Everything you wished you had known about low voltage lighting!

For many years we have been proclaiming the benefits of low voltage tungsten halogen light sources. When driven correctly they can be a stable, quiet, long lasting source of great light, with superb colour rendering and the ability to create brilliance in a manner very few sources can replicate. Low voltage tungsten halogen can be dimmed smoothly and quietly from 100% to zero and delivers atmosphere, warmth and sparkle endlessly to the lit environment.

Although many in the lighting industry saw the potential market for these light sources, in the fight to compete on price instead of quality, many inferior lamps, transformers and dimmers were used. As a consequence, some installers, with only limited experience of the unique nature of this light, achieved poor results and low lamp life.

In this guide you will find the benefits of our experience, gained over decades, perfecting the use of this light source. We hope that whether you are new to low voltage, and using this guide to create your first perfect installation, or an experienced designer or electrical engineer, refreshing your skills and passing on tips to others, this material may be helpful.

What is low voltage lighting?

Definitions:

Low voltage (LV) circuits strictly operate below 1000V so even include mains rated 230V lamps. But many contractors and designers use the term low voltage when they really mean extra low voltage (defined below) operating 12V or 24V lamps.

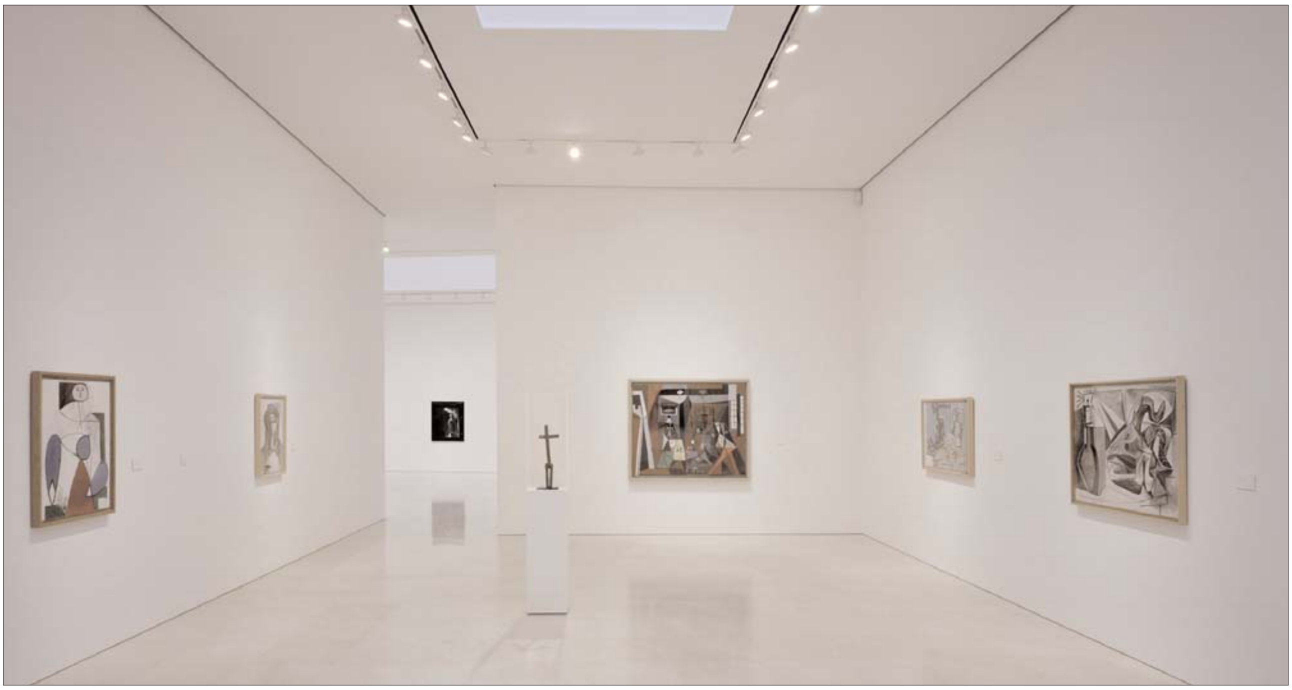
Extra low voltage (ELV) refers to circuits operating at 42V or less. So our typical 12V tungsten halogen lamps, for example, are really part of an ELV system.

Functional extra low voltage (FELV) implies one side of the supply circuit is grounded.

Separated or segregated extra low voltage (SELV), sometimes mistakenly known as safe extra low voltage, means that both legs of the circuit are 'floating', which is much the safest method as no other circuit can create an accidental connection and shock hazard.

Extra low voltage lamps have small, robust filaments allowing precise control of the optical path whereas mains filaments tend to be quite large and are easily broken by mechanical shock. For long lamp life and a wide variety of beam angles, lighting circuits operating lamps at 12V or 24V are required, together with the appropriate transformer.

Multiload are experts in creating SELV systems? Contact us for assistance



Extra low voltage lighting being used to perfection at the Museo Picasso, Malaga.
Photography by David Heald

Multiload Technology Limited 2 Rosemont Road Hampstead London NW3 6NE Telephone +44 (0)20 7794 9152 mail@multiload.co.uk

Lamps, the usual suspects

To achieve the best results choose a good quality lamp.

Start by going for a quality branded make. It is a false economy to use cheaply made lamps, as, in addition to short lamp life, those with reflectors can produce poor beam patterns and messy flare from the back of the reflector itself.

VoltMaster has been proven to give four times the lamp life recommended by lamp manufacturers at the optimum voltage

The lamp is complex and needs respect

Incandescent lamps work by the heating of the metal filament – usually tungsten. The optimal light is emitted by the filament running as hot as possible without melting. Over time, the filament evaporates, becomes weaker, and eventually breaks. A tungsten halogen lamp essentially contains in its quartz envelope a combination of halogen gases (fluorine, chlorine, bromine and iodine), which have a special property when the lamp envelope is maintained above 250°C. They provide what is termed the 'halogen cycle', collecting the evaporated components of the tungsten filament inside the working lamp and re-depositing them back on to the filament. This prolongs its life and allows the filament to be run at a higher temperature, making a more efficient and longer lasting lamp.

Of course infinite lamp life is not possible, as the gas does not put the evaporated tungsten back in exactly the right place, so that thinner weak spots eventually develop.

Attention to detail and clever use of extra low voltage lighting enabled Peter Phillipson to create modern, crisp and cheerful interiors for Brodie and Stone's London Headquarters.

There are two types of ELV tungsten halogen lamps.

Capsule lamps. These consist of a small filament within a quartz envelope. Capsule lamps are used in light fittings with integral reflectors. The effect achieved depends on the choice of light fitting (luminaire). Ceiling recessed luminaries may be shallow and allow the capsule's light to flood everywhere, or be very deep and control the light by elaborate reflector systems.

Reflector lamps. These comprise a capsule lamp together with its own reflector. They are available as:

Dichroics. Available in a variety of beam widths and wattages, taking a portion of the heat out of the light beam and sending it backwards.

Aluminised reflectors. As dichroics but the heat is sent forwards. These are a good choice for fire-safe fittings.

New developments in lamp technology. Huge investments have been made by manufacturers to optimise lamps. A major new development has been the introduction of Infra Red Coated (IRC) lamps. This allows lamps to burn hotter and use less power, eg. a 35W IRC capsule lamp gives the same output as a 50W capsule lamp from the past. This makes them ideal in these days of energy conservation.

Whatever type of lamp is being used, it is essential to make sure that they run at the right colour temperature and to ensure their life is as long as possible. As well as avoiding mechanical shock, the most important requirement is that a **stable regulated voltage must be maintained**.

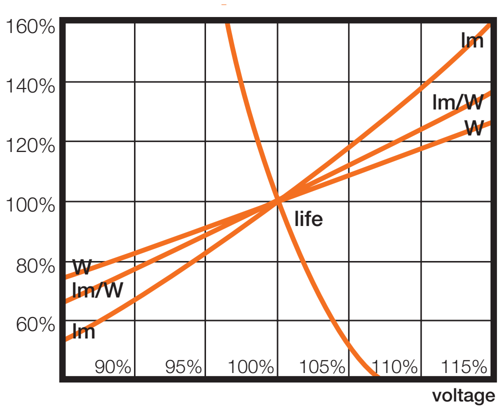
The 12V lamp, for example, is designed to work at its very best when supplied with 11.8V. Over voltage will put extreme pressures on the lamp and under running will create a less efficient and less bright light with a yellow cast.

For the creation of perfect ELV lighting installations, the circuit components that run the lamps must be optimised too.

Problems with electrical supply

Lamp life is severely decreased by over-voltage

Over-voltage has a catastrophic effect on lamp life. With lamps optimised to run at 11.8V RMS, a 5% rise above this halves lamp life; a 10% rise gives a quarter of normal life.

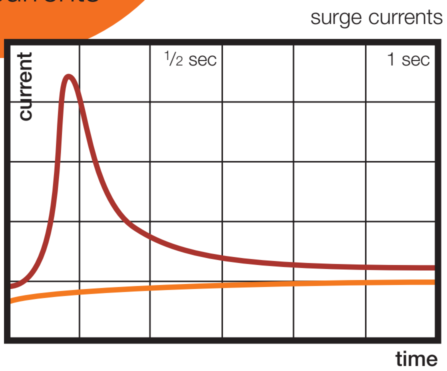


Influence of mains voltage on lamp performance

Light output is greatly compromised by under-voltage

Under-voltage reduces light output, reduces colour temperature (affecting colour rendering) and reduces efficiency, ie. lumen/watt (light for money). As can be seen from the graph, a 5% reduction in voltage reduces lumens/watt by 10%.

VoltMaster's **Soft Start** recognises a mains interruption within a few milliseconds and resets rapidly – totally eliminating high surge currents



Effect of mains voltage

Any changes in the mains supply voltage (primary voltage) to conventional transformers, ie. copper iron or high frequency electronic transformers, are transferred directly to their output (secondary ELV voltage). Therefore mains voltage fluctuations can cause both over-voltage and under-voltage to the lamps.

The mains supply voltage in Europe is a harmonised 230V; however this is allowed to vary by $^{+}$/- 10%, ie. between 207V and 253V.

The imperfect regulation of conventional transformers means that they give an increased output voltage when the load is reduced. For example, if there were several lamps run off a conventional transformer and one lamp failed, the remainder would receive a higher voltage and hence a shortened lamp life. If a second lamp fails the voltage rises further causing a rapid deterioration of the lamps on that transformer. This is known as **'cascade'** failure or the **'domino'** effect.

Over-voltage to the lamps is catastrophic in terms of lamp life. In order to avoid it when the mains goes over-voltage, conventional transformers have to be designed so that at normal mains voltage they under-run the lamps with all the consequent disadvantages.

Lamp life is drastically reduced as a result of high surge currents

When power is first applied to a tungsten halogen lamp, the filament is cold and at a low resistance so that there is an initial surge current which may be up to 20 times the nominal running current, caused by the low resistance of the filament before it heats up. Although the surge lasts for only a fraction of a second, it punches a hole in the filament, and drastically reduces lamp life. As normal running currents are high for ELV lighting (4A for a 50W 12V lamp), the total surge is so great that it can deteriorate switches, over-stress transformers, and cause nuisance tripping of fuses and MCBs.

VoltMaster 'Intelligent Transformers' provide truly stabilised voltage at the lamps irrespective of mains variations between 207V and 253V and any loading up to the maximum rating

www.multiload.co.uk
Multiload Technology Limited 2 Rosemont Road Hampstead London NW3 6NE Telephone +44 (0)20 7794 9152 mail@multiload.co.uk

The advantages of remote positioning of transformers

In many low voltage installations it is desirable to position the transformer well away from the lamps. This successfully overcomes the problems associated with:

- **safety** – mains cannot be run into water areas
- **acoustic noise** – produced by many transformers especially when dimming
- **access** – such as inaccessible ceiling voids
- **maintenance** – where expensive scaffolding towers may be required for access
- **high ambient temperatures** often encountered in ceiling voids.

the solution
VoltMaster can be placed at distances greater than 50m from the lamps
and
give the correct voltage at the lamps, eliminating cascade failure

The high currents of ELV lighting cause significant volt drop in the longer output cables required for remote positioning. The output voltage at the transformer must be therefore increased if the lamps are to have the correct voltage.

With high frequency transformers the lamp voltage can be further lowered by the larger voltage drops caused by high frequency currents in the secondary cables to the lamps. With HF generation the current is not drawn through the core of the cable, but striates around the circumference, thus making the cross-sectional dimension of the cable smaller and increasing cable volt drop. This has the consequence that high frequency transformers must be placed less than one metre from the lamps to keep these losses small.

In copper-iron transformers it is possible to select a tapping giving more or less the correct output voltage for the particular length and thickness of output cable. If the load changes (owing to lamp failure or variable track loading), the volt drop will change, so that the chosen output voltage will no longer give the correct lamp voltage.

Overloading

Some lighting schemes use more than one type of luminaire. Each type will have its own maximum lamp rating marked on it. In addition, a lighting scheme may require lamps whose wattage is below the maximum rating shown. For these two reasons the possibility of them being relamped with an incorrect higher wattage is not uncommon.

The resulting higher load current, whilst insufficient to blow safety fusing, would impact on the transformer, causing it continually to overheat.

One solution is the use of a slow acting thermal cut-out, which may not operate until the person lamping has left.

Another solution is to install an intelligent transformer such as VoltMaster which shuts down immediately if the circuit is overloaded.

When using conventional transformers, for the greatest operational safety, MCBs or Fuses need to be installed in the load circuits, protecting against the possibility of short circuits in the lamps or across the wiring.

The need for RFI suppression

High-frequency transformers by their very nature generate a considerable amount of Radio Frequency Interference (RFI), which is basically high-frequency electrical noise resulting from the high-frequency current produced to run the lamp.

This noise is limited by standards, but because the amount of noise allowed by the standard is per unit of product, a low-power high-frequency transformer, say 50W, is allowed as much noise as a bigger copper-iron transformer rated at say 300W.

Thus a 300W load of 6 x 50W individual high frequency electronic transformers, will produce six times as much RFI as a 300W transformer, and this RFI may well cause problems in other equipment, although the installation is technically 'to standard'.

Careful selection of the transformer can reduce the amount of RFI generated.

Modern worries about filament lamps

In these days of legislation and codes of practice regarding energy use in buildings due to lighting*, it would be understandable to think that all use of filament lamps should be prohibited. It is true that, in the past, tungsten halogen sources were sometimes overused. Today there are a variety of light sources – fluorescent, HID and LED. All have their part to play in the palette of equipment necessary in modern practice.

ELV tungsten halogen is essential for those niche situations where sparkle, colour rendition, light modelling, task lighting and traditional controllable high quality lighting is required.

The future is bright for ELV lighting. Improvements in lamp technology, in particular IRC lamps, offer energy savings of up to 40% compared with lamps produced a few years ago.

* (UK Building Regs: Part L & Part P, or LEED in the US)

save energy . . .
use energy-saving ELV lamps in combination with the incredible lamp life achieved with VoltMaster, to allow the creation of truly sustainable schemes

Dimming

For aesthetic and practical reasons the optimum light from ELV filament lighting can be reduced by dimming, ie. reducing the power consumed by the lamps until a level where the brightness produced sets a scene or mood.

Phase control dimming

For conventional wire-wound and most high frequency electronic transformers dimming is achieved by interposing a dimmer in the mains supply line. This dimmer continually switches the mains supply waveform on and off rapidly at a speed indiscernible to the naked eye. This is called phase control dimming.

The accuracy of switching between positive and negative half cycles of the mains supply waveform must be very accurate, as any imbalance produces what is known as a DC component which is superimposed on the output waveform, and can damage transformers and drives connected to that dimmer. If the mains waveform is switched off at the beginning of the positive and negative half cycles it is called **leading-edge phase control**, and if it switches off at the end of each half cycle it is called trailing-edge. Although the vast majority of high frequency electronic transformers will dim perfectly with '**leading edge**' phase control, some high frequency electronic transformers are designed to be dimmed using '**trailing edge**' phase control.

As has been discussed, conventional wire-wound and high frequency electronic transformers give a reduced voltage to the lamps to avoid over-voltage from the mains supply and to cater for different loadings. When connected to dimmers the maximum output voltage of these transformers is reduced even further due to losses in the dimming circuitry. A transformer giving 11.2V directly from the mains will, when using a dimmer, give, say, a maximum voltage of 10.9V, with the consequent loss of brightness and thus 'light for money'.

VoltMaster 'intelligent transformers' can be **dimmed** reliably using industry standard 1-10V analogue signals with the exact dimmed light level reproduced every time

Signal Controlled Dimming

Electronic transformers exist whose dimming is controlled by a signal, which may be analogue 0-10V or Digital (DSI, DALI, EIB, DMX, etc.). Although these obviously require another cable pair for the signal, they do not need a dimmer.

Understanding ELV circuitry

Some contractors and designers are not happy to calculate volt drops, cable thickness, in-rush currents, nor work out transformer positioning and cable termination.

Multiload has produced a range of technical guides to help simplify wiring and will be pleased to advise on the use of Voltmaster for lighting projects.

In conclusion . .

New or refurbished lighting schemes will use a variety of light sources. There are clear advantages to using filament lamps where appropriate to augment the other sources. It is possible, using Voltmaster, to produce well crafted long lasting installations complying with modern energy limiting strategies.

www.multiload.co.uk
Multiload Technology Limited 2 Rosemont Road Hampstead London NW3 6NE Telephone +44 (0)20 7794 9152 mail@multiload.co.uk