



# ELECTRICS DEPARTMENT

Electricians are responsible for all of the lighting in live production. They are also be also responsible for providing electrical service to all other departments such as audio and rigging.

While similar to any other electrician, the transitory nature of live production means that we utilize unique connectors and standards to safely provide electrical service.

Lighting technology is constantly evolving with new interments and methodology but below you will find the basic fundamentals of a modern lighting package.

## MEASURING AND DEFINING ELECTRICITY

Electricity is the flow of electrons from one place to another. Electrons can flow through any material, but does so more easily in some than in others. How easily it flows is called resistance. The resistance of a material is measured in Ohms.

Matter can be broken down into:

- **Conductors:** electrons flow easily. Low resistance.
- **Semi-conductors:** electron can be made to flow under certain circumstances. Variable resistance according to formulation and circuit conditions.
- **Insulator:** electrons flow with great difficulty. High resistance.

Since electrons are very small, as a practical matter they are usually measured in very large numbers. A Coulomb is  $6.24 \times 10^{18}$  electrons. However, electricians are mostly interested in electrons in motion. The flow of electrons is called current, and is measured in AMPS. **One amp is equal to a flow of one coulomb per second** through a wire.

Making electrons flow through a resistance requires an attractive force to pull them. This force, called Electro-Motive Force or EMF, is measured in **volts**. A Volt is the force required to push 1 Amp through 1 Ohm of resistance.

As electrons flow through a resistance, it performs a certain amount of work. It may be in the form of heat or a magnetic field or motion, but it does something. This work is called Power, and is measured in Watts. One Watt is equal to the work performed by 1 Amp pushed by 1 Volt through a resistance.

**AMPS** is amount of electricity.

**VOLTS** is the Push, not the amount.

**OHMS** slows the flow.

**WATTS** is how much gets done.

**[MORE INFO](#)**

## POWER CONNECTIONS



### **EDISON**

“normal” extension cord. Generally, non-grounded is not suitable for our use. Depending on wire gauge and jacket, suitable for up to 15-amp service.



### **PowerCON**

a lockable equipment AC connector. It's used industrywide for power delivery for lighting, video and in some cases audio applications.



### **SOCAPEX**

Heavy gauge power delivery system. Used for carrying multiple circuits of power, often broken out to individual lighting instruments. Variants are also used to power chain motors.



### **TRUE 1**

a lockable equipment AC connector. Advanced variant of PowerCON. provides breaking capacity and can be connected/ disconnected under live load. Not compatible with PowerCON. Used for lighting, video and audio applications



### **STAGE PIN**

Used for connecting conventional lighting instruments to dimmers. almost exclusively used in Theatre settings.



### **PIN SLEEVE (CEPro)**

International standard for industrial power delivery becoming increasingly common in North America. Depending on type, carries up to 8 conductors and 125-amp loads. Smaller ones are used for some moving lights or machinery (sometimes called CEPro), and larger versions used for high amperage power distribution similar to Feeder/Camlock



### **FEEDER/CAMLOCK**

Used for high amperage power distribution like providing generator power to an entire production.

**\*DANGER\*** MUST BE CONNECTED IN THE CORRECT ORDER **GREEN WHITE BLUE RED BLACK**

and disconnected in the opposite order

**BLACK RED BLUE WHITE GREEN**

Never connect or disconnect feeder without training and/or direct instructions from a crew lead.

# DATA CONNECTIONS-1

	<p><b><u>DMX</u></b> Common Data Standard for advanced lighting fixtures such as LED and Movers. 5 pin or DMX 512 is the current standard but 4 pin and 3 pin is also used for legacy and automation applications.</p> <p><a href="#"><u>MORE INFO!</u></a></p>
	<p><b><u>EtherCON</u></b> standard ethernet connection housed in an XLR style barrel connector. CAT6 and CAT5 are the current standards. Used in local network applications as well as video and automation.</p>
	<p><b><u>COAXIAL/BNC</u></b> 2 conductors. Depending on wire type, used for anything from wireless antennas to HD video transmission. Different ratings of BNC are not interchangeable for all tasks, always check with your lead before using.</p>
	<p><b><u>FIBER OPTIC</u></b> Used for high-speed data signals like sound, video, or networking. There are many more types of fiber optic cable and connector than pictured. If you suspect you are handling a fiber optic cable, proceed with great care because <b>the glass core of the cable is extremely fragile</b> and can easily break if crushed or bent.</p>

# BASIC LIGHTING INSTRUMENTS



## **ELLIPSOIDAL/LEKO/SOURCE4**

An Ellipsoidal is a lighting instrument that uses an ellipsoidal reflector behind the lamp. These lighting instruments can be finely focused and adjusted, and usually include shutters or slots to insert patterns to shape and texture the light beam. These will often be called for by the beam angle produced by the interchangeable lens barrels: i.e., “bring me three 19 degrees” or “let’s swap this out for a 6x9.” PRIMARILY USED IN THEATRE

## **BASIC FUNCTIONS**



## **MOVER**

A moving light, moving head, or just mover is any fixture that has onboard motors to aim and modify the light coming out of the fixture. Early versions simply moved a mirror while the light source stayed still, but now most moving lights look similar to the one pictured. Some use LED light sources, but many still use Short-Arc lamps for extremely bright effects. These fixtures require multiple parameters of control from the lightboard, and so are deemed “intelligent” instruments.

There are many formats of lighting instrument that are sold on different moving heads: Beams, wash beams, washes, profile, pin spots, and other specialized designs. Some moving heads are essentially video projectors designed to move.



### **STROBE/FLOOD**

A flood or strobe is any fixture that outputs light in an unfocused, wide pattern. The flood lighting instrument pictured here is often referred to as a mole or “audience blinder” since it is usually pointed directly towards the audience.



### **STRIP/GROUNDROW**

Usually, a strip of lights pointing a wash of light up at performers or scenic elements. Can also be mounted to truss for effect. These units can either be moving or static although moving units are becoming the standard outside of theatre applications.



### **CYC LIGHT**

A Cyc light is a fixture designed to cast a smooth wash of light on a tall surface from a short distance, most often to light a cyc. They can be multicell devices, where each cell can hold a different gel color like the incandescent one pictured, but LED Cyc Lights also common.



### **PAR/PAR-CAN**

The “PAR” in par-can stands for parabolic aluminized reflector, the type of reflector these fixtures use. These types of instruments can either have a lamp with different textures/patterns on the lens to create different beam angles or an interchangeable lens with a separate lamp.

PARs can also come in a variety of sizes. The top photo is a PAR56, and the lower is a Source 4 PAR.

These days, lots of basic LED wash and beam fixtures are called LED par cans even though they use completely different technology, but in many cases, they serve the same purpose.



## **FOLLOW SPOT/ SPOT**

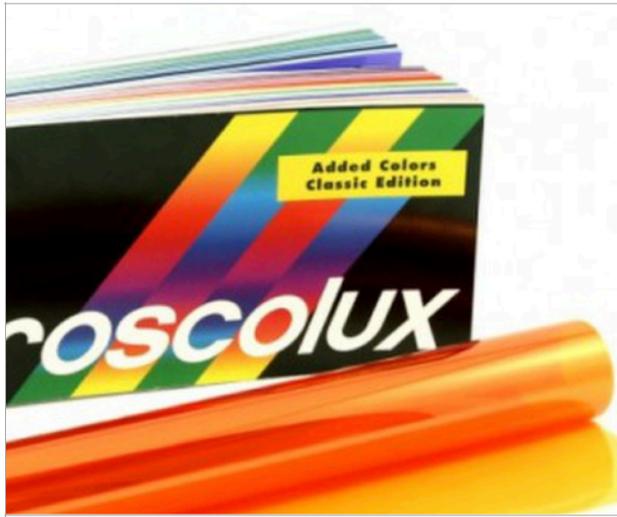
A Follow Spot is a manually operated moving light typically used to highlight a featured actor, often in musicals or other presentational productions. With traditional follow spots, the operator has control over the iris (size of the circle), color (through use of drop in gels) in addition to pan and tilt.

Intensity and edge are attributes that are less controllable by the operator. Most follow spots appropriate for use in large theatres use arc-source lamps which are non-dimmable. The lamp is always lit, and the operator opens a dowser in order for the light to be presented on stage. The edge can be softened by an adjustment of the lenses, but this is not typically something that is easily done during the run of the show- it is a preset that is the same throughout the production. The designer does have the option to use one of the slots in the gel color boomerang to include frost, which allows you to either have a sharp edge (without frost) or soft edge (with frost engaged).

generally spot ops are pulled from the rigging crew in our local. with the exception of Broadway runs.

## **SPOT LIGHT BASICS**

## LIGHTING ACCESSORIES AND GEAR



### **GEL/COLOR**

To change the color of a beam of light, most lighting instruments have a slot in front of the lens to insert a gel frame, which holds a sheet of tinted plastic that only allows the chosen color to pass through.

If you are tasked with cutting gel to size, always confirm what size is needed and never forget to mark the corner of each piece you cut with the manufacturer's abbreviation and color code. Pictured is R316 , AKA Rosco Gallo Gold



### **C-CLAMP**

This kind of C-Clamp is used to attach lighting instruments to steel pipe. Use the small square bolt (Pan Bolt) to rotate the fixture, not the large hex bolt. Do not overtighten these clamps—if tightening the bolt more is drilling a hole in the pipe beneath the clamp bolt, you have gone too far. Never use this kind of clamp on stage truss without a protective shield.

Note—a lighting C-Clamp is different than a C-clamp used in stage carpentry.



### **TRUSS CLAMP**

For mounting lighting instruments to stage truss without damaging a truss chord, use these truss clamps. Again—no need to overtighten. As long as the wingnut is in no danger of vibrating loose, you shouldn't need to use a wrench to tighten this.

There are a variety of different manufacturers' versions of this clamp that all hang and tighten differently. This is just one example.



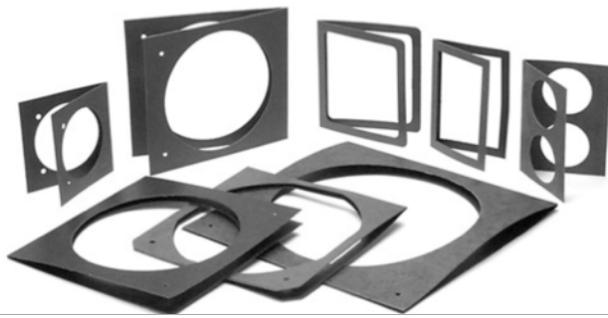
## **LIGHTING CONSOLE/DESK**

To control dimmers and multi-parameter intelligent light fixtures. Common brands include ETC and MA.

While incredible complex, Both companies have resources available if you want to learn to program.

**GRAND MA TUTORIAL**

**ETC EOS TUTORIAL**



## **GEL FRAME**

Gel frames are used to hold gel/color. different types of conventional instruments take different sized frames.



## **GOBO HOLDER/GOBO**

Metal disk with pattern laser cut out, when placed in a leko using a gobo holder in projects the pattern with the light.

finer patterns can be achieved with laser etched glass.



## **GOBO HOLDER**

Metal frame that holds a gobo for use in a leko. A gobo will appear in the reverse orientation from the direction it's loaded.

## **TYLER /CONTAINER/PRE RIG TRUSS**

Modern lighting packages will almost always utilize some variation of pre rigged truss. If you are an electrician this will be your bread and butter. By using modular pre rigged electrics with moving lights touring productions can rapidly assemble complex light-plots. One of the advantages is it removes the locals need to position, cable and hang instruments independently. While manufacturers vary in the specifics they operate on the same principles. Below you will find resources to help you learn the fundamentals. Connections between truss are generally color coded/numbered or both.



### **TRUSS ELECTRIC TIMELAPSE**

### **TRUSS ASSEMBLY/STACKING ANIMATION**

#### **NOTES**

**NEVER CUT OR DISCONNECT TAPE / ZIPTIED OR OTHERWISE ATTACHED CABLE FROM A TRUSS. WAIT FOR CLEAR AND EXPLICIT INSTRUCTIONS FROM A LEAD.**

**ONLY MAKE CONNECTIONS WHEN TOLD TO TO DO SO.**

**IF A TRUSS HAS RIGGING HARDWARE PRE-INSTALLED DON'T TOUCH IT UNLESS EXPLICITLY DIRECTED TO BY YOUR LEAD OR A MEMBER OF THE RIGGING DEPARTMENT.**

# AUDIO DEPARTMENT

The Audio/Sound department is responsible for the delivery and amplification of sound as signal for the production. The Source could be anything from prerecorded videos, live music, spoken dialogue etc etc. The Audio department uses a wide array of constantly evolving technology to this end. below you will find common equipment and terminology as well as resources to describe the underlying science of Audio production.

## MEASURING AND DEFINING SOUND

Sound itself is the movement of a medium like air as acoustic energy passes through it. Sound travels as pressure waves which cause air molecules to vibrate. This in turn is detected by the eardrums. The number of vibrations per second are referred to as Hertz. The human ear is capable of detecting from about 25 Hz to 25,000 Hz. The higher the frequency, the higher the perceived pitch. The low end is called Bass and the high end Treble.

Sound is measured in Bells, which are further divided into 10 deciBels, or 10 dB. A Bell is actually a ratio of one level to another. It takes an increase of about 3 dB to make a noticeable change in volume, and an increase of 10 dB to make sound TWICE as loud as the previous level. But, since the ear has a logarithmic response, decibels are also logarithmic. An increase of 10 dB represents 10 times the actual power, and 20 dB, twice as loud as 10 dB, would be 100 times the power of 0 dB! A doubling of a small level sound takes a relatively small increase in power, but doubling a loud sound takes a HUGE increase in power.

For reference, 0 dB in Sound Pressure Level (or SPL) has been set as the softest sound most young people with undamaged ears can hear. 100 dB is about the loudness of loud classical music, and in actual power is about 10,000,000,000 times as powerful as 0 dB. Rock music runs about 110 dB and the threshold of pain about 120 dB

Sound energy is actually quite small, and hard to manipulate. It must be converted to another form of energy to be controlled easily: electricity. A device which changes one form of energy to another is called a Transducer. A Microphone is the basic transducer that changes sound to electricity. the resulting electricity is always Alternating Current, or AC

# AUDIO CONNECTIONS

	<p><b><u>XLR</u></b> Standard balanced audio cable. Used for sound sources to destinations, like microphones to a mixer. *in some cases, specially made 3-pin XLR cables are used as DMX cables</p>
	<p><b><u>SpeakON (NL2,NL4,NL8)</u></b> Twist lock connector used in audio systems for connecting loudspeakers to amplifiers. Different sizes carry either 2, 4 or 8 connectors.</p> <p>Speakon cables are intended solely for use in high current audio applications.</p>
	<p><b><u>1/4" TS/TRS CABLE</u></b> TIP SLEEVE common type of cable provides connection between speakers and amplifier sources. Comes in balanced/unbalanced variants. Available in multiple diameters and types for various applications.</p>

## AUDIO CABLE BASICS

# AUDIO EQUIPMENT



## **MICROPHONE**

Mics come in all shapes and sizes. Condenser microphones are often more sensitive, which is why they are often preferred on strings and woodwinds. Dynamic microphones are often preferred for things like loud vocals and drums. All microphones have a polar pattern in which they best detect sound, which should be considered when choosing and placing them.



## **MIC STAND**

Mic stands come in many shapes and sizes. When storing them, collapse each joint as short as they will go, retract the legs, and ask the lead if the microphone clip gets carefully unscrewed and stored with the microphone.



## **SPEAKER**

Sometimes called a speaker cabinet or cab, or fill speakers. Self-contained unit made up of a speaker (sometimes 2 or 3), its enclosure, and sometimes a built-in amplifier. Used in smaller venues, or to reach places that a line array can't.



## **ANTENNA (SHARK FIN)**

Most wireless microphone signals are received by an antenna that looks like a sideways shark fin. You may also see antennas that look like a helix or plastic dome.



### **SOUND SNAKE/BREAK OUT**

A snake is a multi-pin cable that is usually designed with a rugged stage box on one end, sometimes referred to as a breakout the other end is designed to connect to a mixer.



### **SUBWOOFER/SUBS**

Subwoofers are large speakers mounted in enclosures specifically designed to reproduce low frequency sounds either in conjunction with or to reinforce a line array. In the our context they usually live in the pit in line with the audience.



### **LINE ARRAY**

A Line array is an array of speaker designed to complement each other to consistently cover an area in sound. Most large productions use them, and they are often rigged from the ceiling or grid above a stage. While the exact process varies from brand to brand the angles of a line array can be adjusted using a series of pins and brackets.

### **EXAMPLE ASSEMBLY**



### **CLEAR-COM**

Clear-Com is an electronic intercom, widely used to enable stage management and crew communications in theatre, filmmaking, video and television production, concerts, professional sports competitions, special events and audiovisual presentations. Wired types are used for their reliability however in recent years wireless systems are available.



### **WEDGE/MONITOR**

A monitor refers to any speaker used in a production that isn't used to amplify the show to the audience. A wedge or floor monitor sits on stage in front of a performer so they can hear themselves and the rest of the musicians. A backstage monitor might be used so performers or technicians know what point the program is at. A side fill monitor fills a stage with a monitor feed for a more immersive effect for performers.



### **AMP RACK**

many shows travel with rack cases containing amplifiers. Often found underneath the stage, or in monitor world. Be aware, amplifier racks are extremely heavy.



### **MIXER/SOUND BOARD**

The mixer allows an operator or engineer to adjust all of the signals being fed into it. The majority of mixers today are digital. generally monitors are mixed separately than the master mix.

# DATA CONNECTIONS



## DMX

Common Data Standard for advanced lighting fixtures such as LED and Movers. 5 pin or DMX 512 is the current standard but 4 pin and 3 pin is also used for legacy and automation applications.

[MORE INFO!](#)



## EtherCON

standard ethernet connection housed in an XLR style barrel connector. CAT6 and CAT5 are the current standards. Used in local network applications as well as video and automation.



## COAXIAL/BNC

2 conductors. Depending on wire type, used for anything from wireless antennas to HD video transmission. Different ratings of BNC are not interchangeable for all tasks, always check with your lead before using.



## FIBER OPTIC

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# CARPENTRY DEPARTMENT

The Carpentry department is responsible for the assembly of the stage and any additional platforming and scenic elements in a production. Modern staging is highly modular and generally built out of metal and composite materials. During the show the carpentry department is in charge of moving scenery on and off stage or repositioning scenery between scenes/sets.

In theatre productions the carpentry department is also responsible for soft goods such as curtains. A subset of carpenters “fly men” are responsible for moving soft goods during a performance using a counterweight position known as the fly rail.

Whether in theatre or live production the Carpenter is the most generalized job in the local, if it needs to move or is big it's reasonable to assume the Carpentry department will have something to do with it.

## SOFT GOODS AND YOU

Soft goods are curtains used to frame the performance and come in a wide variety of types and material. Below we will explore the basic types as well the proper storage and folding techniques.

## SOFT GOODS AND YOU

**CURTAINS** a cloth that fills the stage opening. Generally opaque, usually in dark or subdued colors, made from heavy cloth. The best are made from **velour**, as this fabric is best at light absorption and has the lowest reflection.

**LEGS** narrow curtains used as masking at sides of stage to hide wings.

**TORMENTORS** furthest downstage legs, the "torms". Used to reduce the size of the proscenium opening. Often hard, with a frame and hard subsurface beneath a velour covering.

**BORDERS** short curtains used to mask the top of stage, to mask the loft.

**TEASER** furthest downstage border also used to reshape proscenium opening. The teaser is sometimes called the grand drape or the Valence.

**PORTAL** border and legs combined into a single piece with a large opening.

