GUIDANCE DOCUMENT

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PROVIDING GUIDANCE TO MANUFACTURERS AND USER COMMUNITIES

GUIDANCE ON TRAFFIC SIGNAL DIMMING FOR PERMANENT AND NON PERMANENT EQUIPMENT

Introduction

This document has been compiled to clarify the rationale behind and processes to invoke traffic signal dimming for equipment used on UK roads.   It applies to traffic signals used at portable, temporary and permanent installations. It also applies to cycle signals, tram signals and to farside and nearside pedestrian signals.

Regulatory Signs are not dimmed.

It does not apply to message signs (VMS) as the dimming of these is fully provided for in BS EN 12966.

For the purposes of this guidance non-permanent means temporary signals (specified as DfT working drawing 3000) and portable signal heads (DfT working drawing 3000.1)

1. Why The UK Uses Dimming

BS EN 12368 provides for the specification of 200mm and 300mm diameter traffic signals across Europe and the UK. It includes options for three classis of on-axis intensity, i.e. signal brightness.

These three classes within EN 12368 have their origins in the need to accommodate disparate national standards for traffic signals that existed prior to EN 12368 being first published. The three class minima are 100 cd, 200 cd and 400 cd.

UK invokes the 400 cd class for 200mm signals and the 100 cd class for 100mm cycle signals. (TSRGD Schedule 14 Part 1 item 3). Optical performances for other (UK-specific) equipment are provided in the appropriate TOPAS standard.

Signals of these levels of brightness provide good visibility under UK daylight conditions where in summer ambient light may be ~ 100,000 Lux. (The UK invokes the highest phantom ratio requirements to also address conditions of low sun.) They also allow for some degradation in signal output over the service life, provided that the signal lenses are regularly cleaned and other required maintenance is performed.

Noting that signal visibility depends on the contrast between the signal and the ambient light levels, while these levels of light output are effective during daylight they lead to substantial perceptions of glare by road-users under nighttime conditions. (Glare is the presence of light source(s) in the field of view that cause discomfort and/or disability.)

Glare has the effect of reducing

- The effectiveness of signals, particularly signals with symbol masks, which may not be easily resolved by the driver
- The visual performance of a driver limiting their ability to identify less well-lit objects beyond or near the signal and
- may require a period of time for recovery of normal vision after passing the signal.

These effects of glare reduce the safety of road users and pedestrians. Glare is a worse problem when nighttime ambient conditions near the traffic signals do not contain other light sources. Rural nighttime ambient light levels can be below 1 Lux. Where street lighting and/or other light sources are present, for example from building (shop front) lighting along the carriageway, then night time ambient light levels may be higher and glare is less of a problem. Some urban environments are too brightly lit for dimming to be invoked at all.

In order to prevent the adverse effects of glare, UK traffic signals are required to have the facility to be dimmed under certain conditions, (TOPAS2500B 3.29).

It should be noted that, as well as reducing glare, dimming has a number of indirect outcomes, namely

reduction of energy use (and this is reflected in the asset inventory used to assess unmetered power use by the inclusion of a switch regime) and

for halogen capsule lamps, alternating periods of dim operation and periods of bright operation extend their lifespan.

In summary, for optimum effectiveness traffic signals need to have good visibility relative to the ambient light levels, but not provide excessive light output.

While all signals must be capable of being dimmed the decision to implement dimming is generally determined by the user (for permanent signals this will be the road authority) for non-permanent signals this will generally be determined by the signals operator or provider.

The dimming requirements called up for the UK are defined in the relevant TOPAS standards as follows:

TOPAS Standard	Title	Permitted Dimming Light Level Range (as a % of bright as measured on the axis of the signal)
TOPAS 2543	Performance Specification for Signal Heads	To 50509
TOPAS 2511	Performance Specification for Nearside Signal and Demand Unit	15% - 25%
TOPAS 2514	Performance Specification for Light Signals for the Control of Tramcars	15% - 38%
TOPAS 2540	Performance Specification for Portable & Temporary Traffic Signalling Systems for Temporary Traffic Management	15% - 38%
TOPAS 2544	Performance Specification for Wait Indicator Equipment	15% - 38%
TOPAS 2581	Performance Specification for Pedestrian Countdown units for use at Traffic Signals	15% - 38%

Table 1 Dimming levels: TOPAS Standards that include a requirement for dimming

2. Details of Switching Signals Between the Bright and Dim States

The process of dimming can be split into three steps

- Determining when to dim
- Controlling the signal
- Altering the signal light output

2.1. Determining When To Dim

This requires a system awareness of the ambient light levels. While standards do not specify the method for gathering this data the majority of systems rely on a single solar cell per site, typically mounted on a signal head and with good exposure to the open sky so that its response is representative of ambient light conditions. Portable signals may use one solar cell per signal head or one solar cell per site (TOPAS 2540). Permanent traffic signals may use different types of solar cell, with older ones being thermal and newer ones electronic. Provided these devices switch their outputs at the same ambient light levels then it does not matter what underlying technology is used to achieve this.

The primary role of the solar cell is to determine dawn and dusk. It does this by applying two ambient light thresholds. When ambient falls below 55 Lux the solar cell activates its output (typically switching the signal supply voltage to a controller input). When the ambient light level rises above 110 Lux the solar cell switches off the output and no voltage is offered at the output. The use of two different thresholds (hysteresis) avoids jitter in the dimming during dusk and dawn.

Other methods of determining dusk and dawn are possible and not precluded.

TOPAS 2523B provides details of ambient light levels (in section 2.5) and voltages for bright and dim operation (in sections 2.6 & 2.7).

2.2. Controlling the Signal

For the majority of traffic control equipment, the requirement to dim is controlled by applying a reduced supply voltage to the equipment. **Error! Reference source not found.** below (i.e. the copied Figure A.1 of CLC/TS50509) shows the standard LED signal response to the applied voltage.

CLC TS 50509 includes an appendix for the UK requirements including a graphical representation of the supply voltages and corresponding light output for ELV operation. This is reproduced below.

The response of any dimmable signal to the application of a dimming voltage must be to reduce its light output. The control voltage for both bright and dim take permitted ranges with no overlap.

Voltage controlled dimming supports interoperability.

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Annex A
(informative)

Additional requirements under operating conditions - United Kingdom

NOTE This is a representation of existing UK requirements.

A.1 Operation over voltage range

The signal shall operate within the ranges defined in Figure A.1 below. There shall be no discontinuity of light output at the dim/bright threshold or the low voltage switch off threshold.

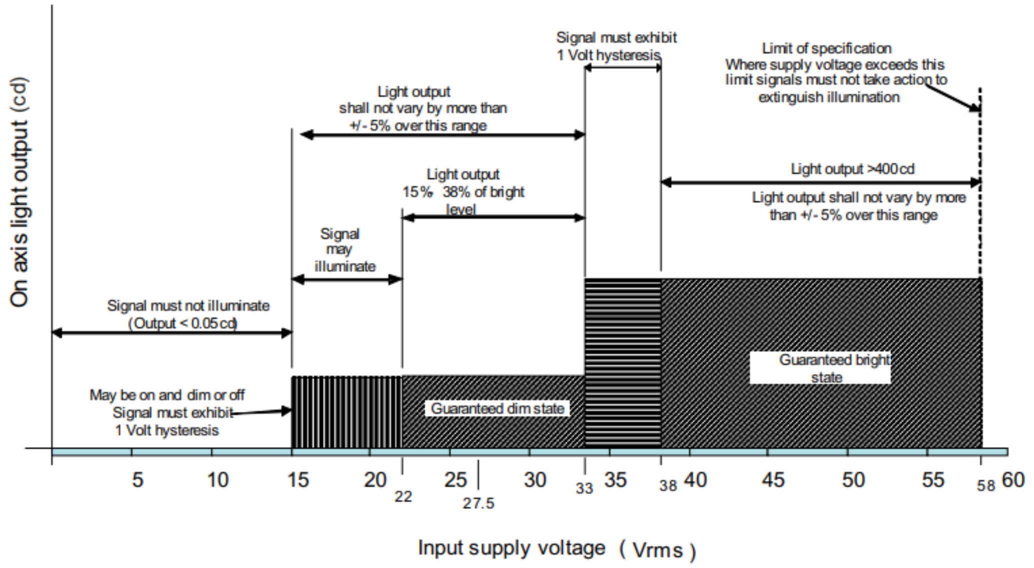

Figure A.1 - Operation over voltage range

Figure 1 Relationship Between Supply Voltage and Signal Light Output from CLC/TS50509

2.2.1. PWM & Data Messages

Both pulse width modulation and data messaging to the signal head offer alternatives to voltage-based dimming. Neither are simple topics and there are significant issues around interoperability and testing. For those reasons they are not discussed further here.

2.3. Altering The Signal Light Output

The range of permitted light output measured (relative to the actual light output in the bright state) is also defined in the UK appendix of CLC TS 50509.

The reduction in light output in the dimmed state is characterised by the dimming ratio. This is defined as the ratio of the on-axis light intensity in the dim state at the nominal dim voltage to the on-axis light intensity in the bright state at the nominal bright voltage. The dimming ratio is expressed as a percentage.

Measurements of dimmed output and the dimming ratio should be made and presented in the optical performance test reports for all equipment.

Within the control voltage ranges CLC/TS 50509 sets limits for the change in the bright or dimmed light output of LED signals. This information is presented in Figure 2 below.

A.2 Linearity of light output

In order to prevent flickering lights or large fluctuations in light output for changes in input voltage, the following is stated as a requirement. The light output may vary within the tolerance shown in the diagram below, however it should be a linear change over the range, i.e. it should not fluctuate between less than the nominal and more than the nominal.

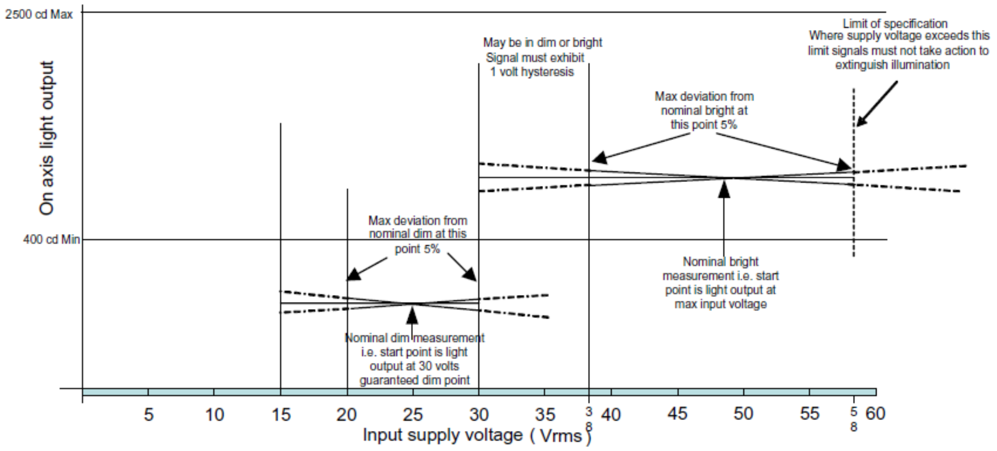

Figure A.2 - Light output over voltage range

Figure 2 Variation Of Permitted Light Output Within Each Operational Supply Range

For incandescent light sources changing the operating conditions of the light source may alter the chromatic output. For these sources it is necessary to also confirm that the chromatic (colour coordinates) of the signal remain within the permitted limits when dimmed. This effect may also occur with LED signals, particularly older designs.

Dimmed state chromaticity should be measured and the results presented in the optical performance test reports for all signalling equipment covered by this guidance.

3. Failure Mode of Dimming Systems

In the UK TOPAS standards (previously Type Approval Specifications) identify that in the event of a detectable failure of the dimming control the signals should be put into the bright state. The failure mode of the solar cell is required to be open circuit. The failure of any other facility related to dimming (see for example TOPAS 2523B 2.5.5) shall cause the signals to be switched to the bright state.

4. Abuse of Dimming

It is a recognised outcome that running portable traffic signals in a dimmed state reduces power consumption thereby extended the interval between battery changes. There have been instances of placing of opaque masks over the solar cells on portable traffic signals causing them to dim even during daylight conditions. This practice puts road users in danger. Inspections of portable signal deployments should check for and report this practice.

This abuse could be prevented or substantially reduced through the adoption by portable signals of the dimming monitoring requirements for permanent signals provided in TOPAS 2523B 2.5.5

"Traffic Signal Control equipment shall be designed such that if the Solar Cell fails to indicate a state change within a 24-hour period it will cause all signals and pedestrian indicators controlled by that solar cell to switch to the 'bright' state."

Because it is permissible to dim portable signals on a signal-by-signal basis, there is a concern that a signal which, of necessity is located in an environment that would hold that signal continuously in the dim state would then be subject to any monitoring of dimming using the methods of TOPAS 2523 and be reported as a dimming fault. The operation of portable signals in low light environments need not be incompatible with the dimming monitoring requirements of TOPAS 2523.

ARTSM is a member of the TOPAS Group