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# EXPERIENCES WITH ELV TRAFFIC SYSTEMS

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## Executive summary

Recent developments in LED signals, resulting in lower power consumption and increased reliability have allowed the development of a new generation of traffic control systems offering Extra Low Voltage (ELV) to be used for all on-street signals and related equipment.

This paper reviews the benefits of using ELV 'on-street' and discusses the results of the first ST900 ELV trial installations, installed earlier in the summer.

# Introduction

In the UK, the use of Extra Low Voltage (ELV) signal drives is now standard where controlled pedestrian facilities are provided. With a few exceptions, the widespread use of ELV across whole intersections has not yet materialised, largely due to the limitations that arise if traditional incandescent signals are used at ELV voltage levels.

These limitations nearly all relate to the relatively high power requirements of incandescent signals. To maintain the same power level and hence light output using ELV requires a much higher current flow than is normally the case when the same signals are operated using a standard 230V / 160V lamp supply. This severely limits the number of signals that can be driven per phase and also increases the cable volt-drop that is experienced.

The Welsh Office was one of the earliest authorities to employ an ELV style system, requiring that sites should use a 50V -0- 50V lamp supply. This effectively produced a 100V at the signals centred around Earth. Although not strictly an ELV supply by today's definition, it was considered to offer some electrical safety benefits, but also came with the limitations mentioned earlier. For example only 6 incandescent signals per phase could be used (compared with 16 for standard 230V signals) and significant limitations on cable lengths were also imposed.

By contrast, and even though they operate at true ELV levels, these limitations are rarely experienced with modern LED based pedestrian signals because they generally require less power than traditional lamp based solutions. It is the more extensive use of LED technology for traffic signals that now leads to the possibility of implementing fully ELV Installations, without having to accept many of the earlier limitations.

# But why use ELV – what are the benefits?

There is sometimes the temptation to use new technology just because it is new, without really considering if the benefits justify its use. In the case of ELV technology however, there are several very real benefits that suggest that it should now be considered whenever traffic signals are being designed.

### Improved safety

In a traditional 230V installation, damage resulting from road traffic accidents or badly implemented street works can leave mains level potentials exposed, presenting an electric shock risk to members of the public.

Even in a un-damaged site, the need to ensure that members of the Public are not exposed to avoidable electric shock risks, means that street terminations carrying mains potential are usually located where they cannot be easily reached – normally at the top of signal poles. Whilst this is a safe approach from an electrical point of view, it means that maintenance personnel are required to climb ladders etc which, in itself, can be a risky process.

Whilst damage to an ELV system may still result in exposed voltages, the use of inherently safe ELV levels throughout all parts of an installation drastically reduces the risk of an electric shock and significantly improves safety under these circumstances.

The use of ELV also enhances the electrical safety for all who are involved in maintenance works on and around the intersection and also has the additional benefit of allowing street terminations to be safely located at the bottom of traffic signal poles. In the longer term this may considerably reduce the need for ladders to be used, further improving safety for maintenance staff.

**Reduced energy consumption**

The power requirement of LED signals continues to fall, offering Authorities a great opportunity to reduce both power costs and their ongoing carbon footprint. For example, the new Helios ELV signals consume only about 11W when in bright, and a tiny 3W when dim. When compared with traditional incandescent signals, this is an average power saving of over 80%.

However because of their very low power consumption, these latest generation signals can be very difficult to lamp monitor reliably, particularly when operating at normal LV levels (230V). Due to their low power and unlike traditional incandescent lamps, they offer almost zero load when switched off. As a result stray voltages can be induced into long cable runs from adjacent live cores, causing the controller to incorrectly detect conflict or correspondence events and switch off.

The use of ELV also helps to reduce these effects and depending on implementation, can also ease the technological challenges present when monitoring low power LED signals, ensuring that overall site reliability is maintained.

**Reduced costs**

As well as offering reduced energy costs, ELV systems can offer significant installation cost savings.

Where both LV and ELV connections are required at a traffic signal pole - for example where a signal head and above ground detector are required - it is currently necessary to run two separate cables – one for the LV connections and one for the ELV connections. The use of a totally ELV system removes this requirement for separation and hence offers scope for significantly reducing the number and cost of cables, particularly in larger intersections.

Additionally, the improvements in the lamp monitoring techniques that are aided by the use of ELV mean that direct monitoring of these signals without the need for any additional equipment to be fitted inside them, or the controller, reduces the cost of ELV LED signals by as much as 30% compared with their LV equivalents.

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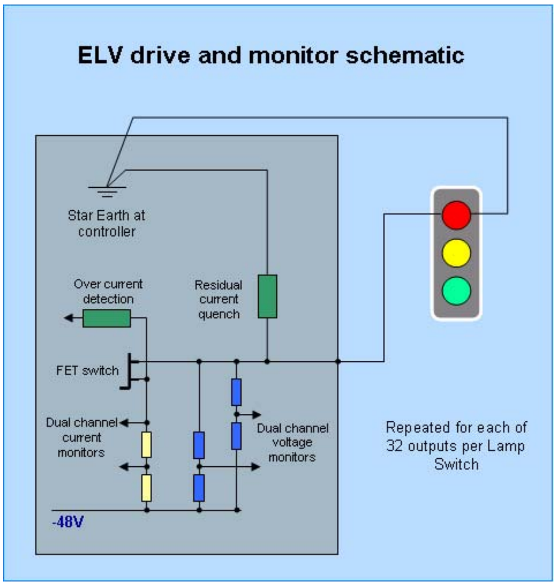
# Does ELV work on the street?

The new Siemens ST900 family of traffic controllers offers both standard LV lamp switching (as per the ST800) and a totally new ELV lamp switching solution, designed specifically to work with the very latest LED technology.




The most notable feature of ST900 ELV is the use of a fully rectified - and hence essentially DC - lamp supply.

This allows the design of the lamp switches to be implemented using highly efficient FET devices, rather than traditional triacs. These offer a very low and well defined volt-drop, which is critical in an ELV system as well as significantly reducing power wastage and unnecessary heating.

By way of an example a traditional ST800 lamp switch card switching 20A will waste about 35W of power, which as heat must be removed from the card, or else it will fail. The ST900 ELV card, switching the same current, dissipates only 6W!

The use of a DC style supply also helps to reduce crosstalk between cables which is a particular problem when low power LED signals are used. As previously mentioned, these signals tend to appear almost 'open circuit' when switched off and as a result stray voltages can be induced into long cable runs from adjacent live cores, which can cause the controller to incorrectly detect conflict or correspondence events and switch off.

Whilst using DC means that the problem of induced voltages is much reduced compared with an AC supply, the ST900 ELV also implements a unique 'residual current quench' circuit on each lamp drive output. This provides a low resistance path when the output is not driving its signal, ensuring that any remaining stray voltages are completely eliminated.

**But does this new technology actually work on the street?**

The answer, at least for the ST900 ELV is yes! To date three ELV trial sites of varying complexity have been installed in Poole, Winchester and Newcastle.

Each has used the latest Helios ELV LED signals, nearside indicators where required and ELV solar sensors to provide complete ELV solutions.

All three sites were installed with little difficulty, are working well and thanks to the continued use of the SIRA enhanced lens technology in the Helios ELV signal, look very impressive.

*The first ST900 ELV installation in Poole*

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The experience gained with the trials so far has shown that the effort to design a dedicated ELV system, particularly the measures taken to reduce unnecessary volt-drops in the system have paid off.

As discussed in earlier papers, the issue of volt-drop in ELV traffic systems is a critical one. A few volts dropped in a mains (LV) system are usually not a significant problem as they represent a very small percentage of the available lamp supply. By contrast the same volt-drop in a ELV system is much more significant.

The main reason that this is a problem is the effect that a low lamp supply voltage will have on any attached LED signals. Most modern central light source signals, including Helios ELV, are designed to maintain their light output over a wide range of supply voltage. This means that as the lamp supply varies with the incoming mains supply, or is reduced by volt-drops in the system, the light output stays the same. This is very useful and helps to overcome some issues with cable volt-drops in particular, maintaining the intensity of the signals throughout an installation, irrespective of cable lengths.

However, a reduced lamp supply is used also used to indicate to the LED signals that they should switch to DIM. Normally in a standard mains (LV) site, the dimming voltage is set at 160V, which is about 66% of the normal BRIGHT voltage and a small volt drop in the system does not have a significant impact on this. For ELV, however, the same volt-drop can potentially cause the lamp supply voltage at the end of a long cable run to fall sufficiently to cause the LED signal to switch to DIM incorrectly. Fortunately this issue was also recognised early in the ST900 design process and the DIM voltage of the system has been carefully chosen at 27.5V, which is only 57% of the lamp supply and offers a increased margin to accommodate cable-volt drops.

Nevertheless, greater care has been required in the selection of cable runs and cable lengths in the trial ELV installations and this has lead to the following guidelines that will need to be followed in the future.

**1.0mm squared wire**

| Number of signal aspects per core | Length of cable run (M) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | | | |
| 6 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | | | | | | | | | | | | | | | | | |

*(Figures in boxes indicate number of cores required)*

**1.5mm squared wire**

| Number of signal aspects per core | Length of cable run (M) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | | | |

*(Figures in boxes indicate number of cores required)*

# Conclusions

Despite some minor limitations when very long cable runs are required, the experience to date with the ST900 ELV trial sites has been very positive.

Installation proved to be no more complex than for standard LV sites and thanks to the elimination of separate LV and ELV cables actually proved easier in some cases.

This coupled with the ongoing reduced power costs and the enhanced safety now offered by the sites suggests that complete ELV solutions are increasingly likely to be preferred to the traditional LV ones. Indeed, plans are already well advanced for between 20 and 30 further ELV sites to be installed around the UK in the coming months.