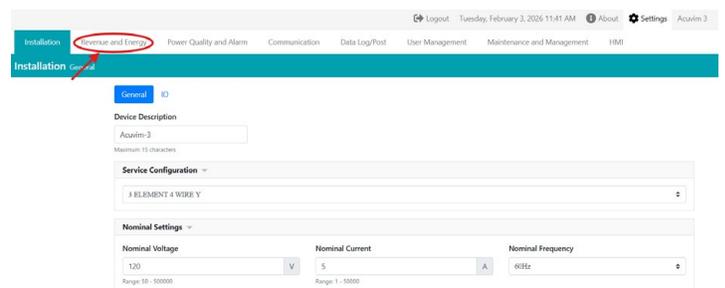


Figure 3 Navigating to Revenue and Energy Tab

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3. Click on the **Transmission** option.

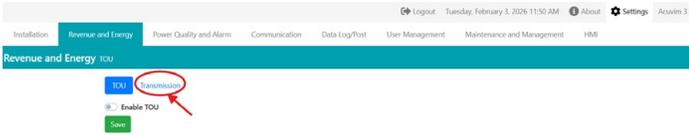


Figure 4 Navigating to Transmission Option

This webpage allows the user to define a simplified electrical model of the system between the physical meter location and the billing (load) point. This configuration determines how line and transformer losses are calculated and allocated and is divided into three logical sections: Basic Settings (Metering Reference), Transmission Line Modeling, and Transformer Modeling.

### 3.1.1 Basic Settings (Metering Reference)

Set the **Meter Location** and **Bill Location** to establish the electrical reference points used for loss compensation and energy accounting as shown in Figure 5.

Available options include:

**Source End (BP1)** – Upstream supply point

**Transformer Primary Side (BP2)** – High-voltage side of the transformer

**Transformer Secondary Side (BP3)** – Low-voltage side of the transformer

**Load End (BP4)** – Downstream load reference

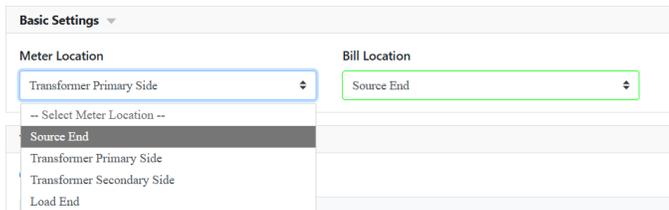


Figure 5 Configuring Billing and Meter Location

When the Bill Location differs from the Meter Location, the meter applies the configured transmission line and transformer models as shown in Table 1 to shift the effective measurement point accordingly.

### 3.2 Transmission Line Modeling

Select an appropriate line model and define the required electrical parameters for each feeder section as shown in Figure 6.

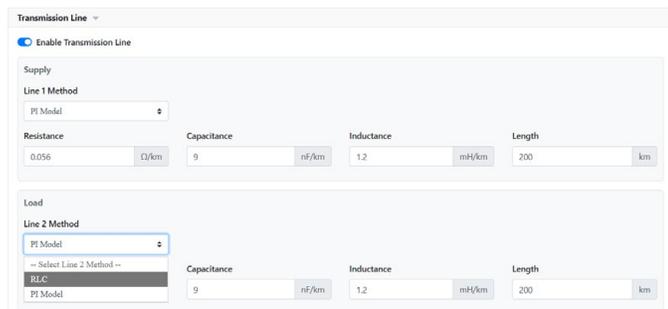


Figure 6 Transmission Line Configuration

Two modeling options are available: **PI model** and **RLC model**.

### 3.2.1 PI Model

When PI Model is selected, the feeder is represented using a distributed-parameter  $\pi$ -equivalent circuit. This allows the model to capture line charging current under light-load or no-load conditions, reactive power generation on long or high-voltage lines, and more realistic voltage profile along the feeder as seen in Figure 7.

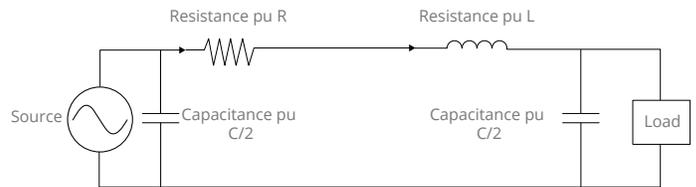


Figure 7 PI Model

This model is recommended for long feeders ( $\geq 80$  km), high-voltage lines ( $\geq 110$  kV), and installations where line charging and reactive effects are non-negligible.

The PI model allows these secondary effects to be represented in the electrical model. However, for active energy loss compensation, the resulting improvement in accuracy is typically limited by the uncertainty of feeder resistance and length parameters, rather than the omission of distributed capacitance.

### 3.2.2 RLC Model

The RLC Model as shown in Figure 8 represents the feeder as a lumped resistance, inductance, and capacitance without distributed effects. This simplified approach accurately captures  $I^2R$  losses which dominate real energy loss, reduces sensitivity to uncertain capacitance data, and simplifies configuration and commissioning.

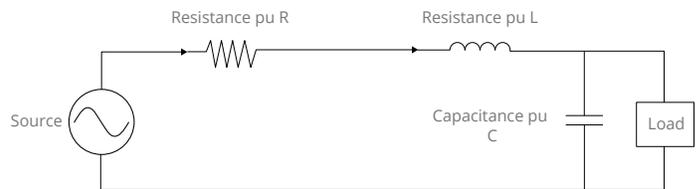


Figure 8 RLC Model

This simplified model is typically suitable for shorter lines ( $\leq 80$  km) where capacitive charging effects are relatively small and have a limited impact on active energy loss correction.

### 3.3 Transformer Modeling

The transformer model is used to estimate load-dependent and constant losses based on user-defined parameters. Two transformer modeling methods are available: **Nameplate Method** and **Loss Constant Method**.

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### 3.3.1 Nameplate Method

The Nameplate Method uses transformer nameplate data to calculate losses in a manner consistent with standard transformer specifications as seen in Figure 9.

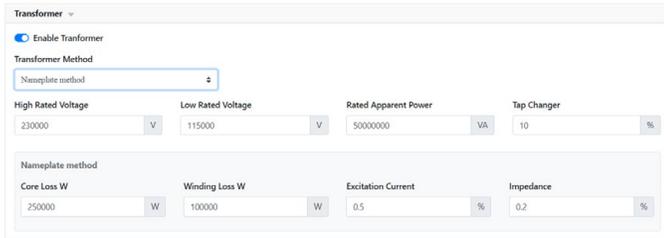


Figure 9 Nameplate Method Configuration of Transformer

The user needs to input the following parameters from the transformer nameplate:

- High Rated Voltage (V)** – Rated primary voltage
- Low Rated Voltage (V)** – Rated secondary voltage
- Rated Apparent Power (VA)** – Transformer MVA rating
- Tap Changer (%)** – Maximum tap variation used for voltage adjustment.
- Core Loss (W)** – Represents no-load (iron) loss. This loss is treated as a constant value, independent of load current.
- Winding Loss (W)** – Represents copper loss at rated load. This loss is scaled with the square of the measured current:  $P_{cu} \propto I^2$
- Excitation Current (%)** – Represents no-load magnetizing current and is used to model transformer behavior at light load.
- Impedance (%)** – Represents the transformer short-circuit impedance and is used for voltage drop estimation.

### 3.3.2 Loss Constant Method

The Loss Constant Method as depicted in Figure 10 allows transformer losses to be defined directly as fixed percentages, without relying on detailed nameplate data. This method is useful when full transformer specifications are unavailable or when approximate loss modeling is sufficient.

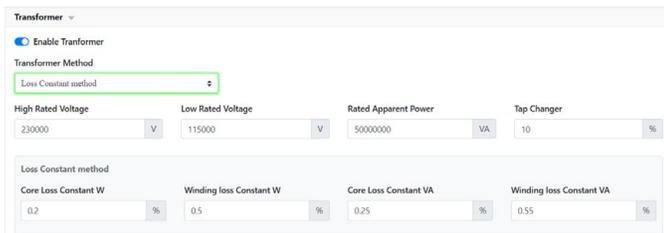


Figure 10 Loss Constant Method Configuration of Transformer

The user needs to input the following parameters along with the transformer ratings:

- Core Loss Constant W (%)** – Defines constant real power loss as a percentage of rated power.
- Winding Loss Constant W (%)** – Defines load-dependent real power loss as a percentage of rated power.

- Core Loss Constant VA (%)** – Defines constant apparent power loss.
- Winding Loss Constant VA (%)** – Defines load-dependent apparent power loss.

### 3.4 Saving the Parameters

After all the parameter values are entered,

1. Click on **Save**.

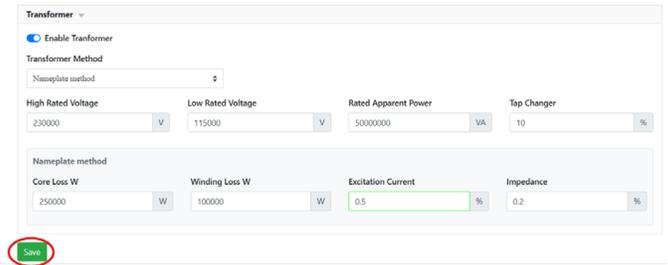


Figure 11 Steps to Save the Parameters #1

2. The **AcuVim 3** prompts the user to reboot the meter. This restart is required to activate the updated electrical model used for loss compensation.
3. Clicking on **Reboot** immediately restarts the meter and applies the updated configuration.

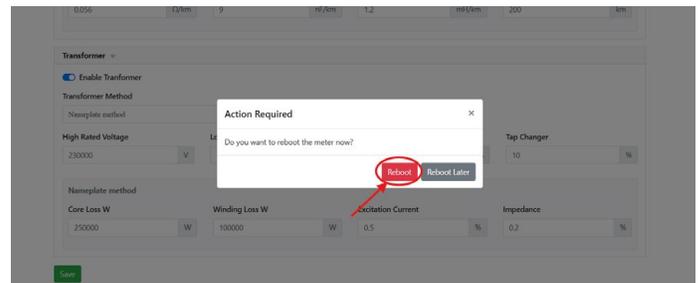


Figure 12 Steps to Save the Parameters #2

**Reboot Later** saves the configuration but defers activation.

### 3.5 Transformer Line and Loss Webpage

To view the transformer and line loss compensation, navigate to the Transformer Line and Loss webpage using the following steps:

1. Click on **AcuVim 3** from the main menu.

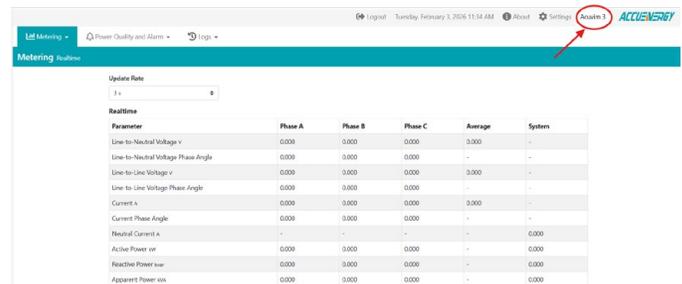


Figure 13 Navigating to Transformer Line and Loss Webpage #1

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2. Select **Metering** from the tab menu.

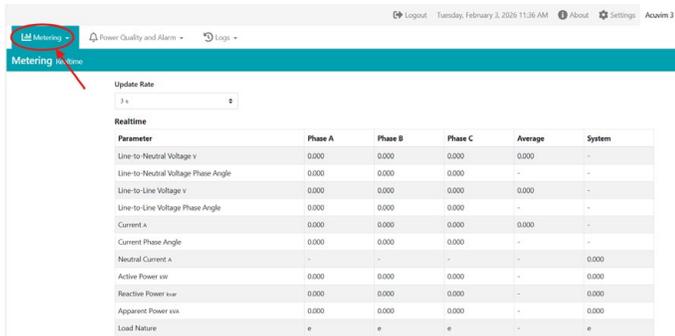


Figure 14 Navigating to Transformer Line and Loss Webpage #2

3. Click on the **Transformer Line and Loss** option as depicted in Figure 15. This webpage, shown in Figure 16, presents a breakdown of model-derived power and energy components related to transformer and line loss compensation, providing transparency into how the configured electrical model contributes to the adjusted energy reference.

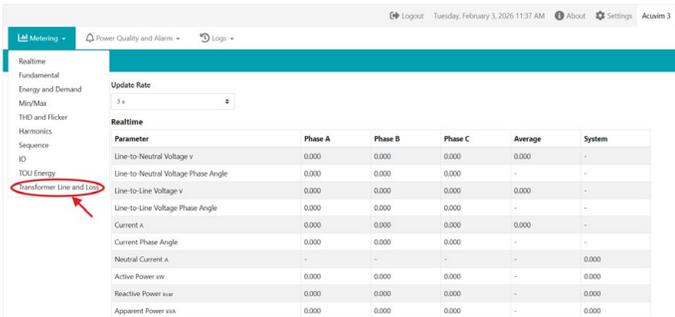


Figure 15 Navigating to Transformer Line and Loss Webpage #3

The **Power** section displays the instantaneous or interval-based loss power for each phase and for the system total. The **Energy** section displays the accumulated losses derived from the corresponding power calculations.

Power					
Parameter	Phase	Transmission Line Supply	Transmission Line Load	Transformer	Total
Active Power kW	Phase A	0.000	0.050	0.066	0.116
	Phase B	0.000	0.032	0.040	0.072
	Phase C	0.000	0.013	0.016	0.028
	System	0.000	0.095	0.122	0.217
	System	0.668	0.024	-nan	-nan
Reactive Power kvar	Phase A	0.406	0.015	-nan	-nan
	Phase B	0.159	0.006	-nan	-nan
	Phase C	1.233	0.045	-nan	-nan
	System	1.233	0.045	-nan	-nan

Energy					
Parameter	Phase	Transmission Line Supply	Transmission Line Load	Transformer	Total
Active Energy kWh (Total)	Phase A	-0.318703	-1.251650	0.170479	2.371226
	Phase B	-0.243311	-0.977205	0.086280	1.740239
	Phase C	-0.286407	-1.250029	-0.037801	1.810957
	System	0.849471	4.219606	0.853345	5.92423
	System	0.571132	-8.751795	-nan	-nan
Reactive Energy kvarh (Total)	Phase A	-0.148346	-7.925559	-nan	-nan
	Phase B	-1.479197	-9.022811	-nan	-nan
	Phase C	11.901456	27.048833	-nan	-nan
	System	0.319174	1.643233	0.408819	2.371226
Active Energy kWh (Net)	Phase A	0.243727	1.228272	0.268241	1.740239
	Phase B	0.286569	1.348102	0.176285	1.810957
	Phase C	0.849471	4.219606	0.853345	5.92423
	System	5.207814	9.956363	nan	nan
	System	3.733856	8.043961	nan	nan
Reactive Energy kvarh (Net)	Phase A	2.879787	9.068906	nan	nan
	Phase B	11.901456	27.048833	nan	nan
	Phase C	11.901456	27.048833	nan	nan
	System	11.901456	27.048833	nan	nan

Figure 16 Transformer Line and Loss Webpage

Positive and negative values indicate the direction of power flow relative to the configured reference point (supply versus load). The Net Energy fields present the absolute magnitude of the accumulated loss-related energy values to support consistent interpretation and comparison across operating conditions.

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