

# How Understanding/Using Ohms Law Can Help Fix/Diagnose Electrical Problems


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# **Fleets constantly face electrical issues, which include problems with:**

- Tractor Batteries
- Liftgate Batteries
- Starter/Alternator (these issues have been reduced greatly)
- Electrical system failures
- Tractor/Trailer electrical lighting



**Most of these electrical problems  
have ways to mitigate the problem**




**Today we will focus on mitigating  
problems with Trailer Lights**

# 33% of all CSA Violations are for Light Issues

## 2-8 Most Frequent Vehicle Violations in Roadside Inspections, 2013

Violation Code	Category	Violation Description	Number of Violations	Number of OOS Violations
393.9	Lighting	Operating Vehicle Not Having the Required Operable Lamps	503,614	44,356
393.75C	Tires	Tire—Other: Tread Depth Less than 2/32 of Inch	209,600	17,302
393.11	Lighting	No/Defective Lighting Devices/Reflective Devices/Projected	205,214	5,891
393.47E	Brakes, All Others	Clamp/Roto-Chamber Type Brake(s) Out of Adjustment	204,911	277
396.3A1	All Other Vehicle Defects	Inspection/Repair and Maintenance Parts and Accessories	177,498	24,847
396.5B	All Other Vehicle Defects	Oil and/or Grease Leak	173,161	2,119
393.95A	Emergency Equipment	No/Discharged/Unsecured Fire Extinguisher	151,150	24



Every Fleet in America Checks  
Trailer Lights... And Every Fleet  
Has Their Own Trailer Light Tester



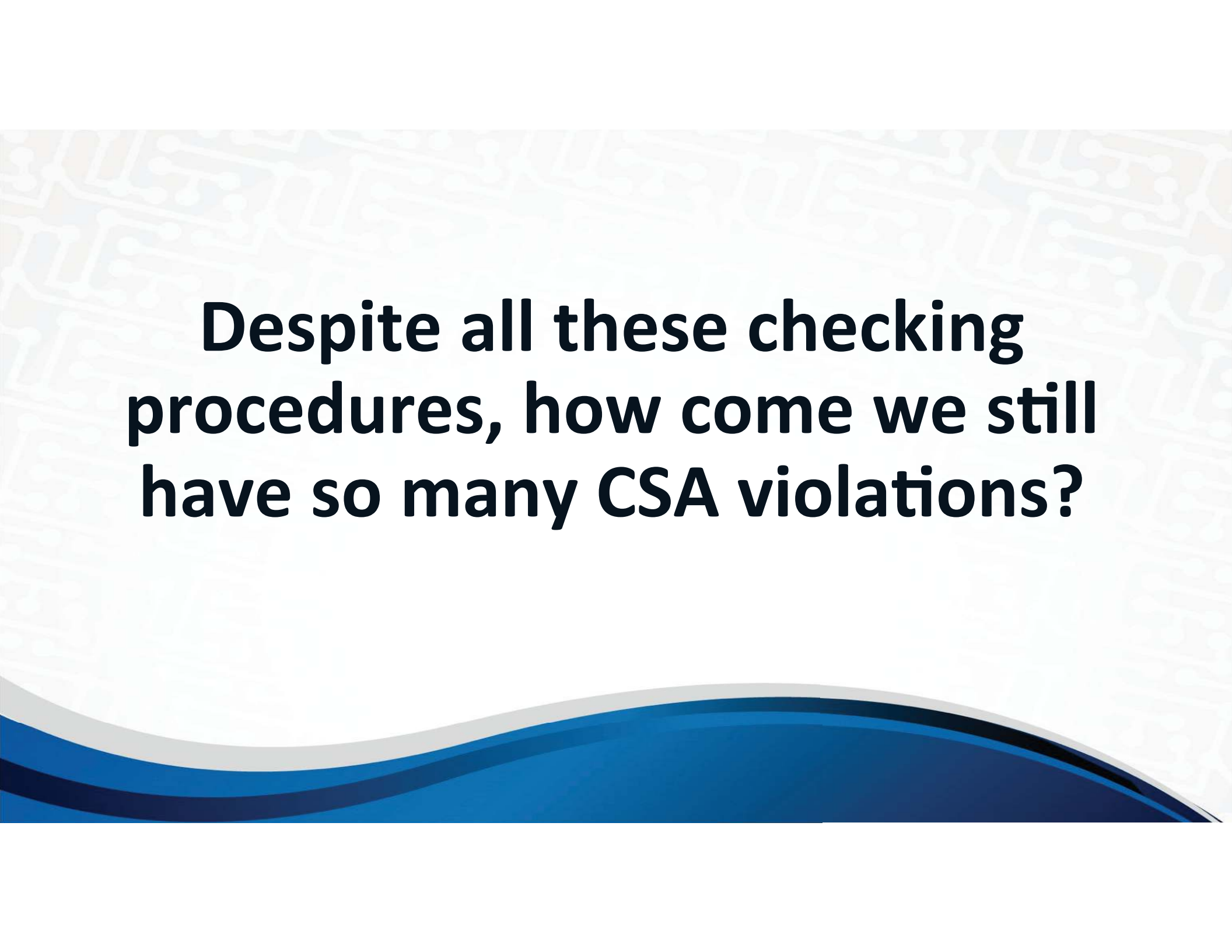
# All Testers Supply Power to Circuits



# Trailer Light Testing Procedure

- Testers supply power to every circuit, causing lights to illuminate.
- Technician walks around the trailer to check lights.
- The only minimal challenge can be that the sun shines through lens which makes the lights appear on.

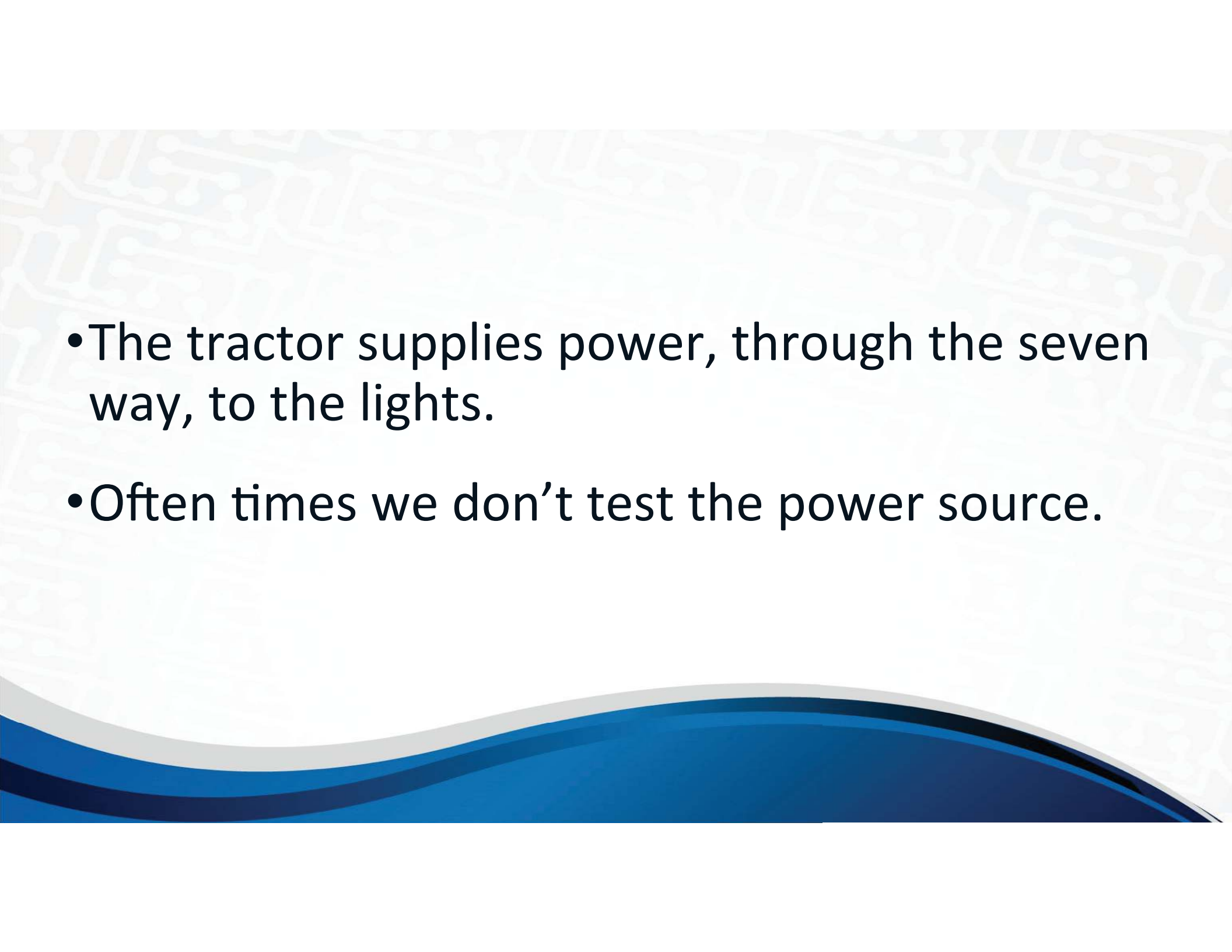




**Despite all these checking procedures, how come we still have so many CSA violations?**

Because often times only half of the system is tested.



- 
- The tractor supplies power, through the seven way, to the lights.
  - Often times we don't test the power source.

# Different ways fleets use to check the power source:

1. Test Light
2. Multi-Meter
3. Diode Tester

# Option 1: Test Light

PRO: Simple

CONS: Very little load and one has to interpret the brilliance of the bulb.

















# Option 2: Voltmeter

**PRO:** It is exact.

**CON:** Does not pull current.



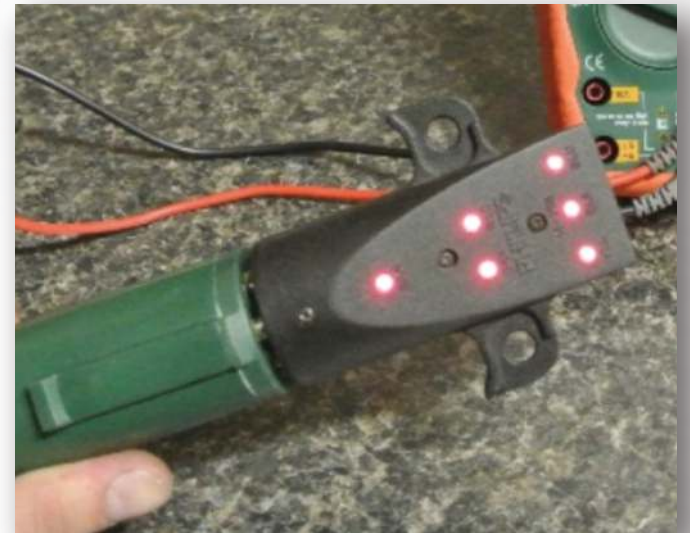




# Diode Light Checker

**PRO:** Simple, effective and sold everywhere.

**CONS:** Pulls a small amount of current.

















**All these forms have one common problem:**

They either pull no or a very small load.



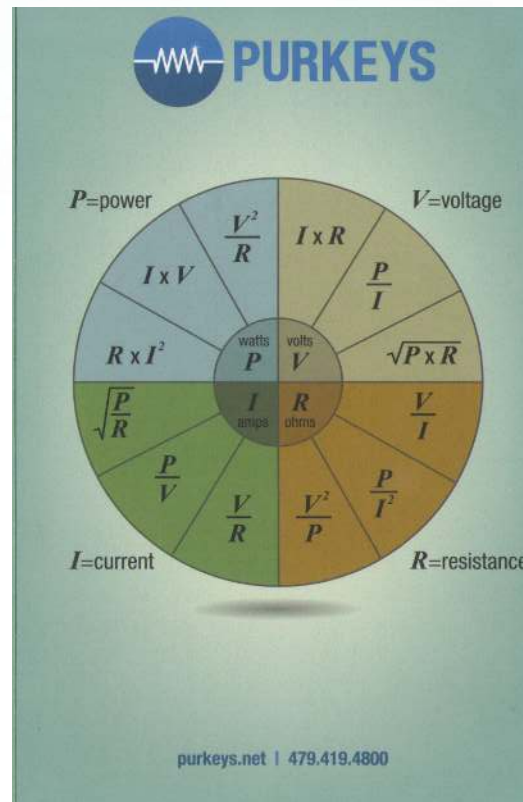
# Ohms Law:

$$V = I \times R$$

$$I = V / R$$

$$R = V / I$$

$$P = I \times V$$



**METER REFERENCE SHEET**

**Examples:**  
X > 10 value of x is greater than 10  
X < 10 value of x is less than 10  
X ≥ 10 value of x is equal to or greater than 10  
X ≤ 10 value of x is equal to or less than 10

**Voltage Drop Calculations**  
m = Thousandth Part.....10<sup>-3</sup> (.000)

**Voltage and Amperage Calculations**  
k = Thousand Fold.....10<sup>3</sup> (1,000)  
M = Million Fold.....10<sup>6</sup> (1,000,000)

**EXAMPLES**

3.15 M Ω	= 3.15 Ω x 10 <sup>6</sup>	= 3,150,000 Ω
0.85 M Ω	= 0.85 Ω x 10 <sup>6</sup>	= 850,000 Ω
21.02 M Ω	= 21.02 Ω x 10 <sup>6</sup>	= 21,020,000 Ω
26.32 k Ω	= 26.32 Ω x 10 <sup>3</sup>	= 26,320 Ω
2.156 k Ω	= 2.156 Ω x 10 <sup>3</sup>	= 2,156 Ω
0.952 k Ω	= 0.952 Ω x 10 <sup>3</sup>	= 952 Ω
3.4 Ω	= 3.4 Ω x 1	= 3.4 Ω
28.6 Ω	= 28.6 Ω x 1	= 28.6 Ω

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## Using Ohms Law

When we use a diode tester—which variables do we know?--Only the current flow (11mA).

We cannot calculate with two remaining unknowns (we do not know  $V$  or  $R$ ).

## Using Ohms Law

**Voltage drop example with diode light load (11mA or .011A)**

$V(\text{Voltage}) = I(\text{current}) \times R(\text{resistance})$

$V = 0.011 \text{ Amps} \times 0.65\Omega$

$V = .00715 \text{ Voltage Drop}$

$12.5 \text{ (tractor voltage)} - .00715 = 12.49 \text{ V Available}$

## Using Ohms Law

**Voltage drop example with typical trailer light load (10A)**

$V(\text{Voltage}) = I(\text{current}) \times R(\text{resistance})$

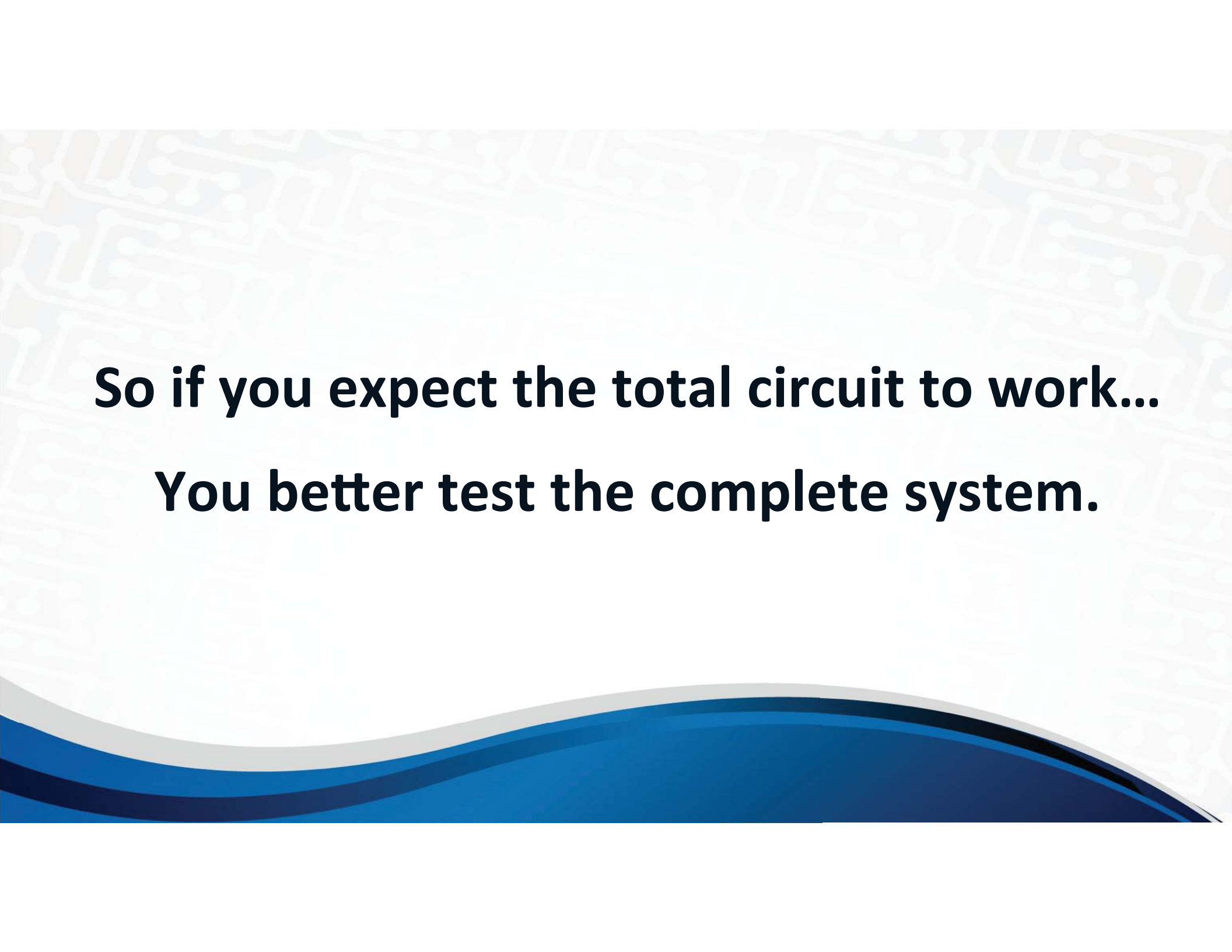
$V = 0.65 \Omega \times 10 \text{ Amps}$

$V = 6.5 \text{ Voltage Drop}$

$12.5 (\text{tractor voltage}) - 6.5 = 6.0V \text{ Available}$

# How voltage drop causes problems with lights

- As incandescent lights lose voltage they lose their light output.
- LED lights will lose some, but you will not notice it. They will work until they drop below a voltage set point, and then suddenly stop working.



**So if you expect the total circuit to work...**  
**You better test the complete system.**

# Using Ohms Law: Example 2

## Batteries on Diesel APU going dead

What do we know?

- 2000W Inverter
- 125A Alternator
- Alternator puts out 14V when running



## Using Ohms Law: Example 2

**Batteries on Diesel APU going dead**

$I$  (current) =  $P$ (power/watts) /  $V$  (voltage)

$I = 2000W$  (inverter) /  $14V$  (alternator  $V$  output)

$I = 2000 / 14 = 142$

Inverter is pulling 142 A. Alternator is only a 125A alternator



# **Quick Tips on How to Mitigate Voltage Drop Problems**

# Tips to Mitigate Voltage Drop Problems

Use GXL Wire



- Higher temp rating
- Higher abrasion ratings
- Will not reflow

# Tips to Mitigate Voltage Drop Problems

- Use Proper Gauge Wire
- Use Quality Connectors/Fuses/Etc
- Use the proper tools



# Tips to Mitigate Voltage Drop Problems

- Crimp the ends well
- Solder/weld whenever possible
- Use Heat Shrink
- Don't poke holes in wire with test lights

# Tips to Mitigate Voltage Drop Problems

- Cover wire with protective layer whenever it is rubbing or making contact with another surface (make sure to secure wire/protective layer every few inches (to avoid chaffing)).
- Use only the amount of length of wire you need. The longer the wire the more resistance.

# Questions & Answers

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