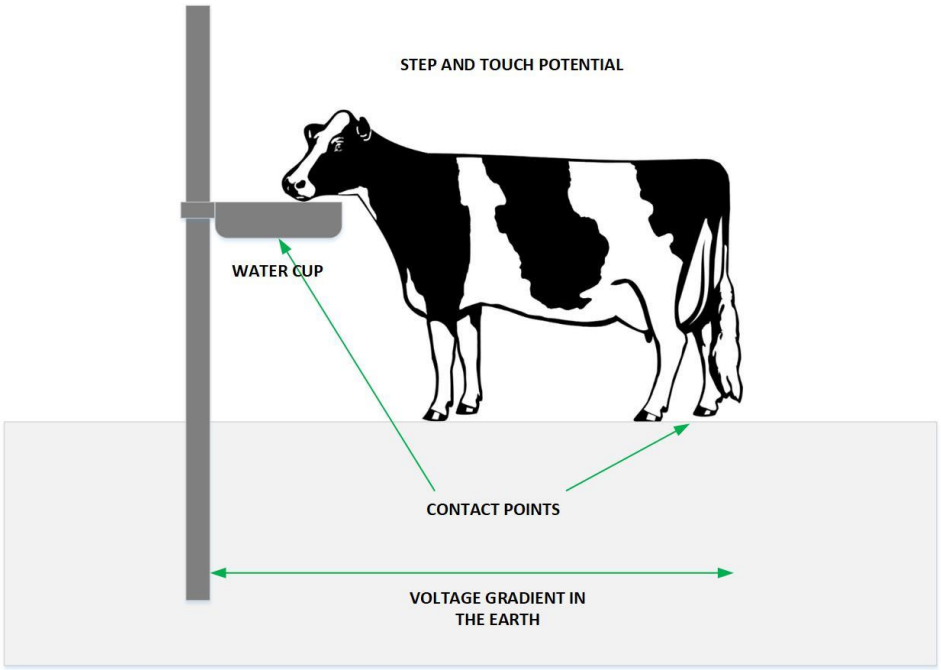
Stray Voltage

Stray voltage, also known as neutral to earth voltage (NEV), is a condition where a potential difference of 2-10 volts exists between a grounded object and the grounded neutral conductor carrying the return current. Dairy cattle's sensitivity to small potential differences can cause decreased milk production and significantly impact a dairy farmer's income. Large single phase services combined with poor earth return and small primary neutral conductors are prone to producing NEV. Troubleshooting consists of:

- A remote driven ground rod
- Total separation of primary and secondary neutrals at the transformer during de-energization
- Low / no load voltage readings from secondary neutral and primary neutral to ground rod
- Full load readings from secondary neutral and primary neutral to ground rod

The troubleshooting process helps to determine if NEV exists and if it is a result of the circuit feeding the member, the circuit at the road, the member's circuit (service), or a foreign circuit. A stray voltage blocker (e.g. Ronk blocker) can be used to safely isolate the primary and secondary neutrals, keeping voltage differences to an acceptable level, and is a common solution that electric cooperatives employ to resolve issues caused by NEV.

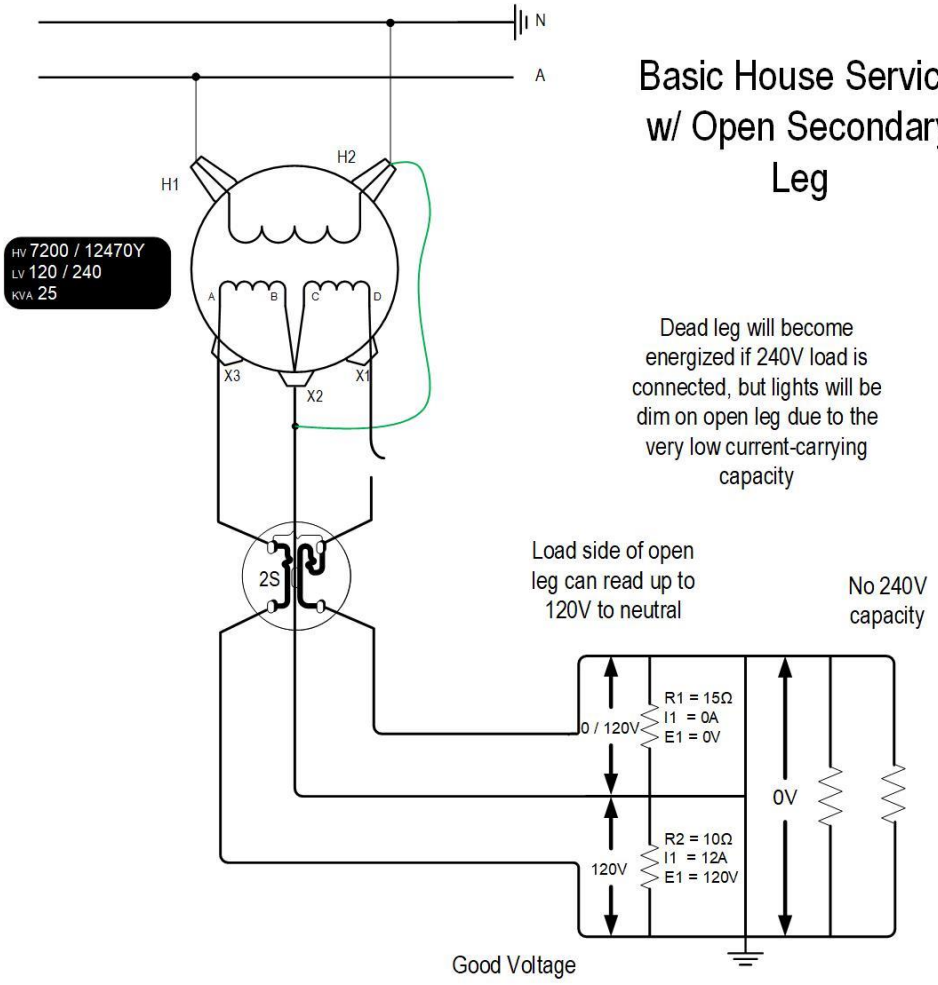


Partial Power (120/240V Single-Phase Circuit)

A partial power condition is typically the result of an open-circuited secondary leg between the load and the energized transformer. A common complaint from the member is that half the lights are on and the other half are not working at all or only dimly lit.

Though not limited to it, a common occurrence is when underground secondary cable insulation breaks down in the earth. The oxidization that builds up around an aluminum cable as the insulation breaks down will insulate it from the earth and typically allow the circuit to remain energized until the conductor eventually corrodes completely in two, triggering a partial power complaint.

When the leg is completely open, an electromechanical meter cannot turn and a solid state meter cannot light up even during power usage since the potential coil in the meter is connected phase-to-phase. Troubleshooting with voltage readings at the meter socket will help to determine the condition. Temporary repair options include using a Service Saver to convert 120V 2W into 120/240V 3W but will only utilize one-half of the KVA of the source transformer.



Low Voltage

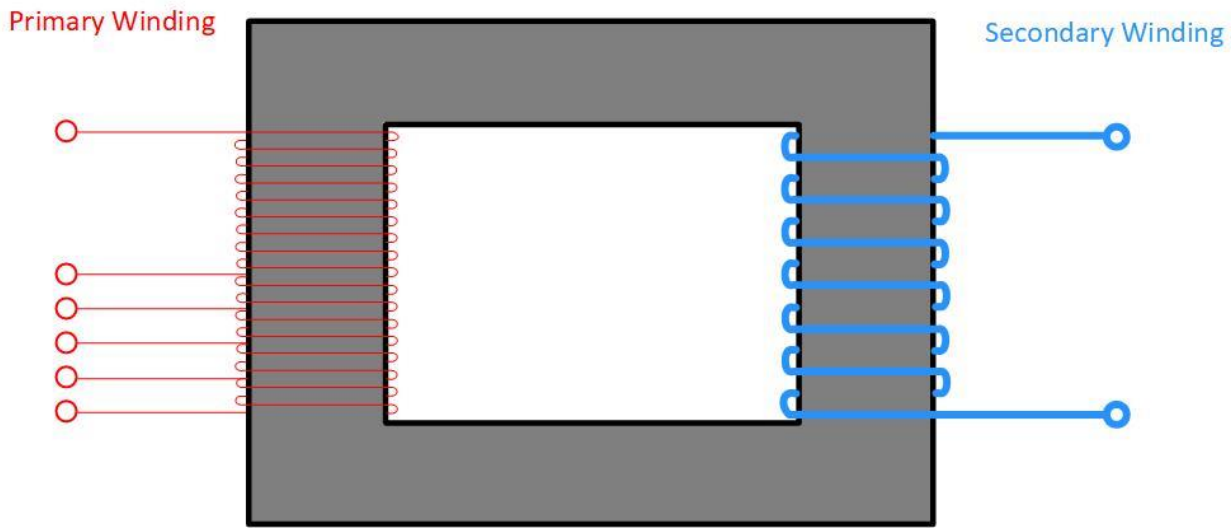
Low voltage complaints sometimes come in during times of peak demand and can be described as a condition where the voltage at the meter socket under load is less than 114/228V, or less than 95% of the nominal voltage. Low voltage can be a result of issues either on the primary or secondary circuit.

During peak demand, high-resistance primary circuits can dip to levels below an acceptable limit and affect many members, even with voltage regulating equipment working properly. This is an issue requiring an engineer's attention.

During peak demand, high-resistance secondary circuits, such as long runs of small service conductors, can also result in low voltage for the member. Low voltage may also be the result of low incoming primary voltage at the distribution transformer combined with high-resistance secondary circuits and high KVA demand.

Most low voltage issues require an engineer's attention, though a tap-changing transformer may serve as an acceptable temporary fix to change the transformer winding ratio and raise the voltage. However, the troubleshooter must be sure to keep taps at a level that the voltage will not rise to unacceptable limits during off-peak hours.

TAP-CHANGING DISTRIBUTION TRANSFORMER



High Voltage

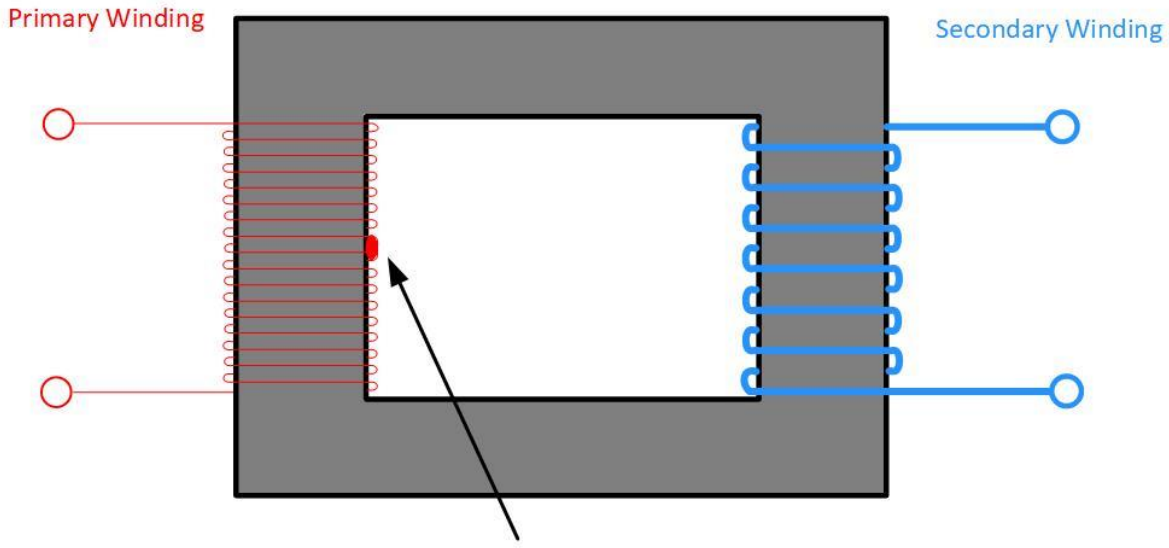
A high voltage complaint is an infrequent occurrence and the cause is often easy to pinpoint utilizing basic troubleshooting techniques. High voltage can be a result of issues on the primary circuit or the secondary circuit. Some describe high voltage on a 120/240V single-phase service as voltage that exceeds 126/252V at the meter socket, and often exceeding 130/260V.

High voltage on the primary circuit will most often come as a result of a voltage regulator that is working improperly or stuck in the raise (boost) position, affecting many members.

High voltage on the secondary circuit will typically come as a result of “off-winding ratio”. This is a condition which occurs when lightning strikes the distribution transformer without causing an outage, yet resulting in the primary windings arcing through the insulation and welding themselves together during the short circuit. The output ratio of the transformer is changed and increases the service voltage, resulting in the need to replace the transformer. High voltage can also result from a tap-changing transformer on an improper setting.

A simple troubleshooting technique of checking voltage in multiple locations that feed off of at least two different transformers can easily point the worker to the root of the problem.

DISTRIBUTION STEP-DOWN TRANSFORMER



Off-winding ratio occurs when the high voltage windings arc through the insulation and weld together, causing the output ratio to change and the service voltage to raise.

Bright and Dim Lights (120/240V Single-Phase Circuit)

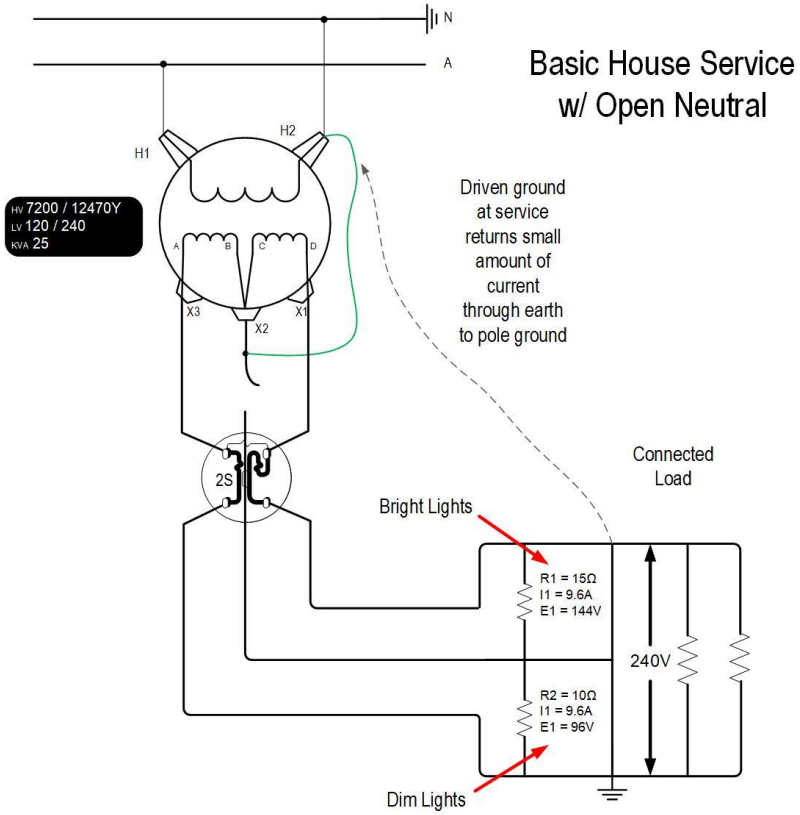
Bright and dim lights are most often the result of an open-circuited secondary neutral which causes unequal phase-to-neutral voltage readings when unbalanced 120V loads are connected. Since the circuit lacks a solid return, the phase-to-neutral voltage fluctuates to the level needed to maintain equal amperage in each of the two 120-volt circuits, in line with Ohm's law.

The voltage raises and lowers according to 120V load connected to each side. 240V loads remain unaffected since a neutral return is not part of the 240V circuit. If the sum of the unequal voltage readings between each phase and neutral matches the phase-to-phase circuit voltage, an open neutral can be confirmed. Many household items can be "fried" when this condition exists.

A low resistance permanently driven ground rod at the service point along with a low resistance path back through the earth to the pole ground can reduce, but not eliminate, voltage fluctuation during unbalanced loading conditions.

Troubleshooting methods may consist of a combination of the following:

- Line to Neutral tester – e.g. Mega Beast (no load connected)
- Voltage readings taken across neutral connections (load connected)
- Voltage readings taken phase-to-neutral in various parts of the circuit (load connected)
- Amperage readings taken around entire triplex conductor (load connected)



Blinking / Flickering Lights

Blinking or flickering lights is a broad complaint which can be the result of many different issues on the electrical system which can stem from the primary circuit or the secondary circuit. Though blinking and flickering lights are different, it can be difficult for the member to describe exactly what is happening and very hard for the troubleshooter to determine the problem.

Issues on the primary circuit causing blinking lights can be caused by intermittent operations of a recloser due to a temporary fault on the system that occasionally shows up. Examples may include faulty lightning arresters and dead animals. Flickering lights on the primary circuit may include trees intermittently contacting the line, a faulty connection on the system, or even something like problems with the ground grid at the distribution substation.

Secondary circuit issues are a common cause of flickering lights and can come from insulation on underground cables breaking down or faulty connections on any conductors anywhere on the secondary circuit. A complaint could even be the result of instantaneous voltage drop due to inrush current during times of air conditioner startup.

A key to finding the problem is interviewing and listening closely to the member or multiple members. If the cause of blinking or flickering lights cannot be pinpointed, a voltage recorder can be used to closely monitor voltage over a period of time. Recent advancement of technology in AMI systems has aided cooperatives in troubleshooting such complaints.

