Amphenol LTW®
Unrivaled InterConnects for Harsh Environments

LED: Horticulture Lighting

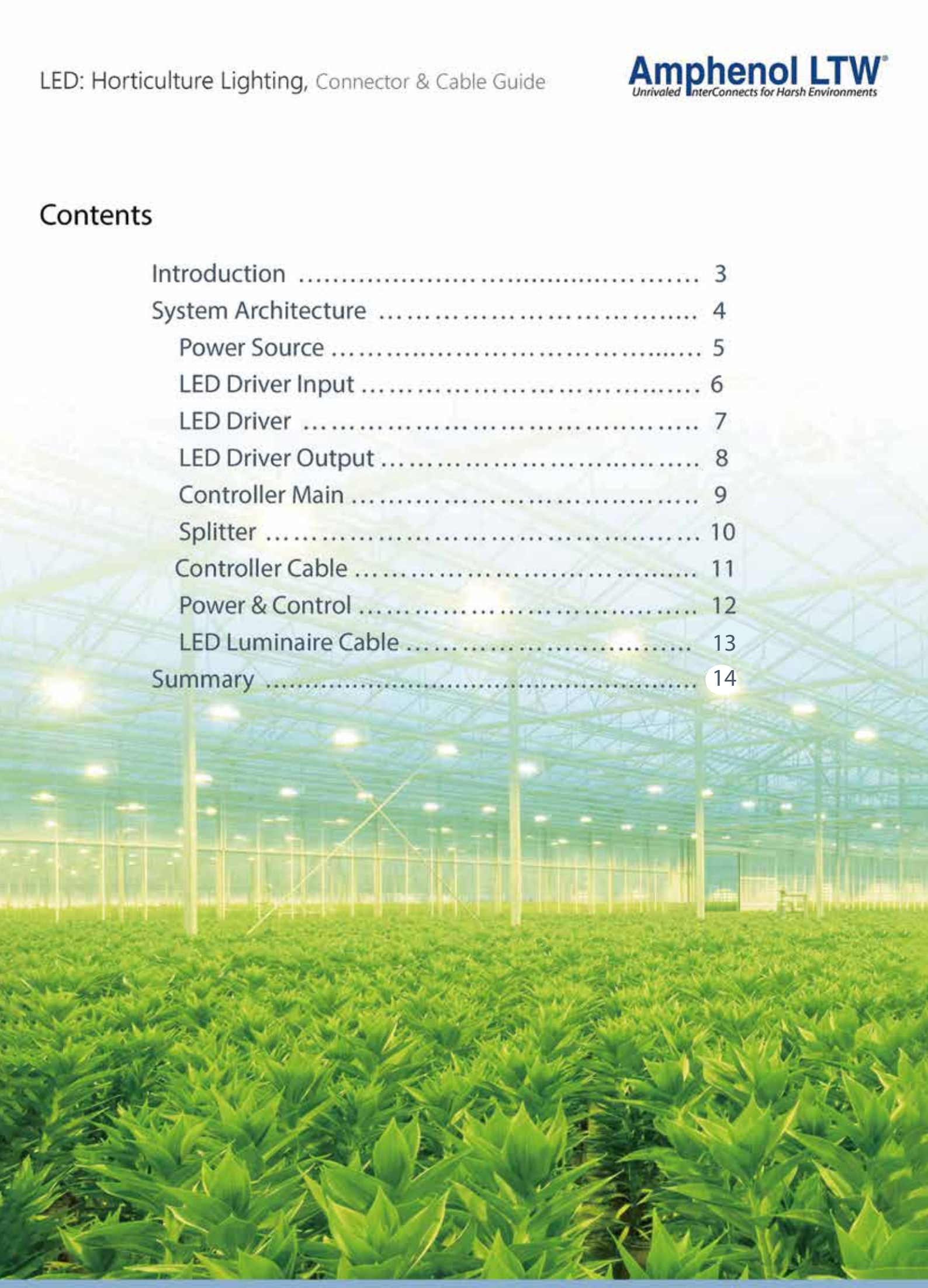
Connector & Cable Guide

Amphenol LTW
Unrivaled InterConnects for Harsh Environments

Contents

Introduction 3
System Architecture 4
- Power Source 5
- LED Driver Input 6
- LED Driver 7
- LED Driver Output 8
- Controller Main 9
- Splitter 10
- Controller Cable 11
- Power & Control 12
- LED Luminaire Cable 13

Summary 14



Introduction

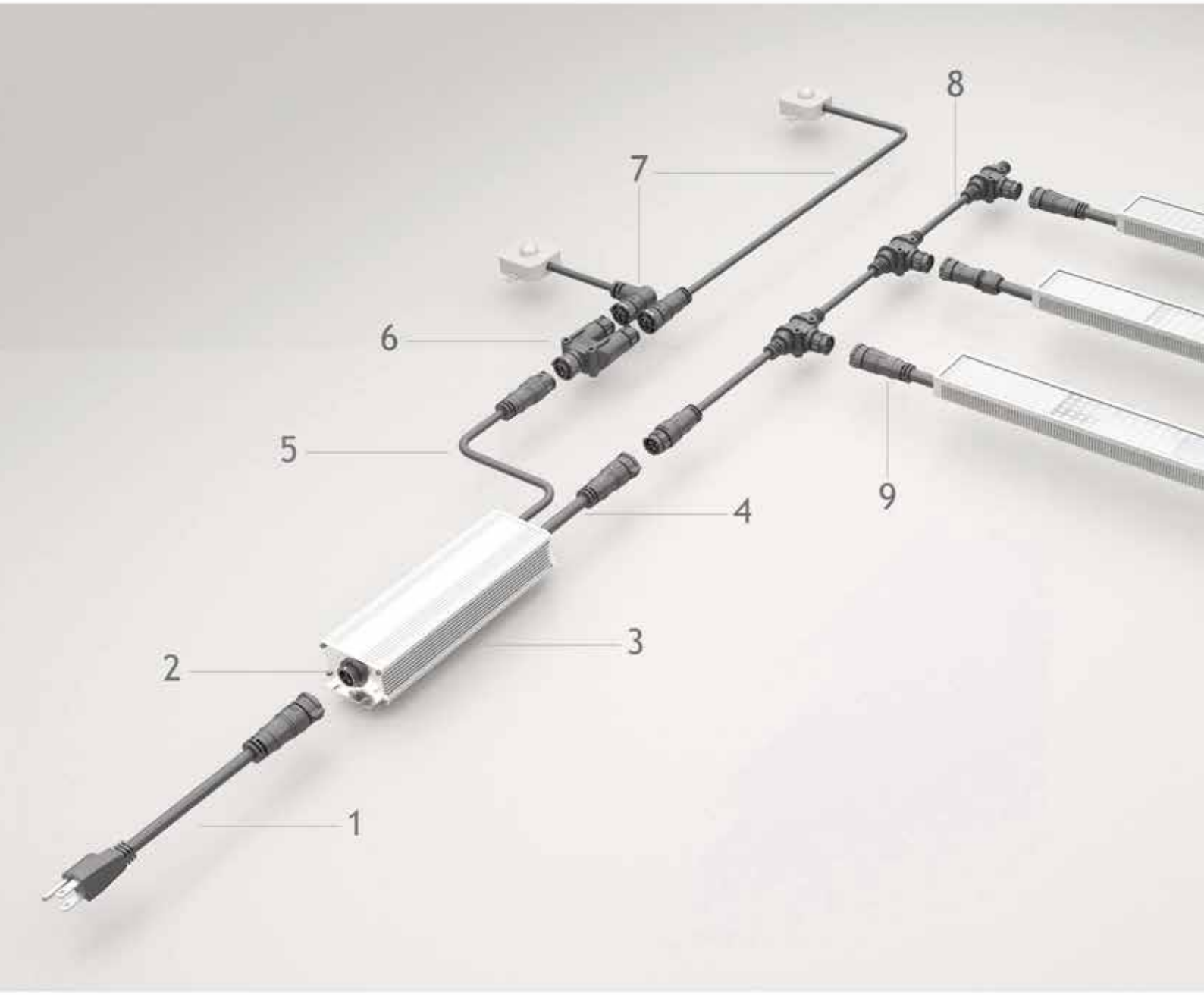
The implementation of LED technology in modern agriculture plays a significant role especially in dealing with the issue of the increasing demand for food production. This demand will rapidly increase as the world population already breach the 8 billion threshold and the obvious effect of climate change on traditional farming is quite devastating - disrupting the growth and harvest yield. Traditional farming also contributes to negative effects on the environment: increases global anthropogenic greenhouse gas (GHG) emissions due to deforestation as more rainforests are converted to farmland; more pesticides are used in cultivating the crops which will contaminate rivers and oceans, damaging the marine ecosystem; frequent land erosion due to tillage and planting more crops that has low-penetrating roots; and, biodiversity loss as more species are in the brink of extinction due to loss of habitat and ingestion of pesticides.

With LEDs, farmers can mitigate the negative effect of outdoor farming since the indoor cultivations are mainly conducted in closed environment where waste material can be treated and disposed properly. Farmers also has frredon in selecting the crops that they want to grow as they have the ability to control the light wavelength according to what a particular plant needs, within the PAR (Photo-synthetically active radiation) at the 400-700nm range, the wavelengths useful in horticulture. Growers also have the freedom to control the luminosity of the luminaire's output, essential to increase production on some plant species; can direct where the light goes, optimizing the energy use to the specific region; can place the LED lights closer to plant as it radiates less heat, resulting to denser farm; can place as many luminaires in a given area since the power consumption is less than other lighting systems, thus, will reduce energy consumption charges; and, has the ability to farm vertically since it is possible to layout lights in every layer of vertical racks deployed upwards, enabling the plant to receive the desired amount of light they need to propagate - this is not feasible in traditional outdoor farming where the upper level will obstruct the light from reaching those in the lower levels. Lastly, with the aid of LED technology, cultivating crops will no longer be necessarily done in traditional vast open farmland but could be done in busy metropolitan areas like New York; giving the opportunity to urban areas to farm and consume very fresh produce.

In spite of that, LED Lighting is not a standalone technology, farmers cannot just deploy the fixtures and deliver the light needed to grow the plants; it needs to have a full system architecture that comprises of power source, LED driver, DC distribution system, and a group of smart sensors monitoring the whole grid of plants. The interconnection of these components is made possible with the presence of reliable connectors and cabling systems; in which, ALTW pride itself on having a set of products that dominates this market segment and has been in the industry for more than a decade understanding the growers' needs and concerns.

In the following pages, we are going to walk through the components of LED for horticulture lighting, what are their roles, and what ALTW products can be used – specifications, construction, special features, and upgrade possibilities.

System Architecture



1 - Power Source
2 - LED Driver Input
3 - LED Driver
4 - LED Driver Output
5- Dimmer
6 - Splitter
7 - Controller Cable
8 - Power and Communication Cable
9 - LED Fixture Cable

1 – Power Source

The main function of this component is to draw power from its source – in most cases, the source is from the AC mains, this is the power line that is commonly routed in tall buildings, business centers, residential areas, and of course in indoor horticulture facilities; however, depending on the type of LED driver, this can also from a pure DC source. Since it is typically connected to regional power outlets or sockets, the plug used is either a NEMA connector (for North America) or IEC/ European connector (for European Region); the number of poles is either 2 (no protective earth, PE) or 3 (with PE). The input side of this cable can come as just bare conductors which will be directly hardwired to the power source; however, this method is not recommended unless there are professionals at the site supervising the installation; the best choice is with a connector for faster connection and disconnection to the source.

On the other end of this jumper (cable set) is a female socket. For safety reasons, it is highly recommended that this side (which acts as power output and is instantaneously energized when the plug is connected) have female contacts to prevent someone from accidentally touching the live parts. The housings of female contacts are usually constructed with IP 20 (touch-proof) rating to ensure their safety by not touching the contacts with common tools such as screwdrivers and human fingers.

In a controlled indoor horticulture environment, the type of cable used must withstand the hazards present on the farms such as oil, water spray and spill, and chemicals. Cables such as SOOW, SJTW, and H07RN-F types are commonly used. It should be noted that European and North American safety regulation has some differences in requirements; cables that are allowed in the US may not be allowed in Europe. In some instances, cable manufacturers design a special type of cable that has certification in both regions, thus, one cable can be used in either territory.A

LTW Recommnded Products:

X-lok Series
- Voltage: 300V, 600V
- Current:10A, 20A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0

Mating Cycles: 1000
- Blind-mating, foolproof, touch-proof
- First-Make, last-break options

- Plug: NEMA or IEC connector
- Socket: X-lok A-size, C-Size or D-Size
- Cable: SJTW, H07RN-F (customizable)
- UL 2238, EN61984 (Pending)

Jumper-Adapter and Pigtail
- Socket: X-lok A-size, C-Size or D-Size
- Cable: SJTW, H07RN-F (recommended, sold separately)
- UL 1977, EN61984 (Pending)

2 – LED Driver Input

LED drivers are always packaged in a way that there is a dedicated gateway for powering them. Depending on the size of the driver – increases as power capacity increases and when there are added features in it – its power input gateway could be a connector (receptacle), molded to a cable connector, or bare cable with stripped ends and pre-tinned conductors which will be hardwired to source or terminated with field installable connector on the field; the selection between these options is at the discretion of the LED designer/manufacturer, the advantage between the two is modularity and freedom to select any connector that the end user preferred, respectively.

The number of poles or conductors for the input is 2 or 3, the same as the power source where it will be linked. However, in smart LED drivers that have the ability to link and communicate with other LED drivers in the network, there will be an extra 2 or 3 poles for communication lines; in most cases, these are stand-alone ports since not all end-users will opt for to expand or link their system or one driver per area is enough to cover all the LED fixtures deployed. If the system design is certain that the driver will be linked or needs to communicate with other drivers, then, a hybrid connector will be used and will be built-in at the time the driver is manufactured. Hybrid connectors are made of cores with multiple groups of contacts – one for power and the other for communication or data transfer.

LTW Recommnded Products:

X-lok Series

- Voltage: 300V, 600V
- Current:10A, 20A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- Blind-mating, foolproof, touch-proof
- First-Make, last-break options
- Size: X-lok A-size, C-Size or D-Size
- Cable: SJTW, H07RN-F (customizable)
- UL 2238, EN61984 (Pending)

Field Installable

Molded with Cable

Panel (Receptacle)

3 – LED Driver

Though ALTW does not directly produce LED Drivers, it is capable of building a complete solution of master control with LED driver in it that has the functionality of controlling LED fixtures individually or as a group. Before we dig deeper into that, we need to have a quick overview of the basic functionality of the LED driver in order to fully understand its role in LED Lighting for Horticulture's ecosystem or system architecture. As its name implies, the fundamental role of the LED driver is to drive the LED, that is. This is done by constantly bombarding the circuit with the desirable amount of current or voltage that the LED needs at a given time; its output could be constant-current or constant-voltage - there's a significant difference between these two and either one should be carefully selected depending on what the LED fixtures need. The value that it will supply should always be within the LED's breakdown requirements and maximum amplitude it can carry, else, it will not turn on or will damage the LED, respectively. Before feeding the LED with the power it needs, the driver will first convert the power from its input into clean and smooth electricity by filtering it with its internal circuitry. It then feeds the LEDs with the amount of power they need at a given time.

In using ALTW's master control, a component of its LMS (lighting management system), it is possible to control the lights individually within a group of ten luminaires connected to it by utilizing the DALI protocol where each LED luminaire has its own unique address embedded to their controller; pressing a particular button on the switch panel will send a command to the master control. The signal transmitted from the button carries information about of the luminaire it wants to control, it contains the address and the value of light intensity. The master control then feeds the luminaire with the amount of power required in reference to the information it received - for simplicity, values typically in step, not continuous, within from 0 to 10 where 10 is the maximum power output.

Just a quick info: in general, a lighting communication protocol is a predefined set of rules that corresponds to a certain pattern of electrical pulses, its duration, and min/max value. Each pattern of pulses has a different return value; it could be an address, intensity, or color. Once a receiver and transmitter have been programmed to interpret these rules, it can respond accordingly to whatever instruction is transmitted on the cable. During this event, all of the luminaires will be able to receive the signal transmitted but only the one with the address that has been called out will respond. DALI and DMX are just a few of the protocols used in lighting.

The number of LED luminaires that will be connected to LED drivers should correspond to its maximum power output. This can be found on the datasheet and usually printed on top of the LED driver's enclosure together with input power requirements and other relevant information and certification. As part of good practice, the total power consumption of LEDs should be less than the maximum power of the LED driver.

With the advent of smart devices, LED drivers are becoming more advanced and they can now be controlled online through mobile apps and PCs. It can also provide real-time feedback on its status and health.

4- LED Driver Output

The output of the LED Driver is where the power distribution to luminaires takes place. In the horticulture lighting system, the current rating at this port is mostly higher than the input side, and should be noted that it is DC versus AC or DC at the input side, depending on driver design - the main function of the LED driver is the conversion and regulating the current or voltage at the desirable level through its internal circuity. LEDs are mainly driven by DC current, though are few LED designs that can be driven by AC, thus, the electrical current must be converted as the LED required. The output, depending on the LED driver's design and model, can deliver constant voltage(CV) or constant current(CC), or both. The selection between CV and CC depends on the LED fixture design - what variables it can tolerate - and should be carefully assessed by the lighting designer together with the total power load that the whole system required in order to determine if the driver and the inter-connects (connectors and cable) is capable of delivering the requirements. Do note that CV and CC are NOT interchangeable, load requirements, LED type, and capacity should be known.

There are LED drivers that can deliver variable outputs of both electrical current and voltage. This is useful in an installation that undergoes frequent changes to its load; those setups that have the tendency to change the number of luminaires or power rating per luminaire. The adjustment range of voltage and current is constrained to a specific value - either the voltage is higher than the current or vice versa. It should be noted that the output of these variables will not exceed the maximum output power rating of the LED driver.

Just as at the input side, it can be connected to the external circuit by a cable dangling on the side of the driver - sealed through a grommet or strain relief at the enclosure's wall; or a connector that has the same or greater than the values of the electrical current and voltage of LED driver output. The selection between the two is also at the discretion of the end customer or system designer, the main pros and cons are the easy connector replacement and increase installation cost, and low installation cost (plug-and-play) and inability to replace, respectively. In most cases, the latter is preferred since there is no frequent removal of the system once deployed on-site.

LTW Recommnded Products:

X-lok Series
- Poles: 2 - 5
- Voltage: 300V, 600V
- Current:10A, 20A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- Blind-mating, foolproof, touch-proof
- First-Make, last-break options

Panel (Receptacle)
- Socket: C-Size or D-Size
- UL 1977, UL 2238, EN61984 (Pending)

Jumper-Adapter and Pigtail
- Socket: C-Size or D-Size
- Cable: SJTW, H07RN-F (recommended, sold separately)
- UL 1977, EN61984 (Pending)

5 - Dimmer

Though its name implies as to reduce the intensity, the dimmer's function is not just going to the dark side but it is primarily used to control the illumination intensity of the LED in both directions. This means that you can decrease or increase the brightness intensity of the fixtures by pressing the low and high buttons or rotating the knob clockwise or counter-clockwise of the controller connected to it, depending on what is used. LED drivers specify on their datasheet what are the types of input signals in controlling the dimmer and what are the equivalent output relative to that; it could be from a discrete 0 - 10V, PWM (pulse-width modulation), or resistance variation.

The dimmer's connectivity to its controller can also be done through a cable dangling on the LED driver and sealed by a grommet or strain relief at the enclosure area or through a connector, the selection between these two depends on the LED designer. The advantages and disadvantages of these options are also the same as what has been mentioned in the preceding sections.

Though the function of a dimmer is quite simple, it should be taken into consideration that some drivers have no capability of suppressing electrical noise generated by their internal circuits. When this occurs, the connector used should not propagate the noise externally since this will be a violation of the regulation on EMC; the noise should be contained or suppressed by the cable or internal circuit, respectively. Thus, a shielded connector and cable should be selected in this case.

LTW Recommnded Products:

X-lok Series, A-Size (Shielded and Unshielded)

- Poles: 2 - 5
- Voltage: 300V
- Current: 5A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- UL 1977, EN61984 (Pending)
- Blind-mating, foolproof, touch-proof

Field Installable

Panel (Receptacle)

M12 Series, Shielded and Unshielded

- Poles: 2 - 5
- Voltage: 250V
- Current: 5A,
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- UL 1977

Field Installable

Panel (Receptacle)

6 - Splitter (Optional)

This component is used for branching out the cable to an interconnection system that has multiple inputs or outputs like the dimmer which can be controlled by multiple controllers. The setup of using multiple controllers is just optional and depends on the purpose at the installation site. Some designers prefer to use this setup in order to have multiple access points on controllers or controlling methods - through conventional push-button, rotary switch, or a remotely controlled smart device that has access to the internet or Bluetooth. In a horticulture lighting system that covers a vast floor area, it is a good design practice to have multiple access to the dimmer.

Depending on its purpose, the electrical rating of the splitter should be the same as the trunk cable that it is supporting. For safety, in applications that carry an electrical signal that is greater than extra-low voltage, the output junctions should be made of female contacts to prevent accidental contact with metal objects and human fingers.

LTW Recommnded Products:

X-lok Series
- Poles: 2 - 5
- Voltage: 300V
- Current: 5A
- IP 68 (1m, 24h)
- Mating Cycles: 1000
- Flammability: UL94V - 0
- UL 1977, EN61984 (Pending)
- Blind-mating, foolproof, touch-proof

•Y-Adapter, T-Adapter and T-Cable
Socket: C-Size or D-Size
- Cable: SJTW, H07RN-F (customizable)
- UL 2238, EN61984 (Pending)

Intelligent Pre-Cabling System (IPCS)
- Input: C-Size or D-Size
- Output: A-Size, B-Size, C-Size or D-Size
- Cable: SJTW, H07RN-F
- UL 2238., EN61984 (Pending)

7 - Controller Cable

To link the controller to the dimmer port it needs to utilize a cable as a pathway for transmitting its information - the role of the controller cable. In typical applications, the end of this cable that is located at the controller is usually directly hardwired, which means that there is no connector needed, and the conductors are directly terminated. However, in the case of an indoor horticulture environment, the controller could be exposed to liquid mist and splashes. Thus, it is recommended to terminate the controller with a connector to protect its internal components.

Since the other end will be connected to the Splitter (if utilized) or Dimmer, the connector used should also match to the connector used in those connection points. Some designers utilize connector coding or style variation to prevent erroneous mating; this scheme could accelerate the installation process at the site since there is visual and mechanical guidance for the installers. The connector's gender does not matter, it can be male or female, for the reason that it is carrying an extra-low voltage signal that is safe to touch.

There is one important consideration though, the voltage drop. This is the amount of voltage that is lost as the signal propagates through the cable - the longer the length, the greater the loss. System and lighting designers are able to mitigate this issue by calculating the possible losses in the system. Since all the information is available in the cable datasheet, the voltage drop on the cable can be predicted and can be lowered by implementing several design methods, one of which is utilizing conductor gauges bigger than the current capacity - the bigger the gauge the lower its DC resistance. This principle works in all cable systems at the DC side of the driver - the output (power distribution) and dimmer side.

LTW Recommnded Products:

X-lok Series, Shielded and Unshielded

- Poles: 2 - 5
- Voltage: 300V
- Current: 5A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- UL 1977, EN61984 (Pending)
- Blind-mating, foolproof, touch-proof

Field Installable Molded with Cable

M12 Series, Shielded and Unshielded

- Poles: 2 - 5
- Voltage: 250V
- Current: 5A,
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- UL 1977

Field Installable Molded with Cable

8 - Power and Communication Cable

In order to distribute the power from the driver's output to the LED fixtures, it needs to pass through to a distribution channel - the Power and Communication Cables - that has the capacity to carry the electrical current and voltage while minimizing the loss as much as possible. This cable has a primary and secondary unit: the primary unit is the power carrier which is the trunk, also called the backbone or the feeder which has a high current capacity - utilizing bigger conductor gauges; and, the secondary unit which is made of drop cables or receptacles linked to the trunk with smaller conductor gauges. The secondary unit is where the output connectors are located.

The implementation of this cable should be carefully considered. The power conductors should be able to handle the power requirements of the LED fixtures connected to them. A simple check can be done by summing up the power requirements of each fixture; it should always be less than the maximum capacity of this cable since there are internal losses that will happen as the system is energized like the voltage drop. These internal losses should not be neglected, failure to do so can malfunction the LED fixture as the supplied power is inadequate leading to catastrophic failures and financial losses.

The communication pair, if utilized, always comes in smaller gauges than the one for power; its function is just to relay the low-power signals use to communicate with LED fixtures. Depending on the protocol used, there might be characteristic impedance requirements for the pair - always in pair and may have shielding if required. This impedance is in the range of 75 to 120 ohms; this should match the system requirements since it could lead to reflection losses.

In horticulture lighting systems, there are several types of cable that can be used. But in order to provide an inexpensive option and faster development, the ones that should be chosen are those widely available in the market, easy to manufacture and have shorter lead times. SJTW, SOOW, H07RN-F, and UL21666 are some of the choices. There is a certain type of cable that carries both power and signal, it is called hybrid cable. Hybrid cables are used when both power and signal are present, it is a cost-effective and space-saving solution than utilizing separate cables.

LTW Recommended Products:

X-lok Series
- Poles: 2 - 5
- Voltage: 300V
- Current: 5A
- IP 68 (1m, 24h)
- Mating Cycles: 1000
- Flammability: UL94V - 0
- UL 1977, EN61984 (Pending)
- Blind-mating, foolproof, touch-proof

Modular Distribution System
- Size: C-Size or D-Size
- Cable: SJTW, H07RN-F (customizable)
- UL 2238, EN61984 (Pending)

Intelligent Pre-Cabling System (IPCS)
- Size: C-Size or D-Size
- Output: A-Size, B-Size, C-Size or D-Size
- Cable: SJTW, H07RN-F
- UL 2238., EN61984 (Pending)

9 - LED Fixture Cable

This is the last component of the Horticulture lighting system; its primary role is to feed the LED fixture with the power it needs for illumination. There are several termination schemes on the end at the fixture side, it can be terminated with a connector or just hard wire directly to the fixture. The selection of this cable set should also be carefully considered, its capacity should always be greater than what the LED fixture needs. Again, this is to consider the voltage drop and other possible internal losses, it is better to have extra than to be short!

Just as the other cable sets in the system, the type of cable should also be cost-effective and could help faster development of the product. If a communication channel is present, the connector can be hybrid or two separate connectors carrying power and signal. Since high power might be used, it is a good practice to utilize a plug on this side or connectors with male pins which will be mated to the socket (with female contacts) at the power and signal distribution cable.

LTW Recommnded Products:

X-lok Series, Shielded and Unshielded

- Poles: 2 - 5
- Voltage: 300V
- Current: 5A
- IP 68 (1m, 24h)
- Flammability: UL94V - 0
- Mating Cycles: 1000
- UL 1977, EN61984 (Pending)
- Blind-mating, foolproof, touch-proof

Field Installable

Molded with Cable

Panel (Receptacle)

Summary

The advancement of LED technologies had taken a huge leap since its debut in the 1960s. From a simple remote control bulb and low-intensity electronic indicator, it is now being used in almost all equipment that we use in our everyday life - in our home, office, automotive, airplanes, factories, portable equipment, wearables, and the most important breakthrough of helping us to have a sustainable source of produce to the increasing demand of food production. It may not be a huge surprise that we will be witnessing more innovation in LEDs in the near future. However, no matter what changes may come, the fundamental components required for illuminating the LED will always be the same - it will require a power source, driver and interconnects to link all these basic components. Thus, it is important to know the basic principles and to understand its system architecture; we just upgrade our knowledge once the latest innovation comes!

To optimize the efficiency of the devices in the field, the selection of connectors to interconnect the components must be carefully selected; it could be very beneficial if the right ones are selected or detrimental if wrongly chosen. It is highly recommended to use ALTW's X-lok connector system. The quick installation feature, pre-tested cable assemblies to verify that it meets the specification, and components built with the appropriate materials for the horticulture environment enable this product to truly dominates this particular application. The group of products presented here is a specifically engineered version of X-lok series for this market segment. It has a lot of success stories and testimonials, and it has a renowned cost-saving benefit to growers who utilize this product as it minimizes the downtime and serviceability that lasted for years. The table on the right summarizes the benefits of X-lok.

	Traditional	X-lok
Safety against electric shock		✓
Reliability, eliminates installation error		✓
Physical & Mechanical strength		✓
Pre-tested (Mech., Elec. & Env.)		✓
Reduce Installation time		✓
Material Cost Saving	✓	
Minimize training costs for installers		✓
Labor cost saving: less time & manpower		✓
Offset costs of shortage and unstable labor pool		✓
Ease and speed for maintenance and repair including cost reduction		✓
Reduce the need for highly qualified and certified electricians		✓
UL Certified		✓

The table above shows the main benefits of using X-lok connectors. Though the upfront investment is high as indicated in the Material Cost, this will only be a fraction if the Labor Cost on site will be taken in to account.

The X-lok Connector Series. The solution options of this series are not only limited to what has been shown in the image above or the one presented in the product catalog. It is fully customizable depending on the end application and per the request of the end user.

For more information about ALTW products, you may contact sales@ltw-tech.com or visit our website at www.amphenolltw.com. You can also get the latest update by subscribing to us on LinkedIn, Youtube and Facebook, just search Amphenol LTW.

New Amphenolltw.com E-Commerce Website

Your benefits

- ✓ Worldwide access 24/7
- ✓ Product configurator
- ✓ Real time order tracking
- ✓ Online assistance (live chat)
- ✓ Instant drawing release
- ✓ Instant quotation
- ✓ Order online
- ✓ Catalogue
- ✓ Search by vendor
- ✓ Search by drawing / picture

Amphenol LTW

Contact Us

Luc Kan | Sales & Marketing
Email: luc@ltw-tech.com

Customer Service
Email: sales@ltw-tech.com

Follow Us

Amphenol LTW

Unrivaled InterConnects for Harsh Environments