BEST PRACTICES IN LANDSCAPE LIGHTING

CENTRAL PRO SUPPLY

DESIGN BASICS

LANDSCAPE LIGHTING

WHY LOW VOLTAGE LANDSCAPE LIGHTING?

BEAUTY

» Illuminating distinctive features of the landscape and architecture.
» Setting the appropriate mood.
» Directing the night time experience of occupants and visitors.

SAFETY

» Illuminating pathways, entryways and stairs sufficiently to provide safe passage on a property.

» Pool areas, water features, decks and docks illuminated to prevent accidents.

SECURITY

» Low level lighting strategically placed throughout a property - much more effective and less invasive than line voltage floodlights.

» Plant material in wooded areas illuminated to eliminate areas of no light.

» Property entrances and boundaries illuminated to discourage intruders.

USABILITY

» Low level illumination for making outdoor spaces such as decks, patios & pool areas available at night.

» Eye friendly lighting to minimize glare.

» Appropriate levels of illumination for outdoor cooking & recreation.

WHY LOW VOLTAGE?

» 12v Low Voltage lighting systems do not require underground conduit and traditional 120v codes and regulations, reducing the cost of install and labor.

» 12v LED systems cost less to operate than traditional 120v lighting.

» 12v LED light sources are small enabling the installer to pinpoint the light where needed and allowing the light source to be concealed and often hidden.

DESIGN BASICS

LIGHTING TECHNIQUES

HOW TO LIGHT?

▶ LANDSCAPE LIGHTING GUIDELINES

» Use landscape lighting to help create safer and more secure outdoor living spaces. Pay special attention to pathways, steps, pools, water features and tripping hazards.

» Make outdoor tasks easier with targeted lighting around bar islands, grills, and outdoor living areas

» Create depth by selectively illuminating items and areas both near and far from the viewer. Integrating depth into the lighting design creates a rich three-dimensional visual experience.

» Less is more... Let the dark spaces add contrast to your lighting design. Glaring and overly bright illumination can be uncomfortable and detract from the enjoyment of outdoor living spaces.

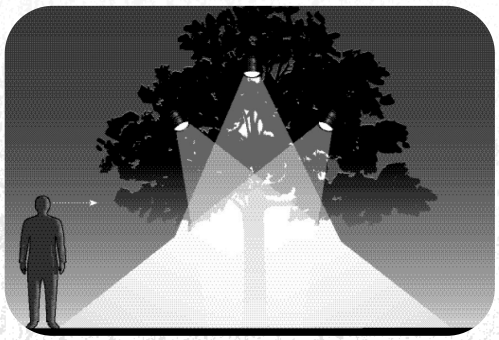
UP LIGHTING

» Highlight a tree or other feature, to provide a dramatic effect, especially with flowering or specimen plant material

» For tree trunks, use low intensity grazing technique to accentuate textures.

DOWN LIGHTING

» Most of our light in everyday life is Down Lighting; sun, moon, stars and interior or exterior lighting. By placing fixtures in trees and on structures, we can simulate natural down lighting and in many cases create visually pleasing effects by casting shadows on driveways, walkways, and lawn areas.



CROSS LIGHTING

» Defines surface texture instead of flattening effect when using a single front light. Used to define focal points. Lamp selection and fixture placement is critical. An angle of 45° between fixtures is often used.

HIGHLIGHT OR FOCAL POINT LIGHTING

» For creating a focal point with more dramatic light.

» Before you create focal points, you have to decide which elements of the selected objects need to be emphasized and from where they will be viewed. These decisions are too subjective to be made without the client's input.

DESIGN BASICS

LANDSCAPE TECHNIQUES

WALL WASHING

» Provides even illumination on walls and signs

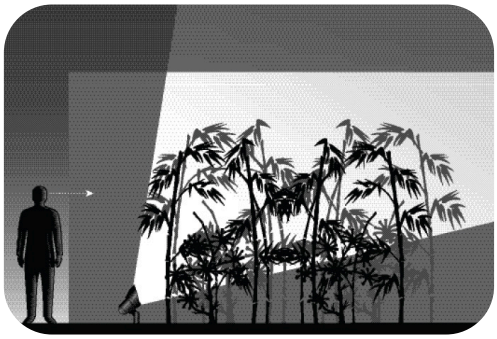
» A technique utilized in accenting architectural surfaces. It can create visual interest and possibly provide area lighting through reflection.

» Take care that these lights are not glaring for occupants inside the house.

SHADOWING

» Create interesting shadows on walls.

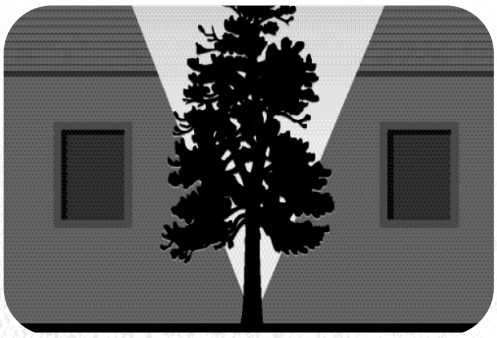
» Shadows create visual interest on the structure. Up and Accent, In-Ground, Well, and some Specialty lights can be-used for this technique.



BACK LIGHTING

» Provides illumination around the edges of an object, thereby emphasizing its shape.

» This technique is best used on objects with interesting shapes. Be sure that the fixture is hidden from view.



WALL/STEP LIGHTING

» Illuminate walls and steps with hardscape or strip lighting. Creating an even pattern throughout the wall or step area.

DESIGN BASICS

LIGHTING TECHNIQUES

PATH / AREA LIGHTING

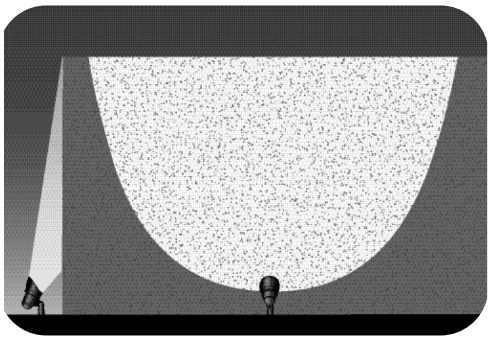
» Light planting beds and paths to provide seamless transition between lighting scenes.

» Stagger the placement for even distribution of light that allows the eye to easily flow through the scene.

GRAZING

» Provide a steeply angled light to accentuate texture on walls and tree trunks by utilizing the irregular surface to create broken shadows & irregular patterns.

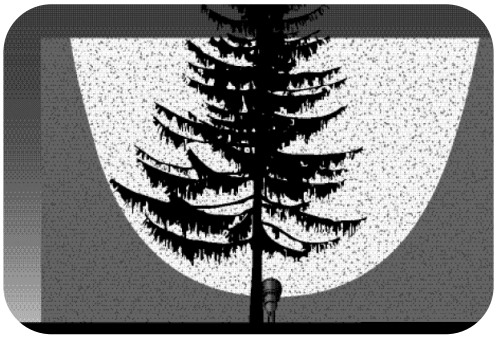
» Position lights within 18 inches of walls or tree trunks.



SILHOUETTING

» Provides a lit surface that acts as a backdrop for unlit plant material or other features.

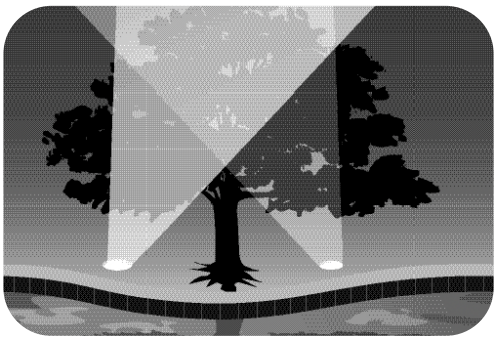
» This technique produces dramatic effects and is best used for features that have distinctive and interesting shapes.



MIRROR LIGHTING

» Take advantage of the reflective surface of water features and create dramatic scenes.

» Consider the viewers perspective when choosing features or plantlife to highlight mirror lighting



DESIGN BASICS

BEST PRACTICES

THE POWER OF LIGHT

Nothing has a greater effect on the comfort of an individual than the quality of light. Lighting displays the beauty of the landscape and highlights the architectural features of the building.

COHESION

- Cohesion refers to the overall appearance of the scene as one continuous panorama.
- "Black holes" detract from the beauty of the design and fatigue the eyes.
- Cohesion is achieved by illuminating borders, backgrounds, and intermediate areas with the creative use of fixtures placed for that purpose.

DEPTH

- Depth refers to the strategic placement of fixtures using different light levels to achieve a three-dimensional scene.
- Depth requires lighting areas that are in the foreground, in the middle, and in the back of the scene.

FOCAL POINTS

- Focal points may be unique features of the property such as, statuary or water features; or they may be functional points such as entrance ways, sitting areas, or gathering places.

BALANCE & SYMMETRY

- If there are repeating patterns such as a row of bushes, fencing, or stone walls, then the designer needs to light those forms in a way to preserve that symmetry.
- The designer also needs to balance the lighting so that one side of the property is not brighter than the other.

PERSPECTIVE

- Perspective refers to the viewers experience from various locations both outside and inside the home. The designer needs to walk the property and ensure that the lighting scene works from all possible vantage points (including from the approaching road).
- Inside the home, the viewer should be able to look out the windows and enjoy the scene without being blinded from fixtures illuminating the house.

VISUAL COMFORT

- To show the effect of lighting and not the source, the designer must make all attempts to prevent glare with the use of shrouds, hex louvers, plants, etc. to hide the source of light.

DIRECTION & QUALITY

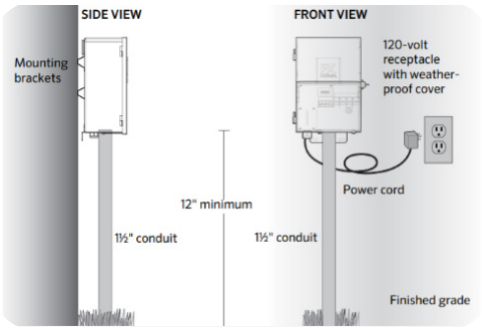
- Low voltage fixtures provide illumination that is highly controllable. Instead of the harsh glare of bare lamps, light is directed to the desired places. In a good lighting design, light sources are not seen, only the reflection of their light off a variety of surfaces.
- The quality of lighting is changed by uplighting (more dramatic), down lighting (more natural), side lighting (emphasizes details), or back lighting (emphasizes form).

LIGHTING BASICS

TRANSFORMERS & POWER

PRIMARY POWER AND TRANSFORMER INSTALLATION (Know your local codes and ordinances and defer to the code with the higher restriction and rating.)

- Outdoor power from the primary utility (home or business) should provide a GFCI 15 amp 120v receptacle outlet with a bubble cover.
- Voltage at the outlet can vary and should be tested before installation to ensure there is adequate voltage available.
- Low voltage lighting transformers are a 10:1 step down, converting high voltage on the primary side to low voltage on the secondary side. Example: If the power at the outlet is reading 115v then the voltage reading on the 12v tap will read 11.5v.
- According to the National Electrical Code (NEC), outdoor low voltage transformers should be mounted at least 12" above grade to prevent water from entering the housing, and should be placed on a secure post or wall, with the bottom of the transformer at least 12 inches from the ground; they must also be Class 2 compliant and positioned at least 5 feet away from any pool or water area. We recommend mounting the transformer a minimum of 18" and prefer 3' where that can be achieved.
- Use appropriate conduit with a male adapter and lock nut from the bottom of the transformer extending a minimum of 6" below grade with a conduit 90 degree elbow where the wire exits.
- Install transformer so power cord has a drip loop, where the cord hangs below the outlet, to ensure water & rain runoff is at the bottom of the lowest point & not into the bubble cover.



SIZING THE TRANSFORMER

- The sum of the LED volt-amps (VA) being powered by a single transformer must not exceed the wattage (W) rating of the transformer. If you are powering halogen lamps, calculate the load by adding the wattage (W) of the lamps in the system. Make sure the load does not exceed the wattage rating of the transformer. Always allow room for expansion on each transformer.
- Not all transformers are rated at 100% load rating. Check load capacity on the transformers you use, if a capacity rating is unknown then do not exceed 80% load on a single transformer.
- If VA is unknown, then use the formula below to determine VA
  - **VA = Wattage / Power Factor**
- If the power factor of the LEDs is unknown, use 0.7 as the value for this calculation. Once you have determined total VA value of the run, make sure the transformer you have selected has excess capacity in the event that new fixtures are connected to the system at a later date.
- **Example: 15 fixtures are each operating a 3W LED lamp with an unknown PF value.**
- **System VA = 15 x 3 / 0.70 = 64.3 VA**

LIGHTING BASICS
LED LAMPS

CHOOSING THE CORRECT LED (LIGHT EMITING DIODE)

Not all LEDs are created equal, and when designing and installing a new low voltage lighting system you want to make sure you are using the correct LED for the effect you are looking for and the application of the light. The LED you choose will also directly reflect daily and annual cost to the homeowner.

DROP-IN VS INTEGRATED

- Drop-in LED lamps are serviceable and upgradable LED lamps that requires a fixture to work. Drop-in LED lamps are usually more cost effective and come with a lesser warranty.
- Integrated LEDs are affixed to the fixture and usually not serviceable. Integrated LEDs usually have a higher lumen output, often have advanced technology build into them, cost more than drop-in LEDs, and come with a longer warranty.

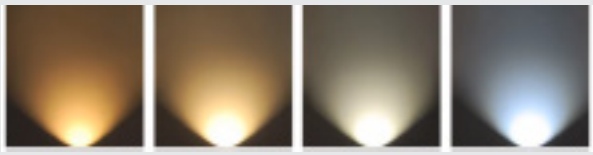
THINGS TO CONSIDERD WHEN DESIGNING

- CCT
- Beam Spread
- Lumens (brightness)
- Fixture needed and lamp required
- Zoning, Dimming, Color

CORRELATED COLOR TEMP (CCT)

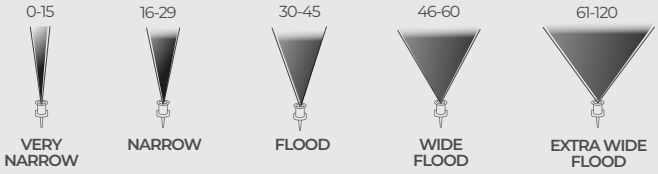
LEDs come in a multitude of color temperatures which are rated on the Kelvin (K) Scale. They range from warmer colors like 2700K to a cool white 6500k. The warmer the color, the more yellow, the cooler the color the more white and blue.

2700K WARM WHITE	3000K WARM WHITE	4000K NEUTRAL WHITE	5000K COOL WHITE



BEAM ANGLE

The spread of light from a light source. Measured in angles of degrees.



ADDITONAL ESSENTIAL LED TERMS

FOOT CANDLE (FC): A unit of measurement of luminescence. Equals the amount of light cast by one candle on a 1'x1' square from a distance of 1'.

COLOR TEMPERATURE: The appearance of light, in terms of warmth or coolness and as measured in Kelvin temperature. High temperature corresponds to cooler, whiter light. Low temperature corresponds to warmer, more yellow light.

COLOR RENDERING: General expression for the effect of a light source on the color appearance of objects when compared with their color appearance under a reference light source.

L.E.D. (Light-Emitting Diode): A semiconductor diode, similar to a computer chip, that emits light when conducting an electrical current. Much more efficient than traditional incandescent lighting.

LUMEN: The unit of measure of the perceived power of light. Higher lumen outputs correspond to brighter light sources.

OHM: A measurement of electrical resistance that causes voltage loss in circuits.

OHM'S LAW: The basic law of electrical current flow. The mathematical equation that explains and quantifies the behavior of electrical circuits. Useful formulas derived from Ohm's Law are:

Watts/Volts = Amps
Amps x Resistance = Volts
Volts x Amps = Watts

VOLT (V): The unit to describe the electrical force that causes current to flow. Landscape lighting typically functions at 12 volts, compared to 120 volts for line/high voltage. "Electrical pressure"

VOLT AMPS (VA): a unit of apparent electrical power, the total amount of power that must be generated by the utility. Dividing a lamp's wattage (W) by the lamp's power factor (PF) results in the VA drawn on the line. W/PF = VA This value is used to properly size a transformer for a LV lighting system utilizing LED.

WATT (W): A unit of electrical power. Lamps are rated in watts to indicate the rate at which they consume energy. (W = VxA) True power consumed is what customers are charged for on the utility bill. "Power"

(Watts on system x Hours per night) x KWH rate
Divided by 1000

$$\frac{(138 \times 10) \times .18}{1{,}000} = .2484$$

.2484 x 30 days = $7.45 (cost to run per month)

LIGHTING BASICS

SECONDARY POWER & VOLTAGE DROP

VOLTAGE DROP

Voltage drop is the difference in electrical potential between two points in a circuit.

Remember voltage is similar to pressure. The longer the run, the less pressure you will have at the end.

Voltage drop occurs in many different areas of a low-voltage lighting system. The first place is at the transformer. Transformers take the primary power from 120v and convert it to the secondary power of 12v making it low voltage Other causes are long cable runs, cable connections, and light fixtures.

Low voltage landscape system voltage drop occurs along the secondary wire and is affected by the distance of the run, the total VA of the run, and the gauge of the wire. As a result, fixtures at the end of the system's run will receive lower voltage than fixtures near the beginning of the run. Voltage loss can be minimized in different ways.

Low voltage wire is necessary to run from the secondary power on the transformer to the fixtures it will operate in the system. Low voltage wire is measured by gauges. Thinner wire has a higher number and has a lower maximum load. The lower the wire number, the thicker the wire and the more current it can carry. Consequently, thicker wire reduces voltage drop so it is suggested that 10/2 or 12/2 wire is used for low voltage landscape lighting systems. Below is a table that lists the cable constant (Kc) value and maximums @12V of different wire gauges:

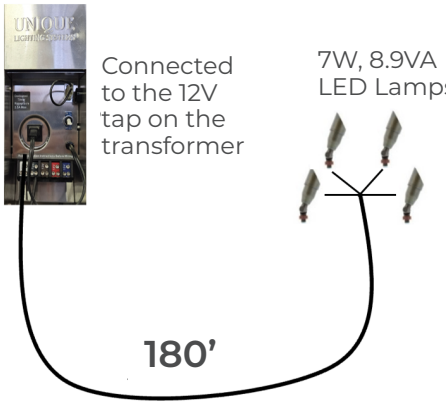
#18/2	1380	8 AMPS OR 96 WATTS
#16/2	2200	11 AMPS OR 132 WATTS
#14/2	3500	16 AMPS OR 192 WATTS
#12/2	7500	20 AMPS OR 240 WATTS
#10/2	11920	30 AMPS OR 360 WATTS
#8/2	18960	40 AMPS OR 480 WATTS

▶ VOLTAGE DROP FORMULA

Use the following formula to calculate voltage drop using the distance of the run (transformer to last fixture), the total VA of the system (load), and the cable constant of the wire listed above:

$$VD = \frac{(L \times VA) \times 2}{KC}$$

VD: Voltage drop
L: One-way length of cable in feet.
VA: Total VA on cable in a section.
2: Is for the 2-wire cable in each circuit.
Kc: Is the "cable constant" for low voltage cable at about 70 degree F.



Example:
VD =(180 x 35.6)x2 / 7500 = 1.71 VD.

Therefore, if the voltage tap is reading 12V and VD is 1.71, then the fixtures should read (12 – 1.71)= 10.29V. Based on this we would recommend placing the homerun line on the 14V tap.

LIGHTING BASICS

SITE VISITS & SALES

A RELAXING OUTDOOR ENVIRONMENT IS ACHIEVED BY

- Smooth transitions
- Varied light levels that direct the eye naturally from one area to another and create depth
- Balanced lighting across the scene
- Focal points
- Visual direction

SALES & DESIGN STEPS:

▶ STEP ONE: DETERMINE THE OBJECTIVES

- What is the budget?
- What area are they wanting lit? Any specific focal points or areas of need/concern?
- Do they want any control/automation with zoning, dimming, or color or simple on/off app control?

▶ STEP TWO: WALK THE PROPERTY

- Where are the primary power sources available?
- View the property from all angles, including the road.
- What is needed to provide safety, security, beauty, and usability to the space?
- Note all transition areas, challenges, and hurdles for installation.
- Take pictures and videos for future reference.
- If app control is desired, test the WiFi signal at the primary power source options.

▶ STEP THREE: FLAG AND ROUGH SKETCH

- Flag the property marking fixture locations and fixture type. Using a landscape plan, Google Earth, or a rough sketch, begin to mark all the fixtures at their precise location.
- Determine which power source best splits the load of the lighting system and fulfills the needs for WiFi connectivity, if necessary.

▶ STEP FOUR: TRANSFORMER & VOLTAGE CALCULATION

- Based on the full load (VA) of the lighting system, determine the size and/or quantity of transformers.
- Check a few of the longest (FT) and largest (VA) runs for voltage loss using the voltage loss charts.
- If necessary, utilize Central or vendor lighting design services to calculate voltage and wire sizing.

▶ STEP FIVE: DESIGN AND SALES PRESENTATION

- Present a detailed design and proposal along with the features and benefits of the products proposed.
- Show them pictures from your portfolio to establish an expectation of results and lighting techniques.
- If necessary, offer a lighting demo to close the deal.

LANDSCAPE LIGHTING
TROUBLESHOOTING

The Outdoor Lighting profession does not require much in the way of tools to install lighting systems. But there is one tool that is indispensable to installing them safely. It is the Voltmeter/Amp Probe. Sometimes these are two separate tools more often than not, both can be found on the same device. * *See Diagram Below:

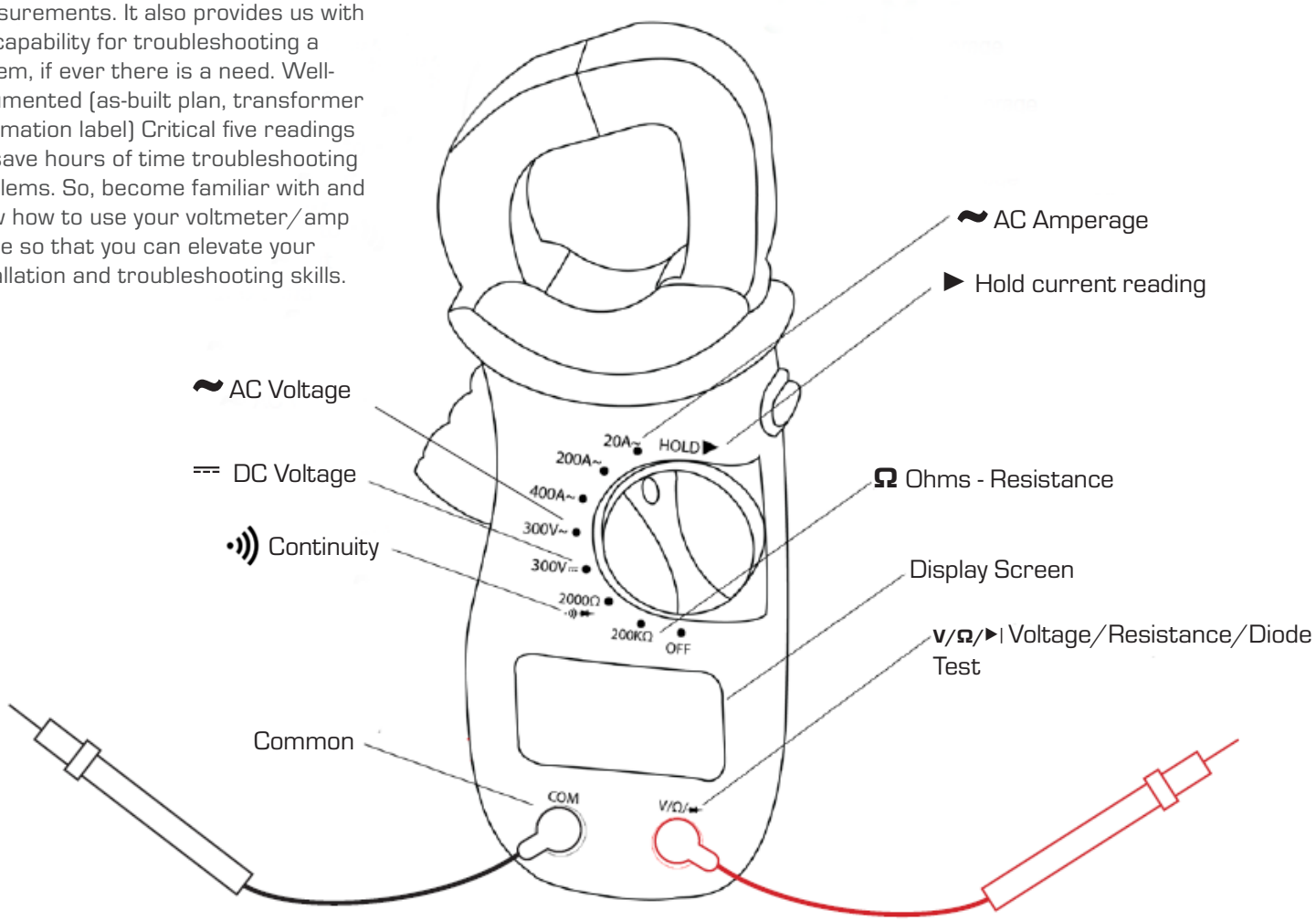
Why is the Voltmeter/Amp probe so important for our work?

The main reason is that to safely install a new system we need to measure and document these five Critical attributes of the system. They are the following:

CRITICAL FIVE

1. Primary Volatge at Transformer Outlet
2. Secondary Voltage at Terminals
3. Primary Amperage (a,b,c)
4. Secondary Amperage on each Secondary Wire (a,b)
5. Secondary Voltage at First Point of Connection or Fixture on each Wire

The Voltmeter/Amp Probe provides the means for taking these measurements. It also provides us with the capability for troubleshooting a system, if ever there is a need. Well-documented (as-built plan, transformer information label) Critical five readings will save hours of time troubleshooting problems. So, become familiar with and know how to use your voltmeter/amp probe so that you can elevate your installation and troubleshooting skills.



LANDSCAPE LIGHTING
TROUBLESHOOTING

METER SETTINGS AND TECHNIQUES FOR THE CRITICAL FIVE

METER SETTING

~ AC Voltage

At the time of installation this meter reading will give us our starting primary voltage at the outlet. During troubleshooting this measurement will confirm power to the transformer.

METER SETTING

~ AC Voltage

This reading will give us secondary voltage at terminals. This will tell you what each secondary voltage terminal is supply to the attached wire runs.

METER SETTINGS AND TECHNIQUES FOR THE CRITICAL FIVE

3a. Primary Amperage Reading with an Amp Loop

METER SETTING

~ AC Voltage

This is how we take a reading of primary amperage with an amp loop. Some transformers do not have an amperage loop readily available, if that is the case see, 3b and 3c.

3b. Primary Amperage Using Modified Extension Cord

METER SETTING

~ AC Voltage

This is how we take a reading of primary amperage without an amp loop. Exceeding your amperage rating on a transformer can be dangerous and can damage the transformer.

3c. Primary Amperage Using Klein Amp Tester (eg. Line splitter)

METER SETTING

~ AC Voltage

This is a tool you can buy to take a primary amperage reading. As the tools can vary, the idea is to find the amperage draw at transformer.

METER SETTINGS AND TECHNIQUES FOR THE CRITICAL FIVE

4 a. Secondary Amperage on One Run at Transformer

METER SETTING

~ AC Voltage

This meter reading will tell us about the secondary amperage on each run. The total amperage of a single run must stay within the amp limits of the wire gauge. This reading is essential for troubleshooting when the reading is lower or higher than the as-built plan.

4b. Secondary Amperage reading at first fixture or connection; CORRECT WAY

METER SETTING

~ AC Voltage

This is the correct way to take a secondary amp reading on a single run. Using one of the wires from a single run; not both.

Secondary Amperage reading at first fixture or connection; INCORRECT WAY

METER SETTING

~ AC Voltage

This is an incorrect way to take a secondary amp reading. A reading must be taken by one of the two wires of different polarity on the same wire run.

METER SETTINGS AND TECHNIQUES FOR THE CRITICAL FIVE

5. Secondary Voltage at the First Ponit of Connection or Fixture on Each Wire

METER SETTING

~ AC Voltage

This meter reading will give us our secondary voltage at the first fixture or first point of connection. Most LED lamps require 9-15 volts of power, make sure your reading is within that operating range. This is a measurement of dynamic secondary voltage.

These meter setting and readings are important for documenting the Critical Five. DC meter settings should only be used when measuring DC power sources, such as batteries and DC transformers.

LANDSCAPE LIGHTING
VOLTAGE DROP

VOLTAGE DROP 8-2

Length \ VA	100	115	130	145	160	175	190	205	220	235	250	265	280	295
10	0.11	0.12	0.14	0.15	0.17	0.18	0.20	0.22	0.23	0.25	0.26	0.28	0.30	0.31
20	0.21	0.24	0.27	0.31	0.34	0.37	0.40	0.43	0.46	0.50	0.53	0.56	0.59	0.62
30	0.32	0.36	0.41	0.46	0.51	0.55	0.60	0.65	0.70	0.74	0.79	0.84	0.89	0.93
40	0.42	0.49	0.55	0.61	0.68	0.74	0.80	0.86	0.93	0.99	1.05	1.12	1.18	1.24
50	0.53	0.61	0.69	0.76	0.84	0.92	1.00	1.08	1.16	1.24	1.32	1.40	1.48	1.56
60	0.63	0.73	0.82	0.92	1.01	1.11	1.20	1.30	1.39	1.49	1.58	1.68	1.77	1.87
70	0.74	0.85	0.96	1.07	1.18	1.29	1.40	1.51	1.62	1.74	1.85	1.96	2.07	2.18
80	0.84	0.97	1.10	1.22	1.35	1.48	1.60	1.73	1.86	1.98	2.11	2.24	2.36	2.49
90	0.95	1.09	1.23	1.38	1.52	1.66	1.80	1.95	2.09	2.23	2.37	2.52	2.66	2.80
100	1.05	1.21	1.37	1.53	1.69	1.85	2.00	2.16	2.32	2.48	2.64	2.80	2.95	3.11
110	1.16	1.33	1.51	1.68	1.86	2.03	2.20	2.38	2.55	2.73	2.90	3.07	3.25	3.42
120	1.27	1.46	1.65	1.84	2.03	2.22	2.41	2.59	2.78	2.97	3.16	3.35	3.54	3.73
130	1.37	1.58	1.78	1.99	2.19	2.40	2.61	2.81	3.02	3.22	3.43	3.63	3.84	4.05
140	1.48	1.70	1.92	2.14	2.36	2.58	2.81	3.03	3.25	3.47	3.69	3.91	4.14	4.36
150	1.58	1.82	2.06	2.29	2.53	2.77	3.01	3.24	3.48	3.72	3.96	4.19	4.43	4.67
160	1.69	1.94	2.19	2.45	2.70	2.95	3.21	3.46	3.71	3.97	4.22	4.47	4.73	4.98
170	1.79	2.06	2.33	2.60	2.87	3.14	3.41	3.68	3.95	4.21	4.48	4.75	5.02	5.29
180	1.90	2.18	2.47	2.75	3.04	3.32	3.61	3.89	4.18	4.46	4.75	5.03	5.32	5.60
190	2.00	2.30	2.61	2.91	3.21	3.51	3.81	4.11	4.41	4.71	5.01	5.31	5.61	5.91

VOLTAGE DROP 10-2

Length \ VA	70	80	90	100	110	120	130	140	150	160	170	180	190	200
25	0.29	0.34	0.38	0.42	0.46	0.50	0.55	0.59	0.63	0.67	0.71	0.76	0.80	0.84
30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.76	0.81	0.86	0.91	0.96	1.01
35	0.41	0.47	0.53	0.59	0.65	0.70	0.76	0.82	0.88	0.94	1.00	1.06	1.12	1.17
40	0.47	0.54	0.60	0.67	0.74	0.81	0.87	0.94	1.01	1.07	1.14	1.21	1.28	1.34
45	0.53	0.60	0.68	0.76	0.83	0.91	0.98	1.06	1.13	1.21	1.28	1.36	1.43	1.51
50	0.59	0.67	0.76	0.84	0.92	1.01	1.09	1.17	1.26	1.34	1.43	1.51	1.59	1.68
55	0.65	0.74	0.83	0.92	1.02	1.11	1.20	1.29	1.38	1.48	1.57	1.66	1.75	1.85
60	0.70	0.81	0.91	1.01	1.11	1.21	1.31	1.41	1.51	1.61	1.71	1.81	1.91	2.01
65	0.76	0.87	0.98	1.09	1.20	1.31	1.42	1.53	1.64	1.74	1.85	1.96	2.07	2.18
70	0.82	0.94	1.06	1.17	1.29	1.41	1.53	1.64	1.76	1.88	2.00	2.11	2.23	2.35
75	0.88	1.01	1.13	1.26	1.38	1.51	1.64	1.76	1.89	2.01	2.14	2.27	2.39	2.52
80	0.94	1.07	1.21	1.34	1.48	1.61	1.74	1.88	2.01	2.15	2.28	2.42	2.55	2.68
85	1.00	1.14	1.28	1.43	1.57	1.71	1.85	2.00	2.14	2.28	2.42	2.57	2.71	2.85
90	1.06	1.21	1.36	1.51	1.66	1.81	1.96	2.11	2.27	2.42	2.57	2.72	2.87	3.02
95	1.12	1.28	1.43	1.59	1.75	1.91	2.07	2.23	2.39	2.55	2.71	2.87	3.03	3.19
100	1.17	1.34	1.51	1.68	1.85	2.01	2.18	2.35	2.52	2.68	2.85	3.02	3.19	3.36
105	1.23	1.41	1.59	1.76	1.94	2.11	2.29	2.47	2.64	2.82	2.99	3.17	3.35	3.52
110	1.29	1.48	1.66	1.85	2.03	2.21	2.40	2.58	2.77	2.95	3.14	3.32	3.51	3.69

LANDSCAPE LIGHTING
VOLTAGE DROP

VOLTAGE DROP 12-2

Length \ VA	10	20	30	40	50	60	70	80	90	100	110	120	130	140
5	0.01	0.03	0.04	0.05	0.07	0.08	0.09	0.11	0.12	0.13	0.15	0.16	0.17	0.19
10	0.03	0.05	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27	0.29	0.32	0.35	0.37
15	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40	0.44	0.48	0.52	0.56
20	0.05	0.11	0.16	0.21	0.27	0.32	0.37	0.43	0.48	0.53	0.59	0.64	0.69	0.75
25	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93
30	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88	0.96	1.04	1.12
35	0.09	0.19	0.28	0.37	0.47	0.56	0.65	0.75	0.84	0.93	1.03	1.12	1.21	1.31
40	0.11	0.21	0.32	0.43	0.53	0.64	0.75	0.85	0.96	1.07	1.17	1.28	1.39	1.49
45	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.20	1.32	1.44	1.56	1.68
50	0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.07	1.20	1.33	1.47	1.60	1.73	1.87
55	0.15	0.29	0.44	0.59	0.73	0.88	1.03	1.17	1.32	1.47	1.61	1.76	1.91	2.05
60	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28	1.44	1.60	1.76	1.92	2.08	2.24
65	0.17	0.35	0.52	0.69	0.87	1.04	1.21	1.39	1.56	1.73	1.91	2.08	2.25	2.43
70	0.19	0.37	0.56	0.75	0.93	1.12	1.31	1.49	1.68	1.87	2.05	2.24	2.43	2.61
75	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80
80	0.21	0.43	0.64	0.85	1.07	1.28	1.49	1.71	1.92	2.13	2.35	2.56	2.77	2.99
90	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.16	2.40	2.64	2.88	3.12	3.36
95	0.25	0.51	0.76	1.01	1.27	1.52	1.77	2.03	2.28	2.53	2.79	3.04	3.29	3.55
100	0.27	0.53	0.80	1.07	1.33	1.60	1.87	2.13	2.40	2.67	2.93	3.20	3.47	3.73

VOLTAGE DROP 14-2

Length \ VA	10	15	20	25	30	35	40	45	50	55	60	65	70	75
5	0.03	0.04	0.06	0.07	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.19	0.20	0.21
10	0.06	0.09	0.11	0.14	0.17	0.20	0.23	0.26	0.29	0.31	0.34	0.37	0.40	0.43
15	0.09	0.13	0.17	0.21	0.26	0.30	0.34	0.39	0.43	0.47	0.51	0.56	0.60	0.64
20	0.11	0.17	0.23	0.29	0.34	0.40	0.46	0.51	0.57	0.63	0.69	0.74	0.80	0.86
25	0.14	0.21	0.29	0.36	0.43	0.50	0.57	0.64	0.71	0.79	0.86	0.93	1.00	1.07
30	0.17	0.26	0.34	0.43	0.51	0.60	0.69	0.77	0.86	0.94	1.03	1.11	1.20	1.29
35	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50
40	0.23	0.34	0.46	0.57	0.69	0.80	0.91	1.03	1.14	1.26	1.37	1.49	1.60	1.71
45	0.26	0.39	0.51	0.64	0.77	0.90	1.03	1.16	1.29	1.41	1.54	1.67	1.80	1.93
50	0.29	0.43	0.57	0.71	0.86	1.00	1.14	1.29	1.43	1.57	1.71	1.86	2.00	2.14
55	0.31	0.47	0.63	0.79	0.94	1.10	1.26	1.41	1.57	1.73	1.89	2.04	2.20	2.36
60	0.34	0.51	0.69	0.86	1.03	1.20	1.37	1.54	1.71	1.89	2.06	2.23	2.40	2.57
65	0.37	0.56	0.74	0.93	1.11	1.30	1.49	1.67	1.86	2.04	2.23	2.41	2.60	2.79
70	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00
75	0.43	0.64	0.86	1.07	1.29	1.50	1.71	1.93	2.14	2.36	2.57	2.79	3.00	3.21
80	0.46	0.69	0.91	1.14	1.37	1.60	1.83	2.06	2.29	2.51	2.74	2.97	3.20	3.43
90	0.51	0.77	1.03	1.29	1.54	1.80	2.06	2.31	2.57	2.83	3.09	3.34	3.60	3.86
95	0.54	0.81	1.09	1.36	1.63	1.90	2.17	2.44	2.71	2.99	3.26	3.53	3.80	4.07
100	0.57	0.86	1.14	1.43	1.71	2.00	2.29	2.57	2.86	3.14	3.43	3.71	4.00	4.29

TERMINOLOGY
LANDSCAPE LIGHTING

Like any other industry, lighting has a language all its own. Below are some of the common words and terms used within the landscape lighting industry.

Accent Lighting: Refers to lighting that is used to highlight or accent a certain feature or element in your landscape.

Ambient Light: Lighting throughout a space that produces general illumination. This can be a combination of natural and artificial light.

Ampere (amp): Unit to express the flow quantity of electricity. Analogous to gallons per minute.

Baffle: An accessory that was created to prevent light from producing glare at certain angles a.k.a. – hex louver.

Beam Spread: The angle between the two directions in the plane (horizontal and vertical) in which the intensity is equal to a stated percentage of the maximum beam intensity.

Binning: General term for the production and sorting methodologies used by LED makers to ensure that the LEDs they manufacture conform to stated specifications for forward voltage, color, and luminous flux.

Bulb: Layman's term for "lamp", also commonly planted in the ground in the Fall.

Cable Constant (Kc): Used in the voltage drop formula, relates to the thickness of copper wire. The thicker the wire, the lower the conductive resistance, resulting in a lower drop in voltage.

Candela (CD): The basic unit of measurement of luminous intensity from a light source in a specific direction.

Candle Power (CP): Luminous intensity (in a particular direction) expressed in candelas.

Chip-On-Board (COB): Chip-on-Board LED technology describes the mounting of a bare LED chip in direct contact with the substrate to produce LED arrays. Due to the small size of the LED chip, Chip-on-Board technology allows for a much higher packing density than surface mount technology. This results in higher intensity & greater uniformity for the user.

Circuit Breaker: A switching device that can be manually operated that automatically opens (switches off) when more than the rated current passes through. Generally rated in amps. A typical residential 120v circuit breaker is 15 or 20 amps.

Color Rendering: General expression for the effect of a light source on the color appearance of objects when compared with their color appearance under a reference light source.

Color Rendering Index (CRI): A measurement of vibrant and true colors, poor CRI can destroy a beautiful landscape. CRI is measured on a scale of 0 to 100, 100 being best. All lamp sources have different CRI measurements. CRI over 80 is considered very good in the LED industry. Colors are bright, vibrant and true.

Correlated Color Temperature (CCT): An expression of light source color or whiteness, stated in degrees Kelvin (K). The CCT rating for a lamp is a general "warmth" or "coolness" measurement of its appearance. The longer the Kelvin temperature the "warmer" the light, the higher the "cooler" the light.

TERMINOLOGY
LANDSCAPE LIGHTING

Conductor: A metallic material that has low resistance to electrical flow such as copper. A circuit must have at least 2 conductors.

Down Lighting: Like up lighting, this is a general term that describes a group of effects that places the illuminating source above the target area. Down lighting can be used to light specific garden elements and pedestrian areas or to illuminate large spaces for safety, security or recreational purposes.

Drivers: Most retrofit LED lamps used for landscape lighting have a small circuit board inside. This circuit board is called a driver. This driver is what accepts 12 volts AC from a transformer and turns this voltage into the DC voltage required to light the LED. Now this rectified voltage goes through a series of small electronic components which make the LED light up.

Efficacy: A measurement of how many lumens a lamp produces per watt consumed.

Electrical Over Stress (EOS): A potential issue with LED lamps if they are installed into the fixture/socket while electricity is powered to the source. This can cause an EOS on many of the internal circuitry parts of the lamp or integrated fixture, causing it to fail. A lightning strike or a poorly made connection can also be a cause of an EOS. LED light sources should not be “hot plugged” when servicing a lighting system, the system should be deactivated while installing LED lamps.

Fixture: Layman’s term for “luminaire.” Designed to house a lamp and conduct electricity to a lamp so that light can be produced.

Flood Lighting: Indiscriminate lighting of an area usually associated with high/line voltage products for security or utility functions.

Foot Candle (FC): A unit of measurement of luminescence. Equals the amount of light cast by one candle on a 1’x1’ square from a distance of 1’.

Gauge: A measurement of electrical conductor (wire or cable) size. The lower the number, the thicker the cable. 8-gauge cable is twice the size of 12-gauge.

Glare: A negative term describing uncontrolled light that produces discomfort to the viewer.

Glare Direct: Glare resulting from high luminance or insufficiently shielded light sources in the field of view. A direct glare source may also affect performance by distracting attention.

Ground: A non-current carrying metallic connection to earth. All 120v circuit must be grounded – 12v circuits do not. The green wire on a 120v circuit is typically the ground.

Ground Fault Current Interrupter (GFCI): A device that detects abnormal current patterns and shuts off power. GFCI’s are always recommended on outdoor circuits.

Halogen Lamp: A type of incandescent lamp which uses a halogen gas in order to increase both light output and rated life. They are known for moderately high efficiency, quality of light, and high rated life compared to regular incandescent lamps.

TERMINOLOGY
LANDSCAPE LIGHTING

Heat Sink: A feature or device that conducts and radiates heat away from sensitive components, such as LEDs and electronics. Fins on LED replacement lamps can serve as a heat sink.

Hot: The conductor or surface that has voltage present. A hot and a common or neutral creates an electrical circuit. Usually color coded as the darker of all wires.

Ingress Protection (IP) Rating: This system classifies and rates the degree of protection provided against the intrusion of dust, accidental contact and water by mechanical casings and electrical enclosures. An example IP rating is 67.

Illuminance: The amount of light striking a surface or object, measured in footcandles or lumens.

Incandescent Lamp: A lamp that produces light when electricity heats a tungsten metal filament.

Kelvin: Kelvin is a scale of temperature that can be used to determine the color of light. 4000K is a white light, a higher number is a cooler lamp, a lower number is a warmer lamp.

Lamp: Technical term for “bulb.”

LED Driver: An electronic circuit that converts input power into a current source- a source in which current remains constant despite fluctuations in voltage. An LED driver protects LEDs from normal voltage fluctuations, over voltages, and voltage spikes.

LED Lamp Life: Lamp life is rated in hours. The hours signify how many hours it takes for that LED lamp to reduce it’s light output to 70% of it’s initial output.

Lens: A transmitting element used to change the direction and control the distribution of light rays. The shielding or diffuser portion of a luminaire made of plastic or glass through which the light passes on its way to the light task.

Light Emitting Diode (LED): Basically, LED’s are tiny light chips or semiconductor diodes that fit easily into an electrical circuit. Unlike ordinary incandescent lamps, they do not have a filament that can burn out or get hot. LEDs have a rated life typically of about 40,000 hours or 14 years of normal use.

Light Trespass: A situation which occurs when, due to lack of adequate beam control, light from a source is distributed onto areas where the illumination is not wanted.

Line Voltage: Generally means 120 volts. A.K.A. High Voltage.

Louver: A series of baffles used to shield a source from view at certain angles or to absorb unwanted light. Can also be referred to as a hex baffle or hex louver.

Low-Voltage Lighting: A general term given to a system that is powered by a step-down transformer that reduces a 120v power input to a 12v output.

Lumen: The unit of measurement for the amount of light emitted by a lamp. One lumen per square foot is one foot-candle.

TERMINOLOGY
LANDSCAPE LIGHTING

Luminaire: Technical term for “fixture”. A complete lighting unit consisting of a lamp holding socket.

MR16 Lamp: “MR” stands for multifaceted reflector, a pressed glass reflector with the inside (reflecting side) surface composed of facets and covered by a reflective coating. These facets provide optical control by gathering the light from the filament to create a concentrated beam of light.

Neutral: A conductor that is common to other circuits and carries no current.

Ohm: A measurement of electrical resistance that causes voltage loss in circuits.

PAR Lamp: Parabolic aluminized reflector lamp or sealed beam lamp. Generally used for auto signal or headlights. PAR36 lamps are commonly used in Low Voltage light systems.

Path Lighting: The most visible source of lighting equipment comes from path lights. Path lighting should be used to draw attention to pedestrian hazards such as grade changes or to illuminate surfaces that can’t be reached by down lighting from trees, eaves and other architectural elements or integral wall mounted fixtures.

Patina: A thin greenish layer, usually basic copper sulfate that forms on copper or copper alloys, such as brass, as a result of corrosion.

Phosphor: A coating of phosphorescent material that absorbs light from a blue or UV LED chip and emits most of its output in the yellow range. The proper combination of blue or UV LED chip and phosphor coating generates white light.

Powder Coat: Powder coating is a completely dry finishing process that uses finely ground particles of pigment and resin which are electrostatically charged and sprayed on products. The result is an attractive, durable, high-quality finish.

Power Factor (PF): A Measure of how effectively a luminaires power source converts electric power input to useful power output. The further the power factor is from the idea PF (1.0), the less effective the power conversion resulting in more wasted power. If you take the apparent power (the wattage listed on the lamp), and divide it by the PF, you will get the VA- or the real power of the LED lamp. For example: 4 watts / PF .85 = 4.7 VA

Quality of Lighting: A description of the aesthetic appearance of an illuminated environment indicating the use and control of light sources.

Reflectance: A measure of the amount of light that strikes a surface that is reflected.

Resistance: Measure of ohms- analogous to friction in hydraulics. A measurement of the restriction of the free flow of electrons in electrical conductors. Copper has a low resistance making it a good conductor. Glass has a high resistance making it a good insulator.

TERMINOLOGY
LANDSCAPE LIGHTING

Short Circuit: An unwanted flow of current between two conductors causing the circuit breaker to trip.

Spill Light: Lumens distributed by the luminaire which are outside the beam spread.

Task Lighting: The function of providing illumination for specific purposes such as recreation or utility.

Transformer: An electrical device used to step down 120- volt current to 12-volt for use on low-voltage lighting systems. A transformer provides roughly 1/10th of the input power.

Underwriters Laboratory: UL is an independent, not-for-profit product safety testing and certification organization. ETL, ARL, and several others perform the same service.

Up Lighting: Description for several lighting techniques that use surface mounted or recessed fixtures aiming upward. This creates a dramatic effect that demands attention – thereby establishing focal points.

Useful Life: The length of time it takes an LED light source to reach a certain percentage of its initial lumen output. Commonly defined as lumen maintenance thresholds L70 (70% of initial lumen output).

Useful Light: The amount of light a lighting luminaire delivers in an application, minus any wasted light.

Volt: Unit to describe the electrical force that causes current to flow- analogous to PSI in hydraulics.

Volt Amps (VA): Refers to the amount of energy in an AC circuit that is consumed – but doesn't contribute to light output. This number is important when designing and planning for an outdoor lighting system. When VA is calculated, the LED lamp typically draws more energy than listed on the lamp. It's important to size the transformer correctly, so VA values are used to do so. Most manufacturers have a VA chart on their website to help the designer measure the voltage drop and size the transformer correctly. If you do not know the VA and want to be safe, you can use a PF of .7 in the formula of W/PF = VA.

Watt (W): Unit of electrical consumption. See Volt- Ampere. Don't confuse wattage with light output- light is expressed in lumens or footcandles. Ex: heat lamps consume a lot of wattage but produce little light.

Wet Location Luminaire: A luminaire designed, tested and approved for installation in wet locations (such as outdoors) per UL standards. It can also be described as "enclosed and gasketed".

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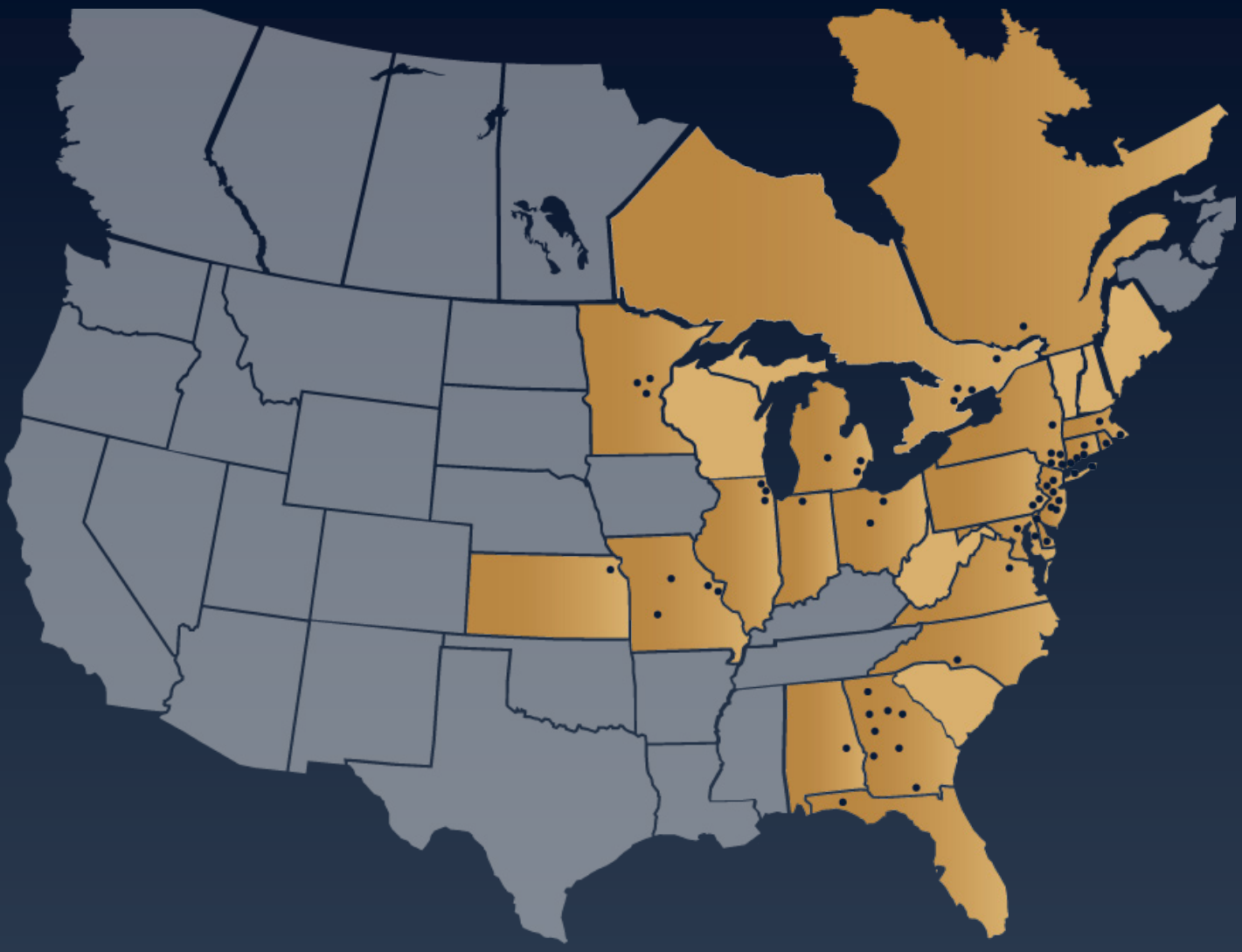

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