



Scottish Health Technical Memorandum 2035

(Part 1 of 3)

Overview and management responsibilities

Mains signalling

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Executive summary

Mains signalling is a means of transmitting information or control signals by superimposing them on the low-voltage (230 volts) mains power supply conductors.

Mains signalling is a method of communication to be compared with other systems such as:

- a. radio transmission;
- b. fixed wiring.

Every healthcare premises will have a low-voltage network (230 V) installed within its fabric. This network extends to virtually every part of the building through the existence of socket-outlets. By utilising these conductors for specified communication signals, economies in data cabling provision may be possible.

While voice communication is used to exchange information, data signals can be sent/received for simple purposes such as calls for attention from patients, or for more complex applications such as monitoring/recording the output from medical equipment and for building management systems.

Historically, on the domestic scene, the simplest application of mains signalling equipment was in its use as baby alarms or with simple intercoms. Electricity supply authorities have used their networks as a signalling medium since the 1930s to control such functions as tariff switching, load management and street lighting.

This part, 'Overview and management responsibilities', outlines to chief executives and managers of healthcare premises their overall responsibility and details their legal obligations in installing and operating a mains signalling system of communication.

Management responsibilities in terms of compliance with statutory instruments are summarised in Chapter 2. An overview of mains signalling systems is given in Chapter 3. Testing and inspection criteria are briefly outlined in Chapter 4. Chapter 5 guides managers on the actions necessary for them to implement the recommendations of this SHTM. Chapter 6 contains definitions of selected staff functions. A glossary of some terms, is included in Chapters 7, and the Reference section completes the part.



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1. Scope

General

- 1.1 Healthcare premises need to send and receive information of many kinds in order to fulfil their function.

NOTE: Throughout this document, healthcare premises will include social services premises covered by the Registered Establishments (Scotland) Act 1998 in Scotland.

- 1.2 Voice communication is used to exchange information both of an administrative nature and in relation to patient care.
- 1.3 Data signals have to be sent and received for simple purposes such as calls for attention from patients, or for more complex applications such as monitoring and recording the output from medical equipment and for building management systems.

NOTE: Mains signalling installations operate in the frequency range 3 kHz to 148.5 kHz. This range makes mains signalling unsuitable for computer local area network applications operating at speeds upwards of 10 MHz.

- 1.4 Mains signalling is a method of communication to be compared with:
- infra-red;
 - radio;
 - fixed wiring (twisted pair).

NOTE: Refer also to SHTM 2005; *Building management systems*.

- 1.5 It has many advantages and some disadvantages, both technical and economic, which need to be considered when choosing a communication system for a particular purpose.
- 1.6 Except for the simplest applications, such as intercoms, mains signalling systems need to be matched to the network on which they are to operate. The purpose of this guidance is to enhance the information available to the designer/purchaser of systems and equipment.
- 1.7 The scope of this Scottish Health Technical Memorandum is limited to mains signalling on the low-voltage installations on a single site. It considers signalling on the public mains only as a matter of background information.



NOTE: In this context, low-voltage implies the 230 V mains voltage.
A single site can comprise more than one building.

- 1.8 Where a building is occupied by more than one user of mains signalling equipment, an agreement has to be reached regarding the adaptation of either separate frequencies or specific allocated times.

2. Management responsibilities

- 2.1 It is incumbent on management to ensure that their electrical installations (including mains signalling systems) comply with all the statutory regulations applicable to communications on their premises. Other functional guidance in terms of standards and codes of practice should be noted.

Statutory requirements

- 2.2 Safety regulations are as laid down in:
- a. the Health and Safety at Work etc Act 1974;
 - b. the Electricity at Work Regulations 1989;
 - c. the Electricity Supply Regulations 1988;
 - d. the Management of Health and Safety at Work Regulations 1999;
 - e. the Provision and Use of Work Equipment Regulations (PUWER) 1998;
 - f. the Manual Handling Operations Regulations 1992;
 - g. the Workplace (Health, Safety and Welfare) Regulations 1992;
 - h. the Personal Protective Equipment at Work (PPE) Regulations 1992;
 - i. the Health and Safety (Display Screen Equipment) Regulations 1992;
 - j. the Supply of Machinery (Safety) Regulations 1992;
 - k. the Low Voltage Electrical Equipment (Safety) Regulations 1989;
 - l. the Construction (Design and Management) Regulations 1994;
 - m. the Electromagnetic Compatibility Regulations 1992.

NOTE: Where there is a requirement to address any of the above, care should be taken to ensure that all amendments following the date of issue are included.



Functional guidance

2.3 Guidance is as laid down in:

- a. British Standards and Codes of Practice;
- b. Health and Safety Executive Guidance;
- c. NHS Model Engineering Specifications – NHS Estates;
- d. Scottish Hospital Planning Notes and Health Building Notes;
- e. Building Standards (Scotland) Regulations 1990;
- f. Scottish Health Technical Memoranda and NHS in Scotland Firecode.

NOTE: For further details please refer to the Reference section.

3. Functional overview

General

- 3.1 Mains signalling is a means of transmitting information or control signals by superimposing them on the low-voltage (230 volts) mains power supply conductors. In this respect the possible signalling applications are similar to those that might be carried out by signals using pilot wires.

NOTE: The terms “mains signalling” and “mains communication” are used interchangeably in this SHTM. The term “mains signalling” has been used commonly in the UK but “mains communication” is used in the titles of some international committees.

Background

- 3.2 The use of mains power conductors to carry data or control signals is not new. For instance, “ripple control” has been used for many years, although not extensively in the UK, by supply undertakings for such applications as tariff switching or street lighting control.

NOTE: Throughout this document, the term “low-voltage network” is used to mean the low-voltage (230 V) mains power distribution supply system.

- 3.3 This application required a considerable amount of power to inject the signal, thus restricting the applications to cases where one signalling source could serve a large number of receivers.
- 3.4 Modern technology has made it easy to generate (transmit) and detect signals at much lower powers and higher frequencies, which has greatly extended the list of possible applications.

Regulations affecting mains signalling

- 3.5 Mains signalling equipment, like most electrical and electronic equipment, comes within the scope of the Electromagnetic Compatibility (EMC) Regulations. Under these regulations all relevant apparatus supplied or taken into use in the UK is required to conform with the essential “protection” requirements of the European EMC Directive, and to carry the CE mark.

NOTE: This is applicable from 1 January 1996, but not retrospectively; it also includes imports. In a healthcare environment, this requirement is particularly relevant due to the vast range of sensitive medical electrical equipment being used.

- 3.6 The EMC Directive requires equipment and systems not to cause excessive electromagnetic interference (EMI), and not to be unduly affected by EMI in its environment when it is properly installed and used for the purpose for which it was intended.
- 3.7 In the case of mains signalling equipment, conformity with the regulations implies compliance with BS EN 50065 'Specifications for signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz'.
- 3.8 By affixing the CE mark to apparatus, a manufacturer makes a statement that his equipment conforms with the requirements of all relevant Directives.
- 3.9 Although the first duty of compliance with the EMC regulations lies with the manufacturer or supplier, the person who takes equipment into service is equally responsible for compliance.
- 3.10 Electricity supply companies are interested in signalling on the distribution mains for remote meter reading and similar applications. The signalling frequency range of 3 kHz to 95 kHz is reserved for supply company use.
- 3.11 To reduce the possibility of interference between the supply companies' signals and the signals used in buildings, the latter are restricted to frequencies between 95 kHz and 148.5 kHz.
- 3.12 There is no obligation to advise the electricity supplier that mains signalling is in use provided that it complies with the regulations discussed above.
- 3.13 The use of public supply mains to signal between different premises is prohibited by legislation as indicated in the Telecommunications Act 1984.

Types of system for use in buildings

Voice communications

- 3.14 The simplest use of mains signalling is for voice communication. Readily available devices are offered to allow carers to listen to cries for attention from babies or calls from sick people. The cheapest devices usually provide only one-way communication, but others giving two-way communication can also be obtained.
- 3.15 Privacy is minimal and it should be assumed that transmissions within the range of one transmitter may be received by users of other similar receivers in the vicinity.

NOTE: Facilities may be provided to change the carrier frequency of the equipment to discriminate between different callers.

Data communication

- 3.16 Using modern modulation and signal processing techniques, low-speed data can be transmitted reliably in digital form over the mains wiring. By this means, information can be transmitted for building management purposes, other remote control applications and the remote registration of instrument readings.

Transmission range

- 3.17 It is difficult to state the transmission range. The signals are certainly attenuated (reduced in strength) by the mains cables and probably by system loads. Further, it may not be possible to communicate between every socket-outlet within a healthcare premises.

NOTE: Most healthcare premises are supplied via a three-phase transformer, where the distribution system, including socket-outlets, is evenly balanced across the three phases. In practice “mains signalling” will not transfer through a distribution transformer.

Safety

- 3.18 Mains signalling equipment, as such, is no more dangerous than any other electronic equipment. Conformity to the safety requirements for low-voltage equipment is certified by the manufacturer affixing the CE mark, but functional safety aspects should be considered in planning a system incorporating mains signalling.

NOTE: Refer to the Low-Voltage Electrical Equipment (Safety) Regulations 1989.

- 3.19 Safety precautions for the normal operation of all control systems are the same whatever method of signal transmission is used. In such cases controlled equipment such as luminaires or motor-driven pumps needs to be treated as live at all times.



Security

- 3.20 A particular feature of mains signalling is that all signals share the same communications path, so the design has to ensure that different signals do not interfere with each other. Also, as with any signalling system using an open transmission medium such as radio or the low-voltage network mains, one must take into account the possibility that the signals may be affected accidentally by interference from other loads on the system or, conceivably, by disturbances deliberately injected.

4. Testing and inspection criteria

- 4.1 Account should be taken of the dual function of mains signalling equipment, that is, as a piece of electronic equipment and as part of a communications network connected to the low-voltage network.
- 4.2 As for any other electronic equipment, testing, inspection and maintenance of mains signalling equipment should be carried out in compliance with the requirements of the Electricity at Work Regulations 1989. This requires that only authorised personnel have access to electrical equipment and supplies.

NOTE: Also refer to SHTM 2020; *Electrical safety code for low voltage systems*.

- 4.3 Personnel who have to work on mains signalling equipment have to understand not only the operation of the signalling devices but also the implications of the interconnection of the signalling channel and the power distribution wiring.
- 4.4 Testing procedures should take account of the need to check correct operation when the equipment would not otherwise be required to function; for instance, temperature control of heating systems during the summer.

NOTE: Refer also to SHTM 2005; *Building management systems*.

5. Management summary

- 5.1 Apart from the simplest systems for voice communication, which are installed by plugging into a convenient socket, the successful operation of a mains signalling installation is strongly dependent on its being designed to meet the needs of the user.

NOTE: A full risk analysis is recommended. Refer to HTM 2050.

- 5.2 Management should therefore ensure that careful attention is given to the preparation of a detailed specification.

NOTE: Guidance on the points to be covered is given in SHTM 2035; 'Design considerations'.

- 5.3 Management should ensure that when mains signalling equipment is installed, electrical maintenance staff are adequately trained to understand the technology and implications both to maintain and repair the signalling equipment itself and to take appropriate action on the low-voltage distribution system.

NOTE: There may be a requirement for specialist test and installation equipment.

- 5.4 According to the nature and size of the installation, a sufficient number of electrical maintenance staff will be needed to deal with unpredictable faults.
- 5.5 A plan should be established for locating and repairing faults, taking account of relative priorities.

6. Designated staff functions

- 6.1 Only trained authorised and competent persons should be appointed by management to control the operation and maintenance of mains signalling.
- 6.2 **Management:** the owner, occupier, employer, general manager, chief executive or other person who is accountable for the premises and is responsible for issuing or implementing a general policy statement under the HSW Act 1974.
- 6.3 **Designated person (electrical):** an individual who has overall authority and responsibility for the premises containing the electrical supply and distribution system within the premises and has a duty under the HSW Act 1974 to prepare and issue a general policy statement on health and safety at work, including the organisation and arrangements for carrying out that policy. This person should not be the authorising engineer.
- 6.4 **Duty holder:** a person on whom the Electricity at Work Regulations 1989 impose a duty in connection with safety.
- 6.5 **Employer:** any person or body who:
- employs one or more individuals under a contract of employment or apprenticeship;
 - provides training under the schemes to which the Health and Safety (Training for Employment) Regulations 1990 (SI 1380) apply.
- 6.6 **Authorising engineer (low voltage):** a Chartered Engineer or Incorporated Electrical Engineer with appropriate experience and possessing the necessary degree of independence from local management who is appointed in writing by management to implement, administer and monitor the safety arrangements for the low voltage electrical supply and distribution systems of that organisation to ensure compliance with the Electricity at Work Regulations 1989, and to assess the suitability and appointment of candidates in writing to be authorised persons (see SHTM 2020; *Electrical safety code for low voltage systems (Escode – LV)*).
- 6.7 **Authorised person (LV – electrical):** an individual possessing adequate technical knowledge and having received appropriate training, appointed in writing by the authorising engineer to be responsible for the practical implementation and operation of management's safety policy and procedures on defined electrical systems (see SHTM 2020).
- 6.8 **Competent person (LV – electrical):** an individual who in the opinion of an authorised person has sufficient technical knowledge and experience to prevent danger while carrying out work on defined electrical systems (see SHTM 2020).

7. Definitions

Department: an abbreviation of the generic term “UK Health Departments”, Scottish Executive Health Department.

System: a system in which all the electrical equipment is, or may be, electrically connected to a common source of electrical energy, including such source and such equipment.

Injury: death or personal injury from electrical shock, electrical burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.

Danger: a risk of injury.

Low voltage (LV): the existence of a potential difference (rms value for a.c.) not exceeding 1000 volts a.c. or 1500 volts d.c. between circuit conductors or 600 volts a.c. or 900 volts d.c. between circuit conductors and earth.

Mains signalling: a means of transmitting information or control signals by superimposing them on the low-voltage (230 volts) mains power supply conductors.

Public supply mains: the electrical supply network that is operated by the electricity companies.

Electrical/electronic equipment: includes anything used, intended to be used or installed to generate, provide, transmit, transform, conduct, distribute, control, measure or use electrical energy.

Equipment: abbreviation of electrical/electronic equipment.

Ripple control: a method of controlling electricity consumption tariffs and electrical loading by the superposition of signal voltages on the low-voltage distribution system, usually in the frequency range 175 Hz to 2 kHz.

Electromagnetic compatibility (EMC): capability of electronic equipment or systems to be operated with a defined margin of safety, in the intended operational environment, at designed levels of efficiency, without degradation due to interference.

Electromagnetic interference (EMI): any undesirable electromagnetic signals causing a malfunction in equipment.

Attenuation: a reduction in the strength of a signal.

Distribution line carrier (DLC): another name for low-voltage mains signalling.



Power line carrier (PLC): another name for mains signalling; originally applied to the transmission of signals on high-voltage overhead lines but now used more generally.

Building management system (BMS): a system comprising electronic equipment and software whose prime function is to control and monitor the operation of building services within a building, including heating, air-conditioning, lighting, and other energy-using areas.

Data: a representation of information or instruction in a formalised manner suitable for communication, interpretation, or processing by humans or computer.

CE mark: a European Commission logo indicating that the equipment/device meets all the relevant European Directives and satisfies the requirements essential for it to be fit for its intended purpose.

References

NOTE:

Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

Publication ID	Title	Publisher	Date	Notes
Acts and Regulations				
	The Building (Scotland) Act	HMSO	1959	
	Clean Air Act	HMSO	1993	
	Electricity Act	HMSO	1989	
	Health and Safety at Work etc Act	HMSO	1974	
	Registered Establishments (Scotland) Act	HMSO	1998	
	Telecommunications Act	HMSO	1984	
	The Water (Scotland) Act	HMSO	1980	
SI 3146	The Active Implantable Medical Devices Regulations	HMSO	1992	
SI 2179 & 187	The Building Standards (Scotland) Regulations (as amended)	HMSO	1990	
	The Building Standards (Scotland) Regulations: Technical Standards Guidance	HMSO	1998	
SI 1460	Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2)	HMSO	1997	
SI 3140	Construction (Design and Management) Regulations	HMSO	1994	
SI 437	Control of Substances Hazardous to Health Regulations (COSHH)	HMSO	1999	
SI 635	Electricity at Work Regulations	HMSO	1989	
SI 1057	Electricity Supply Regulations (as amended)	HMSO	1988 (amd 1994)	
SI 2372	Electromagnetic Compatibility Regulations (as amended)	HMSO	1992	
SI 2451	Gas Safety (Installation and Use) Regulations	HMSO	1998	
SI 917	Health & Safety (First Aid) Regulations	HMSO	1981	
SI 682	Health & Safety (Information for Employees) Regulations	HMSO	1989	



Publication ID	Title	Publisher	Date	Notes
SI 2792	Health and Safety (Display Screen Equipment) Regulations	HMSO	1992	
SI 341	Health and Safety (Safety Signs and Signals) Regulations	HMSO	1996	
SI 1380	Health and Safety (Training for Employment) Regulations	HMSO	1990	
SI 2307	Lifting Operations and Lifting Equipment Regulations (LOLER)	HMSO	1998	
SI 728	Low Voltage Electrical Equipment (Safety) Regulations	HMSO	1989	
SI 3242	Management of Health and Safety at Work Regulations	HMSO	1999	
SI 2793	Manual Handling Operations Regulations	HMSO	1992	
SI 3017	The Medical Devices Regulations	HMSO	1994	
SI 1790	Noise at Work Regulations	HMSO	1989	
SI 3139	Personal Protective Equipment (EC Directive) Regulations (as amended)	HMSO	1992	
SI 2966	Personal Protective Equipment at Work (PPE) Regulations	HMSO	1992	
SI 128	Pressure Systems Safety Regulations (PSSR)	HMSO	2000	
SI 2306	Provision and Use of Work Equipment Regulations (PUWER)	HMSO	1998	
SI 3163	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	HMSO	1995	
SI 3004	Workplace (Health, Safety and Welfare) Regulations	HMSO	1992	
British Standards				
BS 800	Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus	BSI Standards	1988	Amd 6275, 6/90 ; Amd 6578, 6/91
BS 4737	Intruder alarm systems	BSI Standards		
BS 5378-1	Safety Signs and Colours. Specification for colour and design	BSI Standards	1980	
BS 5445	Components of automatic fire detection systems	BSI Standards		
BS 6238	Code of practice for performance monitoring of computer-based systems	BSI Standards	1982 (1993)	



Publication ID	Title	Publisher	Date	Notes
BS 7671	Requirements for Electrical Installations. IEE Wiring Regulations	BSI Standards	1992	(Amd 8356, 01/95)
BS 7807	Code of practice for design, installation and servicing of integrated systems incorporating detection and alarm systems and/or security systems for buildings other than dwellings	BSI Standards	1995	
BS EN 55011	Specification for limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment	BSI Standards	1991	
BS EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment	BSI Standards	1993	
BS EN 50065	Specification for signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz	BSI Standards	1992	
BS EN 50065-1	General requirements, frequency bands and electromagnetic disturbances	BSI Standards	1992	
BS EN 60065	Safety requirements, audio, video and similar electronic apparatus	BSI Standards	1998	
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)	BSI Standards	1992	
BS EN ISO 9000	Quality management and quality assurance standards	BSI Standards		
IEC Publication 417	Graphs symbols for use on equipment	IEC		
IEC 27, 148, 164, 416 and 617	Letter symbols, signs, abbreviations and graphical symbols	BSI Standards		
IEC Publication 50	International electrotechnical vocabulary	BSI Standards		
Scottish Health Technical Guidance				
SHTM 2005	Building management systems	P&EEx	2001	CD-ROM
SHTM 2007	Electrical services supply and distribution	P&EEx	2001	CD-ROM
SHTM 2011	Emergency electrical services	P&EEx	2001	CD-ROM
SHTM 2014	Abatement of electrical interference	P&EEx	2001	CD-ROM
SHTM 2015	Bedhead services	P&EEx	2001	CD-ROM



Publication ID	Title	Publisher	Date	Notes
SHTM 2020	Electrical safety code for low voltage systems (Escode – LV)	P&EEx	2001	CD-ROM
SHPN 1	Health service building in Scotland	HMSO	1991	
SHPN 2	Hospital briefing and operational policy	HMSO	1993	
SHPN 48	Telecommunications	HMSO		
SHTN 1	Post commissioning documentation for health buildings in Scotland	HMSO	1993	
SHTN 2	Domestic hot and cold water systems for Scottish Health Care Premises	P&EEx	2001	CD-ROM
SHTN 4	General Purposes Estates and Functions Model Safety Permit-to-Work Systems	EEF	1997	
	NHS in Scotland – PROCODE	P&EEx	2001	Version 1.1
MEL 46; 56	Management Executive Letters	Scottish Office	1993	
NHS in Scotland Firecode				
SHTM 81	Fire precautions in new hospitals	P&EEx	1999	CD-ROM
SHTM 82	Alarm and detection systems	P&EEx	1999	CD-ROM
SHTM 83	Fire safety in healthcare premises: general fire precautions	P&EEx	1999	CD-ROM
SHTM 84	Fire safety in NHS residential care properties	P&EEx	1999	CD-ROM
SHTM 85	Fire precautions in existing hospitals	P&EEx	1999	CD-ROM
SHTM 86	Fire risk assessment in hospitals	P&EEx	1999	CD-ROM
SHTM 87	Textiles and furniture	P&EEx	1999	CD-ROM
SFPN 3	Escape bed lifts	P&EEx	1999	CD-ROM
SFPN 4	Hospital main kitchens	P&EEx	1999	CD-ROM
SFPN 5	Commercial enterprises on hospital premises	P&EEx	1999	CD-ROM
SFPN 6	Arson prevention and control in NHS healthcare premises	P&EEx	1999	CD-ROM
SFPN 7	Fire precautions in patient hotels	P&EEx	1999	CD-ROM
SFPN 10	Laboratories on hospital premises	P&EEx	1999	CD-ROM
UK Health Technical Guidance				
EH 40	HSE Occupational Exposure limits	HSE	Annual	
MES	Model Engineering Specifications	NHS Estates	1997	As required