

The IEE Regulations, BS 7671 and this Guide

1.1 THE NEED FOR THIS ELECTRICIAN'S GUIDE

The BS 7671 Regulations published by the IET (IEE) summarise all requirements for electrical installations. The document has a legal character and is therefore not always easily understood and implemented by electricians.

The Author of this book has published a guide to the Regulations for over thirty years. The level of detail has been carefully adjusted to ensure relevance as well as ease of understanding and implementation for practising electricians. Over the years, the Electrician's Guide to the Wiring Regulations has proved popular and successful.

This Guide to the 17th Edition is a continuation of the successful series. Again the content has been adjusted to ensure relevance and ease of understanding. It is intended to be accessible to all electricians, including the many electricians who are left to work on their own without the immediate backup of designers. For example, the formulas provided have been simplified in such a way that electricians without advanced maths knowledge can perform the necessary calculations and make the correct installation decision. Students learning to become electricians will also benefit from this approach.

The Author of this Electrician's Guide realises that there is also the 'Electrical Installation Design Guide' published by the Institution of Engineering and Technology (IET), (which was the Institution of Electrical Engineering (IEE)) and the British Standards Institute (BSI). Although the publication contains useful information, in the opinion of this Author, this Electrician's Guide offers a valuable alternative because of the assumptions and approach taken. That is, it is accessible to all electricians, including those working without the support of designers or without advanced maths knowledge, and to student electricians. Those accustomed to his previous editions will also find the style and format familiar.

This Electrician's Guide is not intended to replace the complete Regulations, although all the key regulations have been extracted and explained in the book. If an electrician wishes to master the subject, he/she should also equip him/herself with the Regulations and associated documents. It would be foolish to assume that every detail of BS 7671 is covered in this book, which has only a fraction of the space covered by the 461 pages of the document. Regulations concerning a few very specialist types of installation that are unlikely to be met by most practical electricians have been omitted.

Note on Supply Voltage Level

For many years the supply voltage for single-phase supplies in the UK has been 240 V $\pm$ 6%, giving a possible spread of voltage from 226 V to 254 V. For three-phase supplies the voltage was 415 V $\pm$ 6%, the spread being from 390 V to 440 V. Most continental voltage levels have been 220/380 V.

In 1988 an agreement was reached that voltage levels across Europe should be unified at 230 V single phase and 400 V three-phase with effect from January 1st, 1995. In both cases the tolerance levels were then -6% to $+10\%$, giving a single-phase voltage spread of 216 V to 253 V, with three-phase values between 376 V and 440 V. On January 1st, 2008 the tolerance levels were widened to $\pm 10\%$. This results in acceptable values from 207 V to 253 V for single-phase supplies, and 360 V to 440 V for three-phase supplies.

Since the original supply voltages in the UK lie within the acceptable spread of values, Supply Companies in the UK have not reduced their voltages from 240/415 V. This is hardly surprising, because such action would immediately reduce the energy used by consumers (and the income of the Companies) by more than 8%.

Tables in the 17th Edition have been recalculated to take account of the unified voltage levels. Following this lead, calculations in this book have been based on supply voltages of 230 V and 400 V, but the electrician must bear in mind that true values are higher.

In due course, it is to be expected that manufacturers will supply appliances rated at 230 V for use in the UK. When they do so, there will be problems. A 230 V linear appliance used on a 240 V supply will take 4.3% more current and will consume almost 9% more energy. A 230 V rated 3 kW immersion heater, for example, will actually provide almost 3.27 kW when fed at 240 V. This means that the water will heat a little more quickly but there is unlikely to be a serious problem other than that the life of the heater may be reduced, the level of reduction being difficult to quantify. An immersion heater rated at 3 kW at 230 V but used on a 240 V supply will draw a current slightly in excess of 13 A. Long experience has shown us that 13 A plugs overheat when carrying 12.5 A, so here is yet another argument for not using plugs and sockets to feed 3 kW appliances.

Life reduction is easier to specify in the case of filament lamps. A 230 V rated lamp used at 240 V is likely to achieve only 55% of its rated life (it will fail after about 550 hours instead of the average of 1,000 hours) but will be brighter and will run much hotter, possibly leading to overheating problems in some luminaires. The fact that filament lamps will be phased out on the grounds of inefficiency may well solve the problem eventually. At the higher voltage the starting current for large concentrations of discharge lamps will increase dramatically, especially when they are very cold. High pressure sodium and metal halide lamps will show a significant change in colour output when run at higher voltage than their rating, and rechargeable batteries in 230 V rated emergency lighting luminaires will overheat and suffer drastic life reductions when fed at 240 V.

There could be electrical installation problems here for the future!

1.2 THE IEE REGULATIONS – BS 7671

1.2.1 International basis

All electricians are aware of 'The Regs'. For over a hundred years they have provided the rules that must be followed to ensure that electrical installations are safe. In 2007 the Institution of Electrical Engineers (the IEE) merged with the Institution of

Electronics and Electrical Incorporated Engineers (IEEIE) to form the Institution of Engineering and Technology, known as the IET. However, the term 'IEE' is often retained for the Regulations to prevent possible confusion.

A publication such as 'the Regs' must be regularly updated to take account of technical changes, and to allow for the 'internationalisation' of the Regulations. The ultimate aim is that all countries in the world will have the same wiring regulations. National differences make this still a dream, but we are moving slowly in that direction. The 15th Edition, when it was published in 1981, was the first edition of the IEE Regulations to follow IEC guidelines, and as such was novel in Great Britain. It was totally different from anything we had used before. The 16th and 17th Editions have not come as such a shock.

The international nature of the Regulations sometimes has strange results. For example, in {2.8} there are Regulations covering protection of installations from lightning – in fact, this work can be ignored in the UK because [443.2] points out that no action is necessary if the number of thunderstorm days for the region is less than 25 per annum. Since the UK (but not other parts of Europe) has less lightning activity than this level, these Regulations can be ignored here.

A word is necessary about the identification of parts of this Electrician's Guide and of BS 7671 – the IEE Regulations. In this Electrician's Guide, Regulation numbers are separated by a full point (full stop) and indicated by placing them in square brackets. Thus, [515.3.2] is the second Regulation in the third Section of Chapter 15. in Part 5. To avoid confusion, sections and sub-sections of this Electrician's Guide are divided by full points and enclosed in curly brackets. Hence, {5.4.6} is the sixth sub-section of section 4 of Chapter 5 of this Electrician's Guide.

1.2.2 The Seventeenth Edition

The 17th Edition of BS 7671:2008 Requirements for Electrical Installations, also known as the 17th Edition of the IEE Wiring Regulations, was published in January 2008, and amended in July 2011, these changes becoming effective from January 1st, 2012.

As stated earlier, the current trend is to move towards a set of wiring regulations with worldwide application. IEC publication 364 *Electrical Installations of Buildings* has been available for some time, and the 17th Edition is based on many of its parts. The European Committee for Electrotechnical Standardisation (CENELEC) uses a similar pattern to IEC 364 and to the Wiring Regulations, which, in the 17th Edition has moved still closer to it.

The introduction of the Free European Market in 1993 might well have caused serious problems for UK electrical contractors because, whilst the IEE Wiring Regulations were held in high esteem, they had no legal status that would require Europeans who were carrying out installation work in the UK to abide by them. This difficulty was resolved in October 1992 when the IEE Wiring Regulations became a British Standard, BS 7671, giving them the required international standing. From 2010, BS 7671, together with some Guidance Notes and other associated publications, is available in fully searchable digital form.

It does not follow that an agreed part of IEC 364 will automatically become part of the IEE Wiring Regulations. BS 7671 recognises all harmonised standards (or Harmonised Documents, HDs) that have been agreed by all member states of the European Union. BS EN standards are harmonised standards based on harmonised documents and are published without addition to or deletion from the original HDs. When a BS EN is published the relevant BS is superseded and is withdrawn. A har-

mo rised standard, e.g. BS 7671, may have ad d itions but not de l etions from the original standard. IEC and CENELEC publications follow the pattern that will be shown in {1.2.3}, and it is not always easy to find which Regulations apply to a given application. For example, if we need to find the re quire ments for bond ing, there is no set of Regulations with that title to which we can turn. In stead, we need to consider four separate parts of the Reg ula tions, which in this case are:

- 1 [Chapter 13] Regulation [131.2.2]
- 2 [Section 415] Regulation [415.2]
- 3 [Section 514] Regulation [514.13]
- 4 [Sections 541, 542, 543 and 544] complete.

The question arises 'how do we know where to look for all these dif fer ent Regulations'? The answer is two-fold. First, the Regulations them selves have a good index. Second, this Electrician's Guide also has a useful index, from which the applicable sub-section can be found. At the top of each sub-section in square brackets is the number(s) of the applicable Regulation(s). This Guide also has a Cross Reference Index, so that if the BS 7671 number is known the explanation can be found quickly.

The detail applying to a particular set of circumstances is thus spread in a number of parts of the Regulations, and the overall picture can only be ap pre hended after considering all these separate pieces of information. This Guide is particularly useful in drawing all this information together.

1.2.3 Changes due to the 17th Edition

Some of the changes in the original 17th Edition that particularly affect the average electrician are listed below, but it must be stressed that this list is not comprehensive.

- Requirements for safety services are included [35].
- The term 'direct contact' is now called 'basic protection' and 'indirect contact' becomes 'fault protection' [41].
- Most socket outlet circuits are now required to be protected by 30 mA RCDs [41].
- Tables of maximum earth-fault loop impedance have been modified assuming a supply voltage of 230 V rather than 240 V, giving slightly reduced values [Tables 41.2 to 41.4].
- A new table giving maximum earth-fault loop impedances for RCD-protected circuits has been provided [Table 41.5].
- Functional extra-low voltage (FELV) is now accepted as a protective measure [41].
- 30 mA RCD protection is now acceptable rather than metal covering for concealed cables outside accepted zones [52].
- Metallic water pipes may now be used as earth electrodes in some cases [54].
- Work on circuits with high protective currents has been moved from 'special installations' to the body of the Regulations [543.7].
- A new set of Regulations covering lighting has been added [559].
- The Regulations dealing with Safety Services have been extended [56].
- Parts 6 (Special Installations) and 7 (Inspection and Testing) have changed places.
- The minimum acceptable insulation resistance value has increased from 0.5 M Ω to 1.0 M Ω [612.3.2].

- Requirements for low voltage generating sets are included [55].
- Expanded requirements for emergency escape lighting and fire protection are added [56].
- Highway power supplies have been moved from 'special installations' to the body of the Regulations [559].
- The zones for bathroom installations have been reclassified, each circuit in a bathroom now requires 30 mA RCD protection, and socket outlets can be installed in bathrooms provided that they are more than 3 m from the bath [701].
- The requirement for a shorter disconnection time for agricultural, horticultural and construction site installations intended to limit shock voltage to 25 V no longer applies and they now have a 50 V level like other installations [704 and 705].
- Socket outlets to feed caravan sites must now be individually RCD protected rather than in groups [708].
- Regulations for caravans have been moved to a new Section [708], away from caravan site installations [721].
- New Sections in Part 7 include:-
Marinas and similar locations [709]
Exhibitions, shows and stands [711]
Solar voltaic (pv) power supply systems [712]
Mobile or transportable units [717]
Temporary installations for fairgrounds, amusement parks and circuses [740]
Floor and ceiling heating systems [753]
- Details of the Appendices to BS 7671 will be found in {Table 1.2}.

The first amendment to the 17th Edition was published in 2011 and took effect on January 1st 2012. Some of its changes of particular interest to electricians are:

- Part 2 Definitions modified and expanded
- a new Section 444 deals with alleviation of electromagnetic interference
- orange as the "electrical" colour for conduit has been deleted
- surge protective devices (SPDs) are covered in Section 534
- the periodic inspection report has been changed and named the condition report
- PME requirements in part 7 are expanded

1.2.4 Plan of the Seventeenth Edition

The regulations are in seven parts as shown in {Table 1.1}.

Also included in the Regulations are 15 Appendices, listed in {Table 1.2}. The 17th Edition has a number of publications called 'Guides' which include much material previously to be found in Appendices. These Guides must be considered to form part of the Regulations; their titles are shown in {Table 1.3}.

Table 1.1 Arrangement of the 17th Edition Parts

Part 1	Scope, object and fundamental principles
Part 2	Definitions
Part 3	Assessment of general characteristics
Part 4	Protection for safety
Part 5	Selection and erection of equipment
Part 6	Inspection and testing
Part 7	Special installations or locations – particular requirements

Table 1.2 Appendices to the 17th Edition

The 17th Edition has nine more Appendices than the 16th, but in the first amendment, 11 and 12 are moved to 4.

Appendix 1	British Standards to which reference is made in The Regulations
Appendix 2	Statutory regulations and associated memoranda
Appendix 3	Time/current characteristics of overcurrent protective devices and residual current devices
Appendix 4	Current carrying capacity and voltage drop for cables and flexible cords
Appendix 5	Classification of external influences
Appendix 6	Model forms for certification and reporting
Appendix 7	Harmonised cable core colours
Appendix 8	Current carrying capacity and voltage drop for busbar trunking and powertrack systems
Appendix 9	Definitions – multiple source, d.c. and other systems
Appendix 10	Protection of conductors in parallel against overcurrent
Appendix 11	Effect of harmonic currents on balanced three-phase systems. Moved to Appendix 4.
Appendix 12	Voltage drop in consumers' installations. Moved to Appendix 4.
Appendix 13	Methods for measuring insulation resistance/impedance of floors and walls to earth or to the protective conductor system
Appendix 14	Measurement of fault loop impedance: consideration of the increase of the resistance of conductors with increase of temperature
Appendix 15	Ring and radial final circuit arrangements

Appendices 7 and 12 are of particular interest to electricians concerned with small installations.

Table 1.3 Guides and Guidance Notes to the Regulations

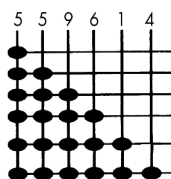
Wiring Matters	
On-site guide	
1	Selection and erection
2	Isolation and switching
3	Inspection and testing
4	Protection against fire
5	Protection against electric shock
6	Protection against overcurrents
7	Special installations and locations
8	Earthing and bonding

It is important to understand the relationship of the Appendices and of the Guidance Notes. Appendices provide information that the designer must have if his work is to comply with the Regulations. Other information, such as good practice, is contained in the Guidance Notes.

It is also important to have an understanding of the layout of the Regulations, so that work can be clearly identified. Each Part is divided into Chapters, which in turn are broken down into Sections within which are to be found the actual regulations themselves. A number, such as 612.13.2, identifies the particular regulation. Note that this Regulation number is spoken as 'six twelve point thirteen point two' and NOT as 'six hundred and twelve thirteen two'.

Whenever a full point separates a group of digits, the numbers represent a regulation; they are further identified in this Guide by placing them in square brackets, e.g. [612.13.2]. The apparent duplication of work within the Regulations may seem to be strange, but is necessary if the internationally agreed layout is to be followed.

The international nature of the Regulations sometimes provides some strange



Part 5	Selection and erection of equipment
Chapter 55	Other equipment
Section 559	Luminaires and lighting installations
Group 559.6	Wiring systems
Regulation 559.6.1	Common rules
Regulation 559.6.1.4	Luminaire support couplers

reading. For example, Regulations [411.6] deal with systems which are earthed using the IT method, described in {5.2.6} of this *Electrician's Guide*. However, such a system is not accepted for public supplies in the UK and is seldom used except in conjunction with private generators.

1.3 THE ELECTRICIAN'S GUIDE

1.3.1 The rationale for this Guide

In the first section of this chapter the reason for writing this Guide has been explained in general terms. It is important to understand that legally the whole of publication (BS 7671) must be followed; it is not permissible to extract one Regulation and to assume that if it is satisfied there is compliance with the whole of the Regulations. All electrical installation work must be carried out competently. The need for legal clarity does not always run parallel with technical clarity. The electrician, as well as his design, if he has one, sometimes has difficulty in deciding exactly what a regulation requires, as well as the reasons for the regulation to be a requirement in the first place. The legal wording of the Regulations is paramount, and therefore it is not simplified to make its meaning more obvious to the electrician who is not expert in legal matters.

The object of this *Electrician's Guide* is to clarify the meaning of the Regulations and to explain the technical thinking behind them as far as is possible in a publication of this size. It is not possible to deal in detail with every Regulation. A choice has been made of those regulations that are considered to be most often met by the electrician in his everyday work. It must be appreciated that this *Electrician's Guide* cannot (and does not seek to) take the place of the Regulations, but merely to complement them.

1.3.2 Using this Electrician's Guide

A complete and systematic study of this *Electrician's Guide* should prove to be of great value to those who seek a fuller understanding of the Regulations. However, it is appreciated that perhaps a majority of readers will have neither the time nor the inclination to read in such wide detail, and will want to use the book for reference purposes. Having found the general area of work, using either the contents list or the index of this *Electrician's Guide*, the text should help them to understand the subject. It has been previously stated that it is necessary for associated regulations to be spread out in various Parts and Chapters of the Wiring Regulations. In this *Electrician's Guide* they are collected together, so that, for example, all work on Earthing will be found in Chapter 5, on Testing and Inspection in Chapter 7, and so on. This *Electrician's Guide* is not a textbook of electrical principles. If difficulty is experienced in this respect, reference should be made to *Electrical Craft Principles* by the same author, published by the IET. This book has been written specifically for electricians.