BS EN 50556:2011

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Road traffic signal systems

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National foreword

This British Standard is the UK implementation of EN 50556:2011. It supersedes BS 7987:2001+A1:2006, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/526, Road traffic control signals.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Road traffic signal systems

Systèmes de signaux de circulation routière

Straßenverkehrs-Signalanlagen

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by CENELEC Task Force BTTF 69-3, Road traffic signal systems.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50556 on 2011-01-02.

This document supersedes HD 638 S1:2001 + A1:2006.

The main changes with respect to HD 638 S1:2001 + A1:2006 are the following:

- update of the normative-references;
- editorial revision;
- reduction of the classes;
- adaptation to the level of technology.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-01-02
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-01-02

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Introduction

To satisfy the legal and regulatory requirements and specific provisions of each CENELEC country, certain characteristics in this standard contain a range which is defined by a number of discrete classes. The class to be used in the country will be selected by the Standards Authority of the CENELEC member of that country from the range specified.

Thus this European Standard contains the essential electrotechnical requirements of all CENELEC countries and permits through the class selection procedure, countries to incorporate their own requirements.

It is believed that this first step will allow, over a period of time, a gradual alignment of Road Traffic Signal Systems in Europe.

1 Scope

This European Standard specifies requirements for Road Traffic Signal Systems, including their development, design, testing, installation and maintenance.

In particular, it forms the electrotechnical part of the following two standards issued by CEN:

- EN 12368, *Traffic control equipment — Signal heads*
- EN 12675, *Traffic signal controllers — Functional safety requirements*

Each of these standards above should be used with this standard either singly or together to define an operational equipment or system. This should be achieved by using the electrotechnical methods and testing defined in this standard.

Where Road Traffic Signal Systems are to be used with other systems, e.g. public lighting or railway signalling and communication, this standard should comply with the other respective standard to ensure that overall safety is not compromised.

Only permanently or temporarily installed Road Traffic Signal Systems are included in this standard. Central office and portable signalling systems are not covered.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12368	Traffic control equipment - Signal heads
EN 12675:2000	Traffic signal controllers - Functional safety requirements
EN 50102	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
EN 50110-1	Operation of electrical installations
EN 50129	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling
EN 50293	Electromagnetic compatibility - Road traffic signal systems - Product standard
EN 60529	Degrees of protection provided by enclosures (IP Code) (IEC 60529)
EN 60950-1:2006	Information technology equipment - Safety - Part 1: General requirements (IEC 60950-1:2005, mod.)
EN 61008 series	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) (IEC 61008 series)
EN 61009 series	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) (IEC 61009 series)
EN ISO 9001:2008	Quality management systems - Requirements (ISO 9001:2008)
HD 384.4 series	Electrical installations of buildings - Part 4: Protection for safety (IEC 60364-4 series)
HD 60364-5-54	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, protective conductors and protective bonding conductors (IEC 60364-5-54)
EN 60068-2-1	Environmental testing - Part 2-1: Tests - Test A: Cold (IEC 60068-2-1)
EN 60068-2-2	Environmental testing - Part 2-2: Tests - Test B: Dry heat (IEC 60068-2-2)
EN 60068-2-5	Environmental testing - Part 2: Tests - Test Sa: Simulated solar radiation at ground level (IEC 60068-2-5)

EN 60068-2-14	Environmental testing - Part 2-14: Tests - Test N: Change of temperature (IEC 60068-2-14)
EN 60068-2-30	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30)
EN 60068-2-64	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64)
EN 61140	Protection against electric shock - Common aspects for installation and equipment (IEC 61140)
CLC/TS 50509	Use of LED signal heads in road traffic signal systems
IEC 60050-191	International Electrotechnical Vocabulary - Chapter 191: Dependability and quality of service
IEC 60050-826	International Electrotechnical Vocabulary - Part 826: Electrical installations
IEC 60183	Guide to the selection of high-voltage cables
IEC 60417 (database)	Graphical symbols for use on equipment

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General

3.1.1
Road Traffic Signal Systems
include systems and devices, provided they are affiliated to them in terms of circuitry

NOTE They may consist of the following elements which is not in itself a complete list:

- Controllers;
- Signal heads, signalling devices and traffic signs
  e.g. signal heads for traffic signals;
  acoustic signal generators;
  mechanical signal generators;
  traffic signs connected to the Road Traffic Signal System;
- Traffic sensors and detectors
  e.g. request push buttons;
  vehicle detectors / Pedestrian Detectors;
- Monitoring equipment
  e.g. photographic monitoring devices;
- Equipment Enclosures;
- Electrical Supply;
- Cables;
- Interconnections;
- Supports.

3.1.2
Failure Mode Analysis
means of examining all failure modes to ensure that signal states endangering the road users and/or risk of electrical hazard cannot occur during normal conditions of operation of a Road Traffic Signal System or if they do occur as a result of or whilst a failure (failure mode) exists that they signal states endangering the road users are detected and prevented from continuing

3.1.3
Signal Safeguarding Facility
facilities intended to prevent states of signals endangering the traffic

3.1.4
monitoring element
device that signals electrical and mechanical states of equipment, preferably for signal circuits, and which converts the obtained information in such a manner that it can be processed in signal safeguarding facilities

3.1.5
hardware
complete Road Traffic Signal System or a (material) part of it

3.1.6
hardware fault
failures of components and any influence that will cause the equipment to fail

NOTE Systematic hardware faults constitute either design faults or systematic production faults.

3.1.7
software
all or part of the sequence instructions for a Road Traffic Signal System including the affiliated documentation

NOTE Software is exclusively immaterial, so that it is subject to no wear or failure mechanisms. Once implemented, software cannot be falsified on its own.

3.1.8
software error
deviation between the realised and intended functional contents of the software

NOTE All errors in the software are systematic errors. They are caused by:
– invalid specification (incorrect formulation of intention);
– incorrect programming (incorrect translation of the specification to sequential instructions).

Apparent program falsification in memories is produced by hardware faults or failures or is caused by inadmissible influencing.

3.2 Traffic engineering

3.2.1
controllers (traffic)
electrical device to control signals

3.2.2
signal group
sequence of conditions applied to a group of signal heads, which always received identical signal light indications

3.2.3
Operating System
principle software that allows a computer to operate, and which establishes the basic foundations, protocols and functions that the computer can perform, including communication with internal and external resources

3.2.4
Application Program
software that determines specific tasks that a computer can perform, i.e. operate as a traffic controller

NOTE Application software rests on and extends the capabilities of the operating system to meet customer needs.

3.2.5
Traffic Data
data which specifies how the application program will perform in the particular circumstances of one traffic system

NOTE This may be considered to be in two parts.

3.2.5.1
Traffic Safety Data

all Traffic Data stored in non-volatile memory that has a direct impact on the safety of road users

3.2.5.2
Traffic Non Safety Data
all the remainder of the data which will not cause an unacceptable danger to the road user if the data is changed

3.2.6
Design Authority
Design Responsible
individual or group (organisation) responsible for the safe design and manufacturing, including the instructions for safe use, installation and maintenance of the equipment or system

3.3 Electrotechnical

3.3.1
live part
see IEC 60050-826

3.3.2
enclosure (EN 50102)
part providing protection of equipment against certain external influences and, in any direction, protection against contact

NOTE This definition from the existing International Electrotechnical Vocabulary (IEC 60050-826) needs the following explanations under the scope of this standard:

a) Enclosures provide protection of equipment against harmful effects of mechanical impacts and protection of persons and livestock against access to hazardous parts.
b) Barriers, shapes of openings or any other means - whether attached to the enclosure or formed by the enclosed equipment - suitable to prevent or limit the penetration of the specified test probes are considered as part of the enclosure, except when they can be removed without the use of a tool.

3.3.3
complete protection
protection that achieves:

a) effective and durable prevention of contact with live parts by the attachment of obstacles at least conforming to type of protection IP2x as defined in EN 60529;

   or

b) complete enclosure of live parts by insulating material that can be removed only by destruction (protection by insulating envelopment)

3.3.4
partial protection
protection that prevents the possibility of accidental contact by persons or by objects usually handled by them in one of the following ways:

a) by placing live parts at a distance that the possibility of accidental contact by persons or objects usually handled by them is excluded (protection against accidental contact by a safety clearance);

   or

b) by attaching obstacles conforming at least to type of protection IP1x as defined in EN 60529 (protection against accidental contact by the attachment of obstacles)

3.3.5
reinforced insulation
see EN 60529

3.3.6
nominal voltages
see IEC 60050-826

3.3.7
earthed systems
see IEC 60050-826

3.3.8
Class 0 equipment
see EN 61140

3.3.9
Class I equipment
see EN 61140

3.3.10
Class II equipment
see EN 61140

3.3.11
Class III equipment
see EN 61140

3.3.12
safety extra-low voltage
SELV
see EN 61140

3.3.13
protective conductor (symbol PE)
see IEC 60050-826

3.3.14
earthing conductor
see IEC 60050-826

3.3.15
RCD
see EN 61008 series and EN 61009 series

3.3.16
voltage dip
see IEC 60050-161

3.3.17
insulation
see EN 60950-1:2006, 1.2.9

4 Electrical supply and limits

4.1 Nominal voltages

The standard nominal voltage for connection to the public supply shall be taken to be 230 V $AC_{r.m.s}$. Other nominal voltages shall be permitted.

4.2 Operating voltage range

The system shall be classified according to its mains voltage range within which the Road Traffic Signal System shall work as defined by EN 12675, as follows:

nominal voltage - 13 % ...+ 10 %

The system shall not display signals which contravene EN 12675 when the supply voltage is outside the above voltage ranges.

4.3 Low voltage

4.3.1 Auxiliary state switch response voltage (V_{aux})

It is expected that all controllers will have a point where low input supply voltage will mean that the monitoring systems employed may be unable to operate and therefore would be unable to guarantee the detection or prevention of signal states which endanger traffic. The controller shall be prevented from reaching this limit and should switch to a safe state (see Note), in a controlled manner before this point is reached.

In a controlled manner means that it shall shut down in such a way as to prevent any likelihood of a hazardous signal state being displayed during the process of switching to the safe state.

NOTE The safe state noted above may either be all signals off or a flashing display of either red or yellow or a combination of red and yellow, which is recognised in the country in which the controller is to be used as a safe state, warning users to proceed carefully / give way to others.

4.3.2 Power up activation voltage

The system shall become active when the supply voltage reaches a value within its operating voltage range. The restart procedure shall normally be automatic or in exceptional circumstances it may be by manual or remote control. No signalling state dangerous to traffic shall be possible and the signalling state shall conform to EN 12675.

4.4 Overvoltage

The system shall be classified as follows according to whether or not a protective device is incorporated which cuts off the supply voltage to prevent damage. Where incorporated, the protective device shall operate when the supply voltage is greater than the operating voltage range.

- **Class D0:** no protective device is required;
- **Class D1:** a protective device is required to provide protection up to 1 500 $V_{r.m.s}$.

4.5 Voltage dip

The system shall be classified according to the duration of dips in supply which affect the operation. In order to avoid undesirable reactions by the signal safeguarding facilities, the system shall operate as shown in Table 1 according to the duration of the voltage dip below V_{aux}.

Period t_1 is a timeperiod of a voltage dip in the supply which will not affect the normal operation of the system.

Period t_2 is a timeperiod of voltage dip in the supply when the system shall change to signals OFF followed by the start up sequence.

Table 1 − Classification according to voltage dip

Criterion	Values ms
Period t_1	< 20
Period t_2	> 100

For any voltage dip in the supply between t_1 and t_2 the controller may remain working correctly or change to signals OFF followed by the start up sequence.

4.6 Mains frequency

The system shall be classified as follows according to the acceptable variations in mains frequency:

50 Hz ± 4 %

5 Safety

5.1 Electrical safety

5.1.1 General

5.1.1.1 Introduction

The Road Traffic Signal System shall conform to HD 384.4 series. This subclause deals with the additional requirements for Road Traffic Signal Systems.

5.1.1.2 Criteria − Leakage current

5.1.1.2.1 Road Traffic Signal Systems

Class T1:
For Road Traffic Signal Systems, leakage current protection facilities conforming to HD 384.4.41 shall be fitted. Earth leakage circuit breakers conforming to EN 61008 series for nominal currents 20 % greater than the expected current and nominal leakage currents ≤ 0,3 A shall be installed.

Class T2:
No requirement for leakage current protection facilities for the whole system, however the customer may request facilities as class T1.

5.1.1.2.2 Maintenance equipment supply

To conform with HD 60364-4-41, an earth leakage circuit breaker conforming to EN 61008 series with nominal leakage currents ≤ 0,03 A shall be installed.

5.1.1.3 Earthing

5.1.1.3.1 General

This subclause applies to the installation or part of the installation which is class I conforming to EN 61140.

5.1.1.3.2 Protective earth conductor (PE)

The system shall conform to HD 60364-5-54.

Protective earth conductors shall connect together all conductive parts and the PE terminals throughout the system. They shall either be created by conductors in a cable or by separately installed wires and/or construction parts.

In controllers the PE conductors shall be connected to the PE terminal / earth bus bar.

NOTE Metallic bodies which, by virtue of their location or smallness, cannot be touched or are unlikely to become live should be designated excluded devices, i.e. they need not be connected to the PE conductor.

5.1.1.3.3 PE wiring of external equipment

NOTE 1 Examples of external equipment are poles, signal heads and detectors.

The system shall be classified according to the following methods.

Accessible conductive parts shall be connected to the PE conductors incorporated in the cables or a separate PE cable.

NOTE 2 Armouring of cables may also be used as PE conductors where the cable construction permits.

5.1.1.4 Enclosure

The enclosure shall provide the mechanical protection to IK07 (see EN 50102) with the following criteria:

No damage shall occur to the equipment contained within the enclosure and the equipment shall continue to operate to its specification. There shall be no degradation of the IP rating of the equipment.

Class V1:
Enclosures shall provide protection to IP44. When the manual panel is open, the protection provided shall be to IP42. When the enclosure is open the protection shall be to IP20.

Class V2:
Enclosures shall provide protection to IP54. When the manual panel is open, the protection provided shall be to IP23. When the enclosure is open the protection shall be to IP21.

5.1.1.5 Access

Covers, doors, flaps, or similar allowing access to controls, circuits or live parts when opened, shall be capable of being opened only with the aid of a key or a tool. Keys may be specified either on a country basis or by the customer.

5.1.1.6 Over-current protection

Supply voltages within the enclosure or external to the enclosure shall have excess current protection, generally in accordance with HD 384.4 series.

5.1.1.7 Terminations

The system shall be classified according to its access to mains terminations as follows:

Class H0: No separate access to mains terminations.

Class H1: separate access to meters or parts of a mains terminal, etc.

5.1.2 Controller Signal outputs

The controller shall provide electrical power to the signals (as described in EN 12368), and the signals shall use this power. Electrical details of compatible signal heads shall be specified by the controller manufacturer in order to ensure the safety of the system. This should list either those signals know to be compatible or the class of signals to EN 12368 or CLC/TS 50509 that would by definition make them compatible with the control systems required monitoring performance and prevention of hazardous displays.

5.1.3 Interconnections

5.1.3.1 PE Terminal

The terminal points of the PE conductor on bodies shall be easily accessible and shall bear the identification mark specified in IEC 60417. They shall provide bare metallic contact and serrated washers shall be used.

5.1.3.2 General terminations

The terminal points shall be of corrosion resisting materials.

5.1.4 Cables

5.1.4.1 PE cable dimensions

The minimum cross sections of PE conductors shall be as follows:

a) if part of a composite cable: the size of the largest conductor;

b) if laid in a protected manner: 2,5 mm^2 copper;

c) if laid in an unprotected manner: 4,0 mm^2 copper.

5.1.4.2 Earth cable dimensions

The minimum cross sections of earth conductors shall be as follows:

a) if corrosion protected: 16 mm^2 copper or galvanised steel;

b) if corrosion unprotected: 25 mm^2 copper;

50 mm^2 galvanised steel.

5.1.4.3 Distribution cables

Distribution cables shall be designed to work in the environment found in traffic signal systems. They shall be of adequate cross section to withstand fault currents which may occur under fault conditions.

NOTE This is dependent on the size of the protection device, the temperature range and the insulation material.

The rating voltage of cables carrying mains voltage shall be 1 000 V min. between conductors (this is the value U as defined in IEC 60183 and is generally the second of the two values noted for a cable, U_o/U where U_o is the maximum a.c. voltage between a conductor and earth and U is the maximum between conductors).

The number of cores specified for the installation will depend on the facilities required.

5.1.5 Insulation

5.1.5.1 Isolated circuits

In case of electrically isolated circuits: the insulation between the live parts of these circuits shall be calculated for the higher operating voltage.

5.1.5.2 Linked circuits

In case of circuits linked in an electrically conductive manner and with different voltages: the calculation of the reference voltage for the insulation between live parts shall be orientated to the highest operating voltage.

5.1.5.3 Insulation paths

5.1.5.3.1 General

For insulation paths EN 60950-1 applies, clearance and creepage distances and thickness of insulation see EN 60950-1:2006, 2.10.

5.1.5.3 2 Live parts and bodies

In addition to reliable electrical isolation of live parts in any types of circuits from live parts in power circuits, insulation paths shall be dimensioned for the following criteria.

Between live parts and bodies, the insulation paths of equipment for road traffic signal systems in an enclosure (cabinet) in accordance with 5.1.1.4 shall be dimensioned for overvoltage category II and degree of soiling 2.

NOTE Overvoltage category II: It should be assured that no overvoltage ≥ 2 500 V can be applied, otherwise protection measures are necessary.

Degree of soiling 2: It should be assured that in general no conductive soiling can be applied (EN 60664-1/VDE 0110-1).

5.1.5.3.3 Live parts

Insulation paths between live parts of equipment for road traffic signal systems in an enclosure (cabinet) in accordance with 5.1.1.4 shall be dimensioned.

All terminals and other connection elements for incoming and outgoing cables or wires whose operating voltage is in excess of the extra-low voltage range shall be dimensioned in accordance with overvoltage category III and degree of soiling 3 (e.g. the output connector blocks in controllers, the distributors in the poles and the connection terminals in the signal heads).

5.1.5.4 Insulated devices

On equipment with an insulating enclosure and if reinforced insulation is used, the test voltage between live parts to bodies or to metal films mounted on the outer faces of insulating enclosures shall at least have double the values of the rated voltage. Insulation paths between live parts and bodies shall be dimensioned for overvoltage category III and degree of soiling 3 for the rated voltage.

When the cabinet is in accordance with IP54 and an overvoltage protection is provided the insulation paths may be dimensioned in accordance with overvoltage category II and degree of soiling 2.

Pole distributors are considered to have reinforced insulation if the test voltage between live parts and bodies has at least three times the value of the rated voltage and the insulation paths are dimensioned in accordance with overvoltage category III and degree of soiling 3 for three times the rated voltage.

5.2 Traffic safety

5.2.1 General

For the present subclause concerning rules for the functional safety of Road Traffic Signal Systems the definitions for "item" and "failure" according to IEC 60050-191 shall be applied.

Failures shall be considered at different levels of the Road Traffic Signal System. Failures considered in EN 12675 are apparent to road users, i.e. traffic and pedestrians. In this subclause those failures of items of the Road Traffic Signal System which may lead to the faults described in EN 12675 are considered.

This subclause defines the requirements for traffic signal safety, the testing of which is defined in Clause 6.

5.2.2 Requirements of signal intensity for safety

The signal limits for safety shall be to one of the following classes:

Class AF1:

The luminous intensity of the light output on axis for signals which are required for safety to be ”ON”, e.g. Red, shall be greater than 10 cd (as specified in EN 12368).

The luminous intensity of the light output for signals which are required for safety to be ”OFF”, e.g. Green, shall be less than 0,05 cd (as specified in EN 12368).

The signal manufacturer shall specify the signal requirements either voltage, current or alternative signalling system to ensure that the above limits are met. The system engineer shall ensure that the controller shall provide an action on these limits.

Class AF5:

For signals which are required for safety to be ”ON” and for which monitoring of absence is required, signals shall be considered to be switched "ON" if the voltage on the output of the controller is greater than minimum switch on voltage for the class of signals defined as compatible. In addition a method of confirming that the signals are drawing power (i.e. there is something connected) shall also be provided. This may be either monitoring of the current consumed by the signals or other similar technique. Any such technique shall consider the environmental effects on measurements and this should be demonstrated in the technical assessment of the technique.

For signals which are required for safety to be ”OFF” shall be considered to be switched off if the voltage on the output of the controller is less than 20 % of the full rated output voltage.

5.2.3 Requirements for signal states

5.2.3.1 Signal states which endanger traffic shall be prevented during operation of a Road Traffic Signal System as described in 5.2.3.4. When a system is installed and operated within the manufacturer’s specified limits and there are no random hardware failures or systematic failures (e.g. software errors) the signals will conform to the requirements in EN 12675 for correct operation. It is not allowed to operate a system outside of the specified limits.

5.2.3.2 Failures shall be primarily prevented by formal measures of quality assurance in development and manufacturing as well as by correct installation. This shall be achieved by EN ISO 9001:2008 or equivalent. The occurrence of failures shall also be limited by use of reliable components, proper operation and scheduled maintenance.

5.2.3.3 If a failure could lead to a signal state endangering the traffic as defined in EN 12675 a functional independent safeguarding facility shall lead to a safe state of operation as defined in EN 12675. This safeguarding facility shall become active within a time interval specified according to the following classes:

Class AG1: 100 ms;

Class AG2: 150 ms;

Class AG3: 200 ms;

Class AG4: 300 ms;

Class AG5: 500 ms;

Class AG7: 850 ms.

NOTE This time interval is the time from the dangerous signal occurs until this state has been removed.

5.2.3.4 To ensure that the requirements of 5.2.3.1 to 5.2.3.3 are obeyed one of the following procedures shall be carried out:

(Each country should clearly specify their requirements as to what “signal states dangerous to traffic” are, by defining their selection from EN 12675.)

Class X1:
Both a failure mode analysis according to 5.2.4 and functional tests according to Clause 6 shall be carried out in accordance with signal states dangerous to traffic specified in EN 12675.

Examples of failures to be considered are given in EN 50129.

Class X2:
Functional tests according to Clause 6.
5.2.4 is not mandatory.

5.2.3.5 The signal safeguarding facility shall always be active as long as the controller is powered.

5.2.3.6 The controller software consists of:

- operating system;
- application software;
- traffic safety data;
- traffic non safety data.

It shall not be possible to alter or modify the operating system or the application program of the controller, but the software may be replaced by alternative software which has been tested and approved by the design authority.

It shall not be possible to modify the controller traffic safety data except by an authorised event.

NOTE The modification of traffic safety relevant data by use of a handset or by data received from an external source may in certain circumstances be classed as being authorised.

The modification of traffic non safety relevant data has no restrictions.

5.2.4 Failure consideration (Failure mode analysis)

5.2.4.1 General

The failure consideration shall be carried out according to the following rules. For information purposes these rules are additionally depicted in Figure 1.

The consideration of failures shall be done starting from the highest hierarchical level in the system and proceeding towards the lowest level. At each level the assessment shall be carried out until at the considered level, all possible failures of the involved items fulfil the failure consideration. At that point the analysis shall be considered to have been successful and the analysis shall end.

5.2.4.2 First Single Failure (Failure A)

5.2.4.2.1 The term "single failure" covers the initial failure and any further failures caused as the result of this failure. A signal state endangering traffic (according to EN 12675) due to a "single failure" shall be prevented.

5.2.4.2.2 If this failure could lead to a signal state endangering traffic, a functional independent safeguarding facility shall become active within a time interval specified in 5.2.3.3. This activity of the safeguarding facility shall initiate the failure mode as defined in EN 12675.

5.2.4.2.3 If this failure does **not** lead to a signal state endangering traffic, it may become apparent by an on-line safety diagnostic check or by a scheduled manual proof test. Alternatively it may not become apparent, see 5.2.4.3.

When the failure is detected by an on-line safety diagnostic check, it shall be disclosed within the safety diagnostic check interval (SDCI) by stored message and it may in addition initiate an action. The action may be a restriction of some controller functions or may initiate the failure mode.

When the failure is detected by a scheduled manual proof test, the detection shall occur within a proof test interval (PTI) specified by the manufacturer.

The detected failure shall be repaired within an interval specified by the manufacturer.

The above mentioned intervals shall be determined in a way, that the probability of a second failure which could cause an unsafe condition occurring within those intervals is less than 10^{-5}/year, i.e. the occurrence of a second failure shall not be expected during those intervals.

5.2.4.3 Second Single Failure (Failure B)

5.2.4.3.1 If a first "single failure" is **not** apparent as defined in 5.2.4.2.3, the occurrence of an additional independent "single failure" shall be considered. A signal state endangering traffic due to the combination of both failures shall be prevented.

5.2.4.3.2 If the combination of two independent single failures could lead to a signal state endangering traffic a functional independent safeguarding facility shall become active within a time interval specified in 5.2.3.3. This activity of the safeguarding facility shall initiate the failure mode as defined in EN 12675.

5.2.4.3.3 If the combination of the two single failures does **not** lead to a signal state endangering traffic, it shall become apparent by an on-line safety diagnostic check or by a scheduled manual proof test. If this is not possible it is acceptable that the two faults remain and additional faults are considered otherwise the design shall be considered as unacceptable.

When the failure combination is detected by an on-line safety diagnostic check, it shall be disclosed within the safety diagnostic check interval (SDCI) by stored message and it may in addition initiate an action. The action may be a restriction of some controller functions or may initiate the failure mode.

When the failure combination is detected by a scheduled manual proof test, the detection shall occur within a proof test interval (PTI) specified by the manufacturer.

The detected failure combination shall be repaired within an interval specified by the manufacturer.

The above mentioned intervals shall be determined in a way, that the probability of any further failure which could cause an unsafe condition occurring within those intervals is less than 10^{-5}/year, i.e. the occurrence of any further failure shall not be expected during those intervals.

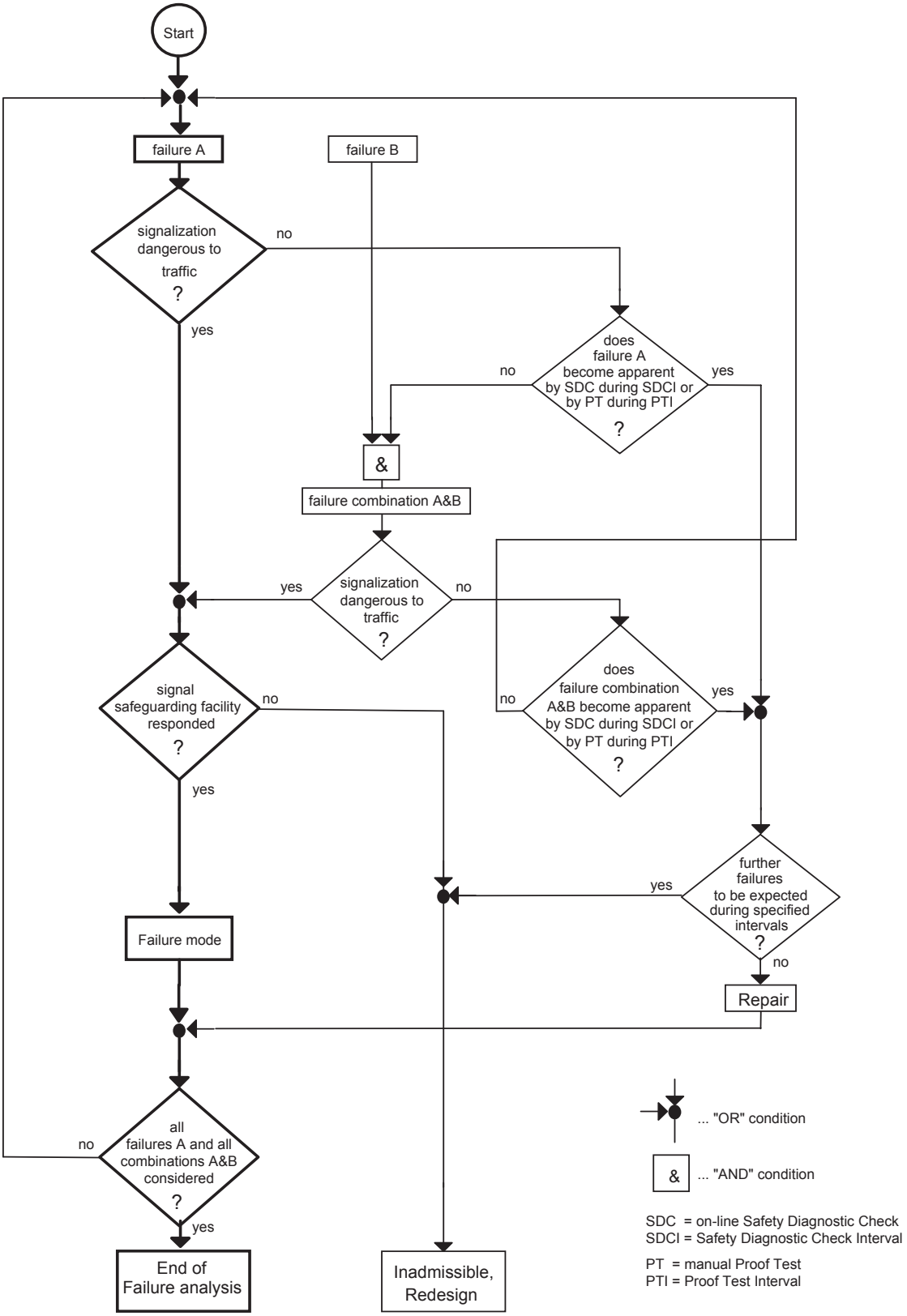

Figure 1 − Failure consideration of a Road Traffic Signal System − Protection against accidents caused by technical failures

NOTE Figure 1 should be read in conjunction with 5.2.4.

5.2.5 Location of monitoring elements for signals

5.2.5.1 General

The following applies to the monitoring elements of signal circuits.

5.2.5.2 Location of monitoring elements for detection of absent signals

The system shall be classified according to the location of the monitoring elements for detection of absent signals, e.g. reds as follows:

Class N0:
No requirement for location is specified.

Class N2:
If the sensing elements are intended to monitor current, it shall be ensured that the correct current is monitored, not a fault current.

This shall be carried out by:

- either ensuring the location of the sensing element is not affected by fault currents, e.g. location in series with the return conductor; or
- test for fault currents; or
- the wiring distribution network is such that reinforced insulation is used to reduce the risk of fault currents.

5.2.5.3 Performance of monitoring elements for detection of unwanted displays

The system shall be tested to certify the performance of monitoring elements which are fitted for the detection of unwanted displays, e.g. greens as follows:

It is considered that the most important function of the safety system is to monitor for and prevent unwanted displays, which could be hazardous to users. Therefore it is required that this monitoring and the associated circuits are both analysed and tested to ensure that under all reasonably practicable circumstances, such signal states are prevented. Furthermore that any faults in the system that might prevent hazardous signal states being identified are also detected and acted upon. Thus for these circuits Class X1 according to 5.2.3.4 and 5.2.4 is required.

6 Testing

6.1 Object

Clause 6 defines the Type testing methods used for checking the individual elements of the system as listed in 3.1.1 which is required to meet this standard. It covers the environmental tests and functional tests which are appropriate to EN 12368 and EN 12675 and it also covers the electrical and EMC tests (EN 50293) which are required to be carried out in order to verify the requirements of this standard.

Full Type test reports shall be produced and available on demand for examination by a customer.

6.2 Organisation of testing

6.2.1 Ordering of tests

6.2.1.1 The tests are grouped into the following groups:

a)	random vibration tests;	(6.3.2)
b)	impact test;	(6.3.3)
c)	protection tests;	(6.3.4)
d)	dry heat, cold, damp heat and optional solar radiation tests;	(6.3.5, 6.3.6, 6.3.7, 6.3.8)
e)	electrical tests;	(6.4)
f)	electrical safety tests;	(6.5)
g)	traffic safety tests;	(6.6)
h)	safety assessment.	(6.6.1.8)

The tests shall normally be free to be completed in any order / sequence.

The EMC tests as specified in 6.7 may move to occur before or after any of the above tests to suit the manufacturer.

6.2.1.2 The same equipment shall pass each of the tests in turn and if any tests fails and requires correction of the equipment all preceding tests shall be repeated unless it can be shown to the tester that the corrective action has not nullified the action of the previous tests.

Replacement of failed fuses or lamps which are classed as spare parts shall be allowed during or after the tests.

Tests of changes in the event of a modification to hardware or software the extent of the re-test shall be agreed with the tester and the manufacturer.

6.2.2 Presentation of equipment

6.2.2.1 The equipment shall be supplied in working order and shall be a standard production version. It shall include all the compulsory characteristics and incorporate any optional characteristics which are required to be approved for sale and are necessary to carry out particular tests.

6.2.2.2 All removable modules forming the equipment under test shall be permanently marked with type numbers and serial numbers. A list of numbers and serial numbers for all modules shall be presented with the equipment.

6.2.2.3 The supplier shall specify the functions of the equipment corresponding to options in the standards referred to. The software version supplied for the tests shall be specified.

6.2.2.4 The equipment shall be accompanied when necessary by all the technical documentation specified in the standards referred to. This documentation shall at least define the configuration details for each test, the technical, installation and maintenance details.

6.2.2.5 The equipment shall be equipped with the connection devices necessary for testing.

6.2.2.6 A controller may be supplied without lights for all tests except the environmental tests and tested using adequate loads at nominal voltage for each signal output except where specific loads are required for safety monitoring reasons. If no lights are supplied, a suitable alternative means shall be supplied which is capable of displaying the state of all signal outputs to be monitored during the test procedure. This display shall be driven directly from the output of the controller and shall be of a form suitable for visually evaluating the changeover from one display state to the next. This may take the form, for example, of an array of miniature coloured lamps.

6.2.2.7 The equipment shall be powered by a single phase supply at the nominal voltage and frequency as specified by the supplier. See Clause 4.

6.3 Environmental tests

6.3.1 General conditions for the tests

6.3.1.1 The test conditions throughout the document shall be as stated in this subclause unless specifically stated otherwise for the particular test.

6.3.1.2 The tests are carried out on the equipment mounted in its enclosure which is wired under the conditions normally encountered in operation and fixed in accordance with the arrangements defined by the supplier for a normal installation at an ambient temperature of 15 °C to 35 °C, except for those tests which are specifically required to be carried out at a higher or lower temperature.

6.3.1.3 For tests requiring verification of the operation of a controller, it shall:

a) be linked to a ground connection and connected to the nominal supply voltage between phase and neutral;

b) except where otherwise defined, be equipped with the maximum number of signal group outputs specified in the data sheet defined by the supplier. Each signal group output shall be connected to a group of separate signals or equivalent load such that one signal group is fully loaded, one signal group has the minimum load and the total controller is fully loaded (see 5.1.2). The selection of which phase is fully loaded, etc. shall be at the discretion of the tester;

c) operate in accordance with a fixed-time sequence which shall include at least one of each type of signal output that the supplier is claiming for the version subject to test. This may typically include:
   1) three-coloured signal heads;
   2) pedestrian signal heads green and red;
   3) special signal heads for cyclists, light rail vehicles/tramways or other special categories.

Operation of the controller is considered to be satisfactory if:

d) the initialisation phase is properly carried out;
e) no anomaly is found in the sequence of lights defined in the test light plan for each of the signals.

In particular, the following points shall be observed for at least one complete cycle:

f) the cyclic nature of operation;
g) compliance with a defined time value;
h) no visible interruption in the change between two colours in the same signal;
i) the time between changes of colour for each signal group;
j) stability of lighting for a set colour;
k) correct lighting/extinction frequency for flashing signals;
l) correct operation on a sample input and output channel.

6.3.1.4 The operation of affiliated equipment will be considered satisfactory if it performs its normal duties, in particular attention shall be paid to the following tests where applicable:

a) the initialisation phase is properly carried out;
b) the cyclic nature of operation;
c) correct operation on a sample relevant input and output function.

6.3.1.5 An insulation test shall be carried out when specified by means of the application of a suitable voltage (at least 500 V DC) between the supply terminals and the ground connection, the impedance value shall be greater than that specified in 8.6.

6.3.2 Random vibration test (in accordance with EN 60068-2-64)

6.3.2.1 The test shall be carried out on the equipment forming the maximum configuration and power loading as specified in 6.3.1.3. The test may be carried out on the equipment with indicators to show the correct operation. The equipment shall be switched on and working normally before conditioning and after the test but may remain disconnected during the period of vibration.

6.3.2.2 The equipment shall be subjected to the random vibration test specified in EN 60068-2-64, Test Fh, for the limits corresponding to the class of operation claimed by the supplier as specified in Clause 11.

6.3.2.3 Before and after the test, operation of the equipment shall be satisfactory in accordance with 6.3.1.4 and 6.3.1.5. The electrical safety of the enclosure shall be maintained after the test, e.g. doors and covers have not become displaced.

6.3.3 Impact tests

6.3.3.1 The electrical safety of the equipment shall be maintained after the test.

6.3.3.2 Impact for equipment enclosures (in accordance with EN 50102)

6.3.3.2.1 The enclosure may be tested by using the vertical drop test or the spring hammer method specified in EN 50102 to the requirements of 5.1.1.4.

6.3.3.2.2 The shocks, numbering 5 per accessible face, are distributed over the whole surface in the ratio of one in each corner and one at the centre. The point of impact shall be located at least 20 mm away from the edge of the face. Doors shall be considered to be faces.

6.3.3.2.3 The test is deemed to be a pass if no cracking or penetration occurs.

6.3.3.2.4 The electrical safety of the equipment shall be maintained after the test.

6.3.4 Degree of protection (in accordance with EN 60529)

6.3.4.1 The equipment shall be tested in accordance with EN 60529 to rating the IP rating as required by 5.1.1.4 for the class of operation claimed by the supplier.

6.3.4.2 Operation shall be satisfactory in accordance with 6.3.1.4 and 6.3.1.5, immediately following the period of the test. In addition the tests as specified in 6.6.3 and 6.6.4 if required shall be carried out and passed within 1 h of the completion of the above test.

6.3.5 Dry heat (in accordance with EN 60068-2-2)

6.3.5.1 The test shall be carried out on the equipment forming the maximum configuration and power loading as specified in 6.3.1.3. The equipment shall be switched on and working normally.

6.3.5.2 The equipment shall be subjected to the dry heat test specified in EN 60068-2-2, Test Bd for the limits corresponding to the class of operation claimed by the supplier and specified in Clause 11.

6.3.5.3 Operation shall be satisfactory in accordance with 6.3.1.3 or 6.3.1.4 throughout the period of the test. Additionally the test specified in 6.3.1.5 shall be carried out at the end of the test cycle.

6.3.6 Cold (in accordance with EN 60068-2-1)

6.3.6.1 The test shall be carried out on the equipment forming the maximum configuration and power loading as specified in 6.3.1.3. The equipment shall be switched off for the period of cooling and for all except the last period at the low temperature, at which point switching on the controller shall cause it to start up and operate correctly.

6.3.6.2 The equipment shall be subjected to the cold test specified in EN 60068-2-1, Test Ab for the limits corresponding to the class of operation claimed by the supplier and specified in Clause 11.

6.3.6.3 The thermostatically controlled heating device shall be switched off except for the last hour and then the operation of the equipment shall be satisfactory. It is acceptable for such a controller to exhibit a delay between the application of power and the commencement of normal operation provided that there is no output to the signal lamps during the delay period.

6.3.6.4 Operation shall be satisfactory in accordance with 6.3.1.3 or 6.3.1.4 when the equipment is switched on. Additionally the test specified in 6.3.1.5 shall be carried out at the end of the test cycle.

6.3.7 Damp heat (in accordance with EN 60068-2-30)

6.3.7.1 The test shall be carried out on the equipment forming the maximum configuration and power loading as specified in 6.3.1.3. The equipment shall be switched on and working normally.

6.3.7.2 The equipment shall be subjected to the damp heat cyclic test specified in EN 60068-2-30, Test Db for the limits corresponding to the class of operation claimed by the supplier and specified in Clause 11.

6.3.7.3 Operation of the equipment shall be satisfactory in accordance with 6.3.1.3 or 6.3.1.4 throughout the period of the test. Additionally the test specified in 6.3.1.5 shall be carried out at the end of the test cycle.

6.3.8 Solar radiation (in accordance with EN 60068-2-5)

6.3.8.1 The test shall be carried out on the equipment forming the maximum configuration and power loading as specified in 6.3.1.3. The equipment shall be switched on and working normally.

6.3.8.2 The equipment shall be subjected to the solar radiation test specified in EN 60068-2-5, Test Sa for the limits corresponding to the class of operation claimed by the supplier and specified in Clause 11.

6.3.8.3 Operation of the equipment shall be satisfactory in accordance with 6.3.1.3 or 6.3.1.4 throughout the period of the test. Additionally the test specified in 6.3.1.5 shall be carried out at the end of the test cycle.

6.4 Electrical tests

6.4.1 Scope of electrical compatibility tests

These tests apply to a representative sample of all electrical inputs and outputs provided by the controller under test with the exception of interfaces to communications interfaces such as the Public switched telephone network. These tests may be carried out without the enclosure.

6.4.2 Output to signal heads

6.4.2.1 This test applies to equipment intended to be connected to signal heads to be supplied separately either by the supplier or by others. The supplier shall state the range of voltages and currents that the controller will supply.

6.4.2.2 Each type output circuit shall be tested in turn at both maximum and minimum loads for output characteristics including:

a) output voltage in the "ON" and "OFF" state;
b) output current drive capability including over-current protection.

6.4.3 External input tests

6.4.3.1 Each type input circuit shall be tested in turn for input characteristics including:

a) input impedance;
b) input threshold high and low voltages;
c) declared overvoltage level (where applicable).

6.4.3.2 Testing may be by means of direct electrical connection to part of the circuit under test or by observation of monitoring facilities.

6.4.3.3 It is not necessary to test multiple identical input circuits.

6.4.3.4 Where a recognised standard interface format is provided by use of standard interface integrated circuits or modules, testing may be by inspection of equipment or documentation.

6.4.3.5 Where the input facility is implemented by means of dedicated integrated circuit devices designed by or for the supplier, it is also necessary to test by means of inspection of test data applicable to those devices.

6.4.4 External output tests

6.4.4.1 Each type of output circuit shall be tested in turn for output characteristics including:

a) output voltage;
b) output current drive capability;
c) isolation capability, if applicable;
d) protection against:
    1) connection to mains voltage;
    2) lightning strikes if included in the equipment technical details.

6.4.4.2 It is not necessary to test multiple identical output circuits.

6.4.4.3 Where a recognised standard interface format is provided by use of standard interface integrated circuits or modules, testing may be by inspection of equipment or documentation.

6.4.4.4 Where the output facility is implemented by means of dedicated integrated circuit devices designed by or for the supplier, it is also necessary to test by means of inspection of test data applicable to those devices in conjunction with documentation showing how it is used in the controller.

6.4.5 Communications interface circuits

Testing of suitability for connection to Telecommunications networks is outside the scope of this document. No tests are therefore required on any such equipped circuits as part of this test. Suppliers shall obtain such approval separately.

6.5 Electrical safety tests

6.5.1 General

This test covers laboratory type tests to verify the safety performance of the controller in respect of electrical safety.

6.5.2 Typical test conditions

a)	Temperature	in the range 15 °C to 35 °C;
b)	Relative humidity	45 % to 75 %;
c)	Atmospheric pressure	68 kPa to 110 kPa;
d)	Supply Voltage	nominal voltage except where otherwise noted;
e)	Equipment configuration	maximum.

6.5.3 Protective conductors continuity test

6.5.3.1 Inspection

A visual inspection shall be carried out to verify that metallic bodies that are earthed by virtue of their means of fixing are connected securely, for example by welding, securely riveting or firmly bolting or by means of metal to metal locations that are under continuous pressure such as slide-in modules.

A visual inspection shall be carried out to verify that hinged items are earthed by an earth bonding conductor fitted across the hinge.

6.5.3.2 Measurement

A test shall be carried out to ensure compliance with HD 60364-5-54 to measure the resistance between the main earth terminal and:

a) each protective earth conductor;
b) the provision for earthing of outgoing cables;
c) the provision for earthing of ancillary equipment.

6.5.4 Labelling

An inspection shall be carried out to verify the correct provision and location of warning labels.

6.5.5 Access to hazardous voltages

A test shall be carried out, taking the form of a visual inspection in accordance with IEC 60536 to ensure that there is no access to:

a) parts at hazardous voltages to the general public;
b) parts at hazardous voltages to a user;
c) parts at hazardous voltages to maintenance personnel without the use of tools to remove obstructions marked with warning labels.

6.5.6 Protection against fire risks

6.5.6.1 A test shall be carried out taking the form of visual inspection of the wiring sizes and the automatic disconnection devices employed. The supplier shall show how the disconnection hierarchy protects the wiring.

6.5.6.2 The supplier shall explain how the controller as normally installed is protected against build up of explosive gases from the ground.

6.5.7 Test of residual current protection means for the installation

Visual inspection to ensure the requirements of 5.1.1.2.1 are met.

6.5.8 Test of residual current protection means for maintenance supplies

Visual inspection to ensure the requirements of 5.1.1.2.2 are met.

6.5.9 Electrical strength test

Equipment shall be tested to a voltage in accordance with their class of protection against electrical shocks as follows:

2U + 1 000 V for Class I	(EN 61140)
2U + 3 000 V for Class II	(EN 61140)
500 V for Class III	(EN 61140)

6.6 Traffic safety tests

6.6.1 Safety tests (EN 12675)

6.6.1.1 Functional tests shall be carried out to verify that the operational safety requirements in Clause 6 of EN 12675:2000 are met.

6.6.1.2 The tests shall be applied to controllers in all declared modes of operation.

6.6.1.3 In each case the controller shall enter the prescribed mode of operation.

6.6.1.4 Where provision is made in the design of the controller for dimming of signals at night, the tests shall be repeated under the dimmed conditions.

6.6.1.5 At least one test shall be made with the supply voltage set to the minimum level and one test with the supply voltage set to the maximum level.

6.6.1.6 For the purposes of the tests the green threshold condition shall be as specified in 5.2.2.

6.6.1.7 For the purposes of the tests the red lamp monitor threshold condition shall be as specified in 5.2.2.

6.6.1.8 The equipment shall be tested in accordance with 5.2.3.4.

6.6.2 Undervoltage tests

6.6.2.1 The object of this test is to verify that the requirements specified in 4.3 are fulfilled.

6.6.2.2 With the controller operating, the supply voltage shall be progressively reduced and the response of the controller observed. The test is deemed to be a pass if operation continues as normal until the voltage falls below the lower nominal voltage limit. If specified, the voltage shall be further reduced to ensure that the controller does not provide an unsafe response below V_{aux} and V_{off} as defined in 4.3.1.

6.6.3 Power up activation voltage test

6.6.3.1 The object of this test is to verify that the conditions specified in 4.3.2 are fulfilled.

6.6.3.2 The voltage applied to the controller shall be increased from zero to its nominal value. In addition the voltage shall be slowly reduced until the controller ceases normal operation when the voltage shall be slowly increased back to nominal voltage. The rate of rise and fall of the voltage shall be anywhere between 0 s/V and 1 s/V.

6.6.3.3 The test is deemed to be a pass if no abnormal operation occurs, no damage occurs and the controller outputs follow the pre-declared power up sequence.

6.6.4 Overvoltage test

6.6.4.1 The object of this test is to verify that the conditions specified in 4.4 (class D1) are fulfilled.

6.6.4.2 This test, where applicable, shall be carried out on equipment forming the maximum configuration.

6.6.4.3 The voltage applied to the controller shall be increased from its nominal to 1 500 $V_{r.m.s}$. The test is deemed to be a pass if no damage occurs and no unsafe output is displayed. It is permitted for traffic signal lamps and fuses to fail during this test and to be replaced without repeating any other tests.

6.6.5 Power supply voltage dips

6.6.5.1 The object of this test is to verify that the conditions specified in 4.5 are fulfilled.

6.6.5.2 The test shall be carried out on equipment forming the minimum configuration and separately on equipment forming the maximum configuration. In both cases the minimum output power loading on a representative phase may be used to check the correct operation of the outputs.

6.6.5.3 The controller shall be subjected to voltage dips, timed to start at zero of the voltage for periods and durations corresponding to the limits as specified in 4.5.

6.6.5.4 The test is deemed to be a pass if for each limiting case the equipment responds in the correct manner for the relevant limit.

6.7 Electromagnetic compatibility testing

Testing shall be carried out in accordance with EN 50293.

7 Electrical interfaces

7.1 General

The traffic signal control system has many interfaces both between the equipment modules within the signal system and with other items which are not part of the system.

The systems engineer shall consider all of these interfaces to ensure compatibility with regard to physical form, e.g. mounting details and electrical interface which shall include consideration of voltage, current, sense, speed, protocol and failure mode to ensure that the complete system meets the requirements of the standards.

The technical documents for all products shall specify their interfaces to enable compatibility to be checked and verified before installation.

It is not a purpose of this document to lay down standards for these interfaces due to the multiplicity of existing and future standards which will occur with the advent of new technology.

7.2 Detector interface

The detector output shall be interfaced to the controller and may be specified by Special National Conditions or if not available by Works Specification or by any means at the discretion of the manufacturer. If a standard parallel interface is used either isolated contacts or an equivalent solid state device is required.

8 Installation

8.1 General

Before work commences on installing a Road Traffic Signal System as a minimum the following shall be taken into account but this activities are not included in this standard:

a) traffic engineering;
b) civil engineering;
c) electrical supply;
d) electrical interfaces.

The system shall be designed so that it does not confuse road users and so that it does not give ambiguous or incorrect information.

The location of the equipment on site shall take into account all safety aspects throughout its life. This shall cover all aspects including manual operation of the signals and maintenance operation, e.g. doors shall not open into the carriageway.

Checks shall be made on the equipment compatibility, both from the point of view of the electrical interfaces and the mechanical assemblies, to ensure safe operation and maintainability throughout its life.

The results of all installation tests shall be recorded.

NOTE The following example of additional items may be considered during installation but are not specified by this standard:

- cleanliness of optical systems;
- check all signals and ancillary equipment are installed in the correct location and orientation;
- check obstacles between signals and users;
- detector loop insulation to earth;
- check of marking and identification of pieces of equipment;
- check of availability of installation documents and conformity;
- test of signal timings relevant to safety;
- additional tests specified by the manufacturer.

8.2 Tests carried out during installation

The following tests as described in 8.4, 8.5.2, 8.5.3, 8.6, 8.7 and 8.9 are a minimum set of tests and none of these can be omitted or removed. Additional tests or more onerous tests can be added or specified by the customer and additional tests may be recommended by the supplier.

The results of the tests shall be entered onto the Site Inspection Certificate together with the following information:

a) the identity of the installation;

b) the type of earthing arrangement;

c) the earthing arrangements applicable to the supply. For example:

T.N.C. A supply system with a combined neutral and protective conductor "PEN" system, with an earthing terminal provided by the Electricity Supply Authority connected to the supply neutral;

T.N.S. A supply system with a separate neutral and protective conductor, with the earthing terminal which may be provided by the Electricity Supply Authority;

d) the results of all the tests specified in the following paragraphs. All the results shall be checked to ensure that they are acceptable before the system is placed into service.

8.3 Test of cables following the installation of cables

Normally individual tests on cables are not required to be carried out at the time of installation and before termination. These cables are tested together with all the system equipment as described in 8.6 prior to application of the mains supply.

8.4 Inspection of terminations following the installation and termination of all equipment and cables

All cable / wire connections shall be checked for security / tightness as applicable. Special attention shall be given where more than one conductor uses the same terminal.

All conductor / wire insulation shall be checked to ensure that excessive bare conductor is not accessible.

Earth connection throughout the Road Traffic Signal System shall be inspected for security and tightness, e.g.:

- main earthing terminal;
- earth point (earthing conductor);
- all cable armouring;
- controller doors and controller case;
- all conductive doors or access panels on pedestrian push button boxes;
- poles;
- signal heads;
- other ancillary equipment.

8.5 Test of impedance

8.5.1 Protective conductors continuity

Following termination of the protective earth conductor at each post, the resistance of each earth conductor and connection shall be measured by suitable means and the result recorded.

8.5.2 Earth impedance test

The resistance of the earth electrode if fitted and its associated connections shall be measured by suitable means and the result recorded. The sum of the earth impedance and the protective conductor shall be low enough to ensure that the voltage under fault conditions does not exceed 50 V AC and that the protective device will be tripped.

8.5.3 Fault loop impedance test

General information note see also HD 384.4, 413.1.3 and 413.1.4.

Class AA0: No test is required.

Class AA1: Fault loop impedance tests shall be performed to measure the fault path impedance at selected positions within an electrical installation both supply impedance and earth fault loop impedance. The fault path comprises of the installation phase conductors, the electricity supplier's phase conductor, the distribution transformer winding, the electricity supplier's earthing conductor and either the neutral return or earth protective conductor routes. (A phase conductor is a conductor of an AC-system for the transmission of electrical energy, other than a neutral conductor.)

The fault loop impedance test measures the fault loop impedance by connecting live to earth via a low resistance, causing a simulated fault current of approx. 25 A to flow for approximately 20 ms from live to earth around the loop.

Within a traffic signal installation, the nominal mains voltage is distributed from the electricity supplier's cut-out through over-current protection devices of descending values and where applicable, a dimming transformer, to terminal devices, e.g. box signs, aspects, wait indicators. Earth fault loop impedance measurements shall be made at enclosures and posts within the installation where terminal devices are installed. The maximum acceptable earth loop impedance is dependent upon the preceding fuse value. The acceptable loop impedance increases as the current carrying capacity of the fuse decreases.

The maximum allowable earth loop resistance of an electrical installation following an in-line RCD where fitted shall be calculated by using the formula:

$$Z = \frac{50\ x\ 1\,000}{I(mA)}$$

where

I(mA) is the operating current in milliamperes for the RCD.

8.6 Insulation of live parts to earth

When tested at a voltage of at least 500 V DC the insulation resistance of all cables and connections between the signals and the controller shall have an impedance to earth of greater than:

1 MΩ

This is the resistance to earth of the complete installation and shall be measured and recorded as follows.

Set the controller mains isolating device to its isolated state. Using the insulation tester, measure the insulation to earth from both phase and neutral conductors on the controller and record on the certificate.

This test shall be repeated whenever an electrical modification of the installation has been carried out.

8.7 RCD (residual current detector / earth leakage breaker)

a) For the complete system

Where a residual current breaker-protected supply is used to provide disconnection in the event of earth faults within fixed controller equipment the breaker shall be functionally tested by means of an RCD tester.

b) For the maintenance socket

Where a residual current breaker-protected supply is provided within the controller for connection of portable equipment for use by service personnel the breaker (30 mA) shall be tested. The following tests shall be carried out using an RCD tester when:

Test 1: The disconnection time at 30 mA shall be less than 0,2 s;
Test 2: The disconnection time at 150 mA shall be less than 0,04 s.

8.8 Fuses

Check that all fuses are fitted as specified by the equipment manufacturer. The installer may reduce the ratings of the fuses in the controller but the current rating shall not be increased.

8.9 Voltage and polarity of supply

A test shall be performed to verify that the controller is connected to line and neutral in the correct sense. With a voltmeter measure between the following points:

- phase to neutral;
- phase to earth;
- neutral to earth;

and record the results.

8.10 Connections between controllers, signals and ancillary equipment

A test shall be performed to verify that the controller output drivers are connected to the correct signals as detailed in the site documentation.

8.11 Safety covers

Check that all safety covers are in place.

8.12 Functional check of road traffic signal systems

Test that the signals are correct in accordance to the site specification and ensure that the programming of the signal safeguarding facility is correct and the safety measures to prevent dangerous signal states are in operation.

9 Maintenance

9.1 General

To maintain Road Traffic Signal Systems, it is necessary to work on electrical installation in the presence of road traffic. Staff shall be suitably qualified and authorised to work on the equipment. Reference shall be made to the safety rules in applicable standards and regulations.

Under no circumstances shall maintenance operations cause incorrect or unsafe information to be provided to the road users. Particular care shall be taken when conducting operations that could conceal one or more lights or disrupt operation of the signalling equipment.

9.2 Types of maintenance

Maintenance is divided into two categories, preventative maintenance and remedial maintenance. Both types have an effect on safety.

Preventative maintenance is work carried out on installation that appears to be operating correctly and the recommended period between each service visit shall be specified by the equipment manufacturer. It shall include such work as replacement of lamps, cleaning, greasing moving parts, painting and examining for deterioration of the equipment to be able to report that remedial action may be necessary.

Remedial maintenance is required when faults or deterioration of the equipment is reported.

9.3 Documentation required for maintenance

The technical documents shall include literature provided by the equipment manufacturers and technical details of the installation. All of these documents shall be dated and indicate when the latest update was made.

The manufacturers shall provide the following documentation:

- user manuals;
- wiring diagrams of the elements being maintained, e.g. external wiring to modules;
- parts lists;
- list of approved spares which may be used without endangering the safety;
- check list detailing the procedures that need to be carried out for safety reasons;
- recommended procedures for long life and minimum failure rate.

The following installation documents are required:

- area plan indicating the site to be maintained;
- functional diagrams;
- installation diagram;
- wiring diagram;
- parts list;
- maintenance log (details of previous maintenance / repair visits).

9.4 Equipment not covered by this standard

In addition to traffic signal equipment (signalling and control equipment), a Road Traffic Signal System comprises road signs, markings, etc. which shall be satisfactorily maintained. In addition other features of the road environment (vegetation, and other signs) shall be maintained correctly and the effects of these features on junction operation shall be taken into account.

9.5 Safety testing procedures

The following is a list of tests and procedures which may be required for maintenance. They are not exhaustive and additional or a subset of these tests may be recommended by the manufacturer.

Maintenance procedures which are necessary to ensure safety shall be recommended by the equipment manufacturer.

a) Inspection of terminations;
b) Test of impedance:
    1) Protective conductors continuity;
    2) Insulation of live parts to earth;
c) Check all fuses are the correct rating and renew where necessary;
d) Check voltage (where specified) and polarity of supply;
e) RCD (earth leakage breaker) test;
f) Check all safety covers in place;
g) Inspect cleanliness of optical systems:
    1) Routine cleaning;
    2) Cleaning when necessary;
h) Replacement of signal lamps either:
    1) Routine replacement; or
    2) Replacement on failure;
i) Check and replacement of batteries when required;
j) Check all signals and ancillary equipment are in the correct orientation;
k) Check of above ground detector orientation;
l) Check degradation of environmental seals;
m) Functional check of signalling;
n) Functional test of signal safeguarding facility;
o) Check for obstacles between signals and users;
p) Detector loop insulation to earth;
q) Check for installation documents and conformity to these documents;
r) Test of signal timings relevant to safety.

9.6 Maintenance testing procedures

Class Y1: The actual procedures which are to be carried out under maintenance shall be specified by the customer who may request a subset of those recommended by the manufacturer and additions may be requested by the customer.

Class Y2: Shall be as prescribed in Table 2.

Table 2 − Requirements for maintenance measures (intervals (PTI) in months)

1	2	3	4	5	6	7	8	9	10
Pos No.		Master control facilities	Controllers and remotely controlled controllers	Signal heads	Illumina-ted traffic signs	Variable traffic signs	Request units	Cable & wiring distri-butors	Mounting & fixing elements
Maintenance:									
1	Maintenance	Specified by the Installer and depending of the availability requirements of the customer							
2	Cleaning	--	Specified by the customer, but within **12** [c]					--	--
3	Replace lamps	--	--	[d]				--	--
4	General check of function and check of signalling	[f]							
5	Check of the junction layout drawing [b]	--	--	**12**				--	--
Safety related tests and inspection:									
6	Check of safety related timings	--	**8** [g]	--	--	[e]	--	--	--
7	Check of safeguarding facility failure monitor and failure mode Random simulation of one conflict.	--	**4** [h]	--	--	[e]	--	--	--
8	Check of safeguarding facility failure monitor and failure mode Simulation of **all** conflicts.	--	**24** [j] (12) [a]	--	--	[e]	--	--	--
9	Check of Residual Current Detector / earth leakage breaker (RCD)	**6**	**6** [i]	--	--	**6** [i]	--	--	--
10	Check of insulation resistance of cables	if necessary (12) [a]							--
11	Check of protective measures against dangerous shock currents	According to EN 50110-1							--

[a] 12 month interval when the signal safeguarding facility is not conforming to former national standards.

[b] A check of the junction layout drawing does not include re-measuring distances, but a check of conformity with the traffic signs and lane markings.

[c] Preferable the optics.

[d] Corresponding to the service life of lamps and the availability requirements of the customer.

[e] Intervals cannot be defined finally until the technical conditions have been defined.

[f] Specified by the customer, latest at replacing of lamps.

[g] Not necessary, when failsafe intergreen monitoring is used.

[h] At controllers with failsafe, redundant or divers multichannel signal safeguarding facility **and** fully independent ”Switch OFF” units the test interval may be extended to six months.

[i] If the RCD is part of the signal safeguarding facility and footnote h is not applicable, the interval shall be reduced to four months.

[j] The simulation of all conflicts every 24 months may be substituted by systematic simulation of single conflicts every four months so that within 36 months each conflict has been simulated once.

10 Marking and labelling

The finished equipment which contains any electrical, electronic or optical parts shall be clearly and durably marked with the following information. The marking may be inside the unit to provide an acceptable external appearance but it shall be visible when access is obtained to the internal parts. There is no need to mark items which do not have any electrical or optical properties, e.g. poles, mounting brackets, etc.

- Manufacturer's name, trademark or identification mark;
- rated electrical characteristics (voltage, current and frequency);
- manufacturer's model or type reference;
- date of manufacture (month and year);
- details of where the class of construction is provided, e.g. handbook, etc.

EXAMPLE OF MARKING:

Signals Company Ltd.	
230 Volts:	30 A | 50 Hz
Model	Type 3
Manufactured	12/94
Class of Construction and Documentation	667/HB/20200

The terminal points of the PE conductor on bodies shall be easily accessible and shall bear the identification mark as specified in IEC 60417.

11 Classification of environmental test conditions

The environmental test parameters for each class of equipment is given in Table 3.

Table 3 − Environmental testing

Test		
Dry heat EN 60068-2-2:2007, Test Bd	Temperature	**Class AB0:** no test (Solar Radiation Test to Class AH1 required) **Class AB1:** 40 °C **Class AB2:** 55 °C **Class AB3:** 60 °C
Equipment switched ON and fully loaded	Duration	16 h
	Measurement	Final hour at the high temperature, while cooling and at ambient temperature
Cold EN 60068-2-1:2007, Test Ab	Temperature	**Class AE1:** - 10 °C **Class AE2:** - 15 °C **Class AE3:** - 25 °C **Class AE4:** - 40 °C
Equipment OFF until the final hour	Duration	16 h
	Measurement	Final hour at the low temperature, while warming up and at ambient temperature
Change of temperature EN 60068-2-14:2009, Test Nb		Temperatures for dry heat and cold classes shall be used
This test may be carried out instead of the dry heat and cold tests	Rate of change of temperature	1 °C/min
or	Cycles	1
alternatively this test is not required if the dry heat and cold test has been completed	Exposure	16 h
During the hot period equipment switched ON and fully loaded and during the cold period equipment switched OFF until the final hour	Measurement	Last hour at the low temperature, while warming up and at ambient temperature Last hour at the high temperature, while cooling and at ambient temperature
Damp Heat, Cyclic EN 60068-2-30:2005, Test Db	Temperature	40 °C
Equipment ON and fully loaded	Cycles	**Class AK1:** 1 **Class AK2:** 2
	Variant	2
	Measurement	First 3 h of both cycles, cool down period after last cycle
Solar radiation EN 60068-2-5:1999, Test Sa	Test procedure:	B **Class AH0:** No test **Class AH1:** Test required
Equipment ON and fully loaded	Temperature:	+ 40 °C
	Cycles:	1
	Measurement	First 3 h, last hour of radiation, and during cool down period

Table 3 − Environmental testing *(continued)*

Test		
Water penetration EN 60529:1991, Test 14		As required to meet the specified IP rating
EMC test As specified in 6.7		Yes
Impact for equipment enclosure EN 50102		IK07: 2 J impact test either drop test or spring hammer
	Criteria:	No cracks or penetration allowed
Class AM: Random Vibration (Transportation and Operational) EN 60068-2-64:2008, Test Fh It is considered that the prime concern is for safety during operation and that the vibration testing levels set here which are those that might be expected during transportation are in excess of normal operational vibration levels. Where the market / country specification states that this transportation test is required (generally where suppliers do not provide final on site testing after transportation prior to handing over in to normal operation) the test can be completed in one of two ways. The test may complete the test with the equipment unpackaged and configured for normal operation where this test can then be considered as covering both transportation and operation. The supplier may at there discretion perform this test with the equipment packaged, however it should be noted that if they do so then an unpackaged operational only test shall also be completed (as detailed in the next section).	Frequency range:	(10 – 500) Hz
	ASD spectrum levels:	0,02 g^2/Hz (10 Hz – 50 Hz) 0,01 g^2/Hz (50 Hz – 150 Hz) 0,002 g^2/Hz (150 Hz – 500 Hz) Overall RMS acceleration: 1,58 g
	Duration:	in each of the three axes **Class AM1:** 1 h **Class AM2:** 2 h

Table 3 − Environmental testing *(continued)*

Test		
Class AL: Random Vibration (Operational) EN 60068-2-64:2008, Test Fh It is considered that the prime concern is for safety during operation and that the vibration testing levels, set here, are those that might be expected during operation. If this test only is specified by market / country requirements, or the supplier takes full responsibility for transportation and putting the equipment in to operation after transportation, then this test alone need be completed. During this test the equipment shall not be packaged for transportation it shall be as it will be during operation.	Frequency range:	(5 – 500) Hz
	ASD spectrum levels:	**Lateral & Fore/Aft axes** Frequency (Hz) — Level (g^2/Hz) 5 — 9,50E-06 10 – 15 — 2,62E-04 25 – 48 — 1,57E-05 54 – 176 — 7,40E-06 205 – 450 — 1,22E-04 465 — 1,57E-03 500 — 8,84E-05 Overall RMS acceleration 0,248 g **Vertical axis** Frequency (Hz) — Level (g^2/Hz) 5 — 1,77E-04 8 – 15 — 1,31E-03 32 — 2,34E-05 197 — 1,58E-06 215 — 7,53E-06 315 — 1,73E-05 436 — 5,09E-06 464 — 8,66E-05 500 — 1,94E-05 Overall RMS acceleration 0,148 8 g
	Duration:	in each of the three axes **Class AL1:** 1 h **Class AL2:** 2 h

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