Wiring Matters

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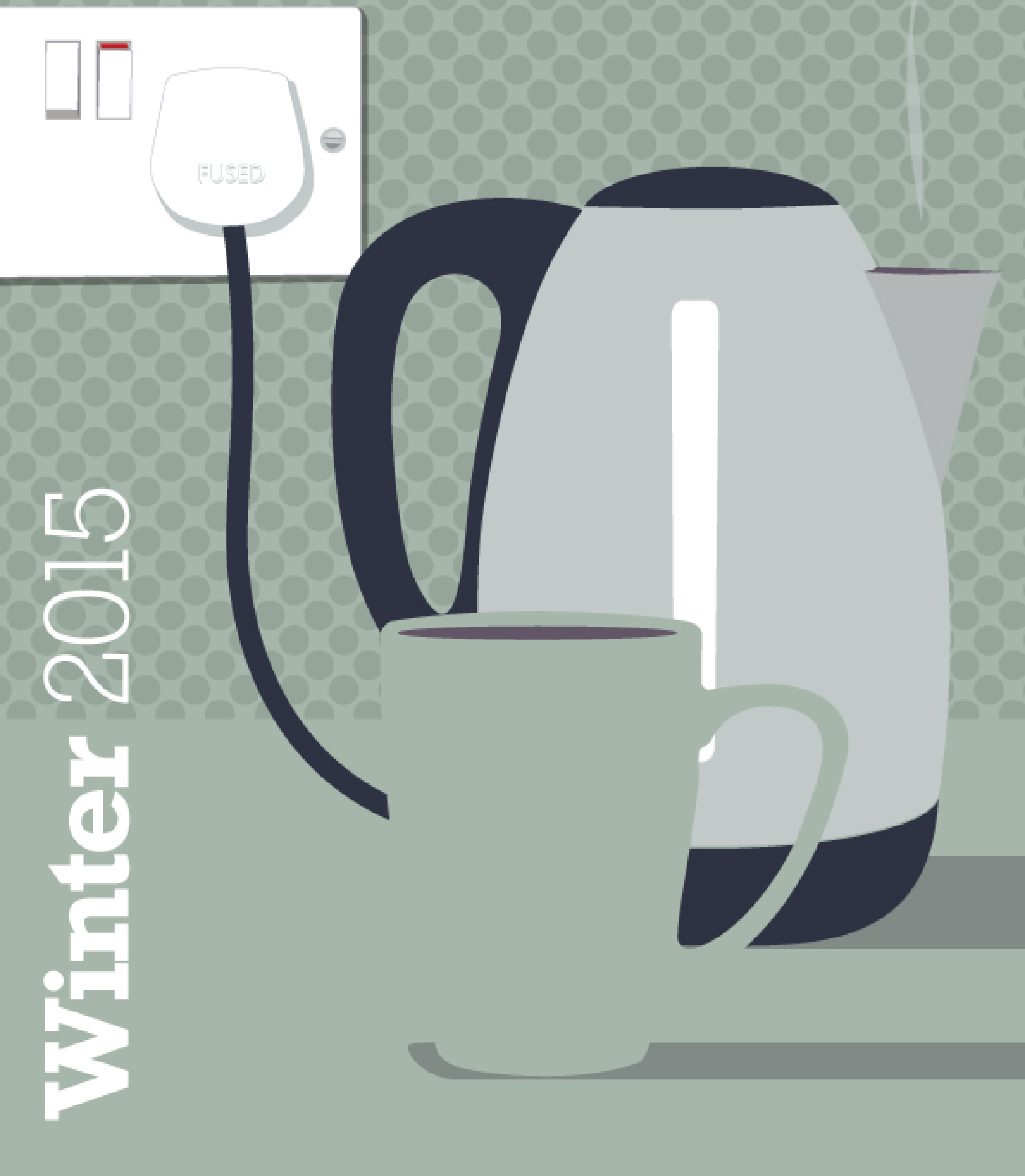

Winter 2015

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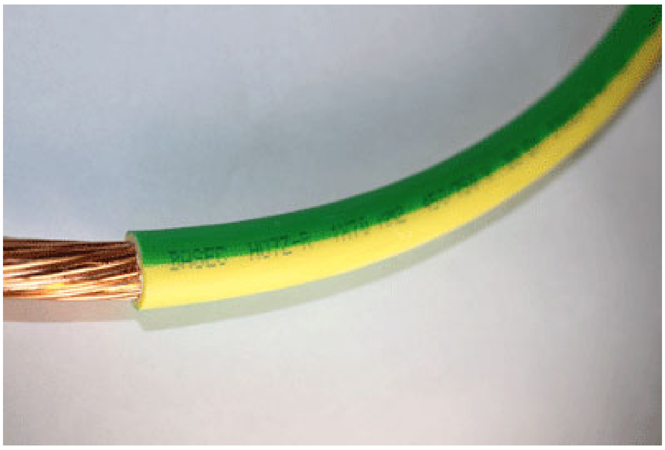
BASEC warning: 6491B low smoke conduit wire

BASEC warning: installers, buyers and distributors urged to check harmonized codes

The British Approvals Service for Cables (BASEC) has issued an industry-wide warning to cable buyers to check the harmonized codes on 6491B single core conduit wire, to ensure it is fit for purpose and conforms to the requirements of BS 7671 *Requirements for Electrical Installations* (the 'IET Wiring Regulations'). BASEC is aware of instances in the market where two different cables are both being marketed as '6491B', when they are very different.



The two types are H07Z-types according to BS EN 50525-3-41 *Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables with special fire performance. Single core non-sheathed cables with halogen-free* ***crosslinked*** *insulation, and low emission of smoke* and H07Z1-types according to BS EN 50525-3-31 *Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables with special fire performance. Single core non-sheathed cables with halogen-free* ***thermoplastic*** *insulation, and low emission of smoke* (emphasis added). If these cables are confused and the wrong cable is installed it could lead to serious faults. This warning also extends to distributors and wholesalers to make sure these cables are marketed correctly, with their harmonized codes clearly shown.

Although both cable types are low smoke and halogen free, there are two fundamental differences between the cables. H07Z has cross-linked insulation and a rated operating temperature of 90 °C. H07Z1 has thermoplastic insulation (not cross-linked), and has a lower rated operating temperature of 70 °C.

Dr Jeremy Hodge, chief executive at BASEC, explains: "Only the H07Z cable type to BS EN 50525-3-41 may be described by the UK cable code 6491B, as set out in the UK annex to the BS EN specification. Although these two cables have similar harmonized codes they have different performance characteristics. For example, if H07Z1 cable were installed in a circuit designed for 90 °C operation, the insulation could melt and there could be dangerous faults causing short circuit, overheating, and possibly fire. Unfortunately, it could be quite an easy mistake to make if the cable is not correctly labelled in full and a contractor just asks for '6491B'."

These types of cable are commonly used in commercial and industrial premises where fire, smoke or fumes may be hazardous, as well as in closed systems, on light fittings, and inside appliances, switchgear and controlgear, particularly where low emissions of smoke and acid gas is required in case of burning. In most cases a 90 °C cable is specified and used.

"There may also be a difference in price, which might make the incorrect cable seem good value," warned Dr. Hodge. "We are urging contractors to double check what they are buying and installing. We are also encouraging importers, distributors and wholesalers to check their stocks and their procurement and sales practices to ensure that they do not sell these cables incorrectly. We encourage traders to only use the UK cable code 6491B for 90 °C H07Z types."

Contractors who may have used '6491B' cable in premises should review their installation records to check whether they may have used incorrect cable. If the 70 °C cables are identified in a 90 °C circuit, it is recommended that the affected cables are removed and replaced with the correct 90 °C cable type, or the circuits may need to be de-rated.

BASEC will be approaching relevant cable manufacturers and traders about the issue.

Further information about BASEC and its role in the electrical industry is available at www.basec.org.uk, technical@basec.org.uk, or follow BASEC on twitter @BASECCables.

Consumer units: a brief overview

There are over twenty million domestic dwellings in the UK and each has an electrical installation, usually with electricity meter and consumer unit arrangement supplying the lighting and power in the dwelling. There are numerous fires in domestic dwellings every year, many due to electrical faults, so Amendment No. 3 to BS 7671, published in 2015, introduced Regulation 421.1.201 to increase the safety of consumer units and similar switchgear. Regulation 421.1.201 comes into force in January 2016. Leon Markwell, Senior Engineer at the IET, writes an overview on what this regulation requires.

Generally, meters and consumer units are not attractive and are consequently hidden from view or placed in out-of-the way locations, such as under the stairs in houses, in garages or outbuildings, or are boxed in and covered. BS 7671 already advises that all electrical installations should be regularly inspected and tested – which sadly does not happen in many domestic dwellings. This lack of inspection and maintenance, coupled with changing electrical loads and load patterns, aging consumer units and a possible lack of adequate ventilation can all lead to overheating of the consumer unit, which could possibly start a fire.

Regulation 421.1.201 has been introduced to require that consumer units and similar switchgear, whether in new installations or where consumer units etc. are being replaced, shall comply with BS EN 61439-3 *Low-voltage switchgear and controlgear assemblies. Distribution boards intended to be operated by ordinary persons (DBO)* and have their enclosures made of non-combustible material, or be enclosed in an accessible cabinet or enclosure itself made of non-combustible material. At this time there is no specific British Standard definition of what 'non-combustible' means, so the only readily non-combustible material that can be currently identified and used to manufacture consumer units and switchgear is steel. Although steel is currently viewed as the only suitable material, manufacturers may identify and propose other materials if these can be shown to be non-combustible.

It is not a requirement that all non-compliant 'combustible' consumer units and switchgear must be replaced – instead, an inspection of a domestic dwelling's electrical installation should be undertaken by a competent person in accordance with the requirements of Chapter 62 of BS 7671 and a decision made as to whether the consumer unit and any associated switchgear are still safe and suitable for their function. Such a decision might be informed by the age, condition and installation circumstances of the domestic dwelling's electrical installation.

Generally, consumer units etc. under wooden staircases in houses or boxed in in wooden cupboard arrangements may be seen to have a potential risk of fire due to a probable lack of ventilation and the adjacent combustible materials. However, electrical equipment in these areas could have their ventilation improved and a local self-contained smoke detector installed.

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Frequently asked questions

Richard Townsend, Senior Engineer at the IET, responds to two frequently asked questions.

Question

If I install a new circuit and the existing consumer unit is plastic, do I have to upgrade the consumer unit to a metal one after the 1st January 2016?

Answer

No, when installing a new circuit to an existing installation, after 1st January 2016, providing there is a spare way on the existing consumer unit, or if you utilise an existing way, there is no requirement to upgrade the consumer unit from a plastic product to a new metal type.

Question

When I put cables into a new metal consumer unit, do I have to use intumescent glands to enforce the fire protection of the consumer unit?

Answer

No, the metal consumer unit is designed to encase a fire within it and restrict the likelihood that a fire may spread. Manufactures' have carried out exhaustive tests on this issue and have found that the cable entry does not have to continue the fire rating of the consumer unit, for it to be effective. The only requirement is to keep IPXXD or IP4X on the horizontal surfaces (Reg 416.2.1) and IPXXB or IP2X on all other surfaces (Reg 416.2.2). Intumescent glands and sealants may be used to ensure the IP ratings are maintained, but they are not a requirement and existing methods of ensuring IP are acceptable.

The IET is putting together guidance on consumer units, which is expected to be published early 2016.

Technical considerations for d.c. installations

Graham Kenyon has over 20 years' experience planning, designing and implementing communication, information, control and security systems, and related facilities, in the challenging environments presented by world-class infrastructure projects. He is a committee member of both the IET's Wiring Regulations Policy Committee, and CIBSE Electrical Services Group. He currently leads an independent consultancy, G Kenyon Technology Ltd.

The re-emergence of d.c. power systems

The public supply electricity supply in the European Union has been harmonized at a nominal 230/400 V 50 Hz a.c. (or 230 V 50 Hz a.c. three-phase, where one phase of a three-phase system is earthed), with a tolerance of + 10 %/- 6 % (see Table 1), and many member countries have been using similar voltages for upwards of 50 years. The skills, techniques, equipment, and products have therefore been geared towards such supplies for quite some time. Emerging technologies, combined with the subject of energy efficiency, are leading designers to consider wider use of d.c. circuits within electrical installations of buildings in a variety of applications including services to data centres, solar photovoltaic installations, energy storage, and LED lighting.

Table 1: Supply voltages in the harmonized public low voltage supply to BS EN 0160:2010+A1:2015

Supply type	Nominal a.c. voltage	a.c. voltage range (tolerance +10 %/-6 %)
Single-phase	230 V	216.2-253.0 V
Three-phase (star-point neutral)	400 V Line to Line (230 V Line to Neutral)	376.0 - 440.0 V (216.2 – 253.0 V)
Three-phase (one line as neutral)	230 V Line to Line (230 V Line to Earth)	216.2 – 253.0 V (216.2 – 253.0 V)

One of the primary reasons for the historical use of a.c. in the public electricity distribution system was the ease with which the voltage could be increased, using a transformer, to reduce losses in long-distance power transmission lines, and subsequently decreased again using a transformer local to the point of use. With modern power electronic techniques, increasing and decreasing d.c. voltages is relatively inexpensive and commonplace, for both low- and high-power devices. This is achieved with d.c. to d.c. converters, which use high-frequency switched-mode circuitry. When arranged to increase the voltage without the use of a transformer, these may operate in a similar manner to the switch, condenser, and coil arrangement that drives spark plugs in a petrol car. Switch-mode converters contain switching transistors and capacitors with inductors and/or transformers, and may even include galvanic isolation. The efficiency of a transformer increases with frequency, as less copper is required in the windings; hence, d.c. to d.c. converters can have a better energy efficiency performance than a.c. transformers, and a.c. to d.c. converters.

The requirement to use d.c. power arises in a wide variety of situations relating to current technologies for energy generation and electronic devices. Solar-photovoltaic generation, for instance, inherently delivers d.c. power. Various technologies that convert energy from the elements (wind, solar, tidal power) do not provide consistent power as the energy source itself is not consistent. To store this power requires d.c. technologies. Energy losses are involved whenever d.c. is converted to a.c. and vice-versa, so if some of the generated or stored d.c. power can be used without converting to a.c. first, energy savings can be achieved.

There has been a large increase in the use of electronic devices, which by their very nature use d.c. power, such as mobile and smart phones, and other portable devices. Again, there are inherent energy losses in transforming the a.c. mains into the extra-low voltage d.c. required by the device, which can be as much as 20 % depending on the adaptor used. The adoption of Universal Serial Bus (USB) and similar charging systems for portable devices has led to a demand for user socket-outlets operating at d.c., which is currently being filled by a multiplicity of after-market transformer-adaptors, many of which are not energy efficient.

In the case of commercial and industrial computing devices, such as those used in data-centres, research has shown that significant energy savings are available where the supplies to equipment racks that house network equipment and servers is operated at low or extra-low voltage d.c. LED and other types of energy-efficient lighting are beginning to enter mainstream, and whilst it is possible to manufacture devices operating from a standard a.c. light fitting, it is far more energy efficient to power them from a d.c. source.

Designers, installers and maintainers may be less familiar with low voltage and extra-low voltage d.c. power. This article discusses some of the challenges that designers, installers and maintainers, are faced with, and introduces the following publications from IET Standards: The recent IET Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings; and the accompanying IET Standards Technical Briefing: Practical considerations for d.c. installations which is due to be available soon.

Considerations for d.c. circuits in buildings

Among the chief considerations for the wider use of d.c. circuits in buildings is selection of appropriate protective devices, switchgear, and accessories. Many of the standards for accessories and protective devices currently common in the industry are a.c. only, and products complying solely with those standards may not be suitable for d.c. systems. Switchgear, plugs and socket outlets used with d.c. systems will be capable of handling and where appropriate suppressing arcing which occurs as plugs are withdrawn or contacts open; this does not occur in a.c. systems as the current-waveform crossing zero helps extinguish arcing. RCDs are not, generally, available for d.c. systems at present. High breaking-capacity (HBC) fuses, including suitably-rated fuses to BS 88, are technically a good choice for protecting d.c. circuits. However, in installations such as those for households, it has become commonplace to utilise resettable devices such as mcbs to help mitigate the risks that might arise from the lack of training and specific knowledge of persons in the premises.

Another primary consideration is whether installers and maintainers have the necessary skills and experience with d.c. installations of the kind being considered. Test equipment and fault-finding practices differ slightly with d.c. circuits; appropriately-rated test equipment must be used. Those using the equipment need to be aware of the limitations of some a.c. equipment settings on d.c. systems. For example, a multimeter on an a.c. setting may read zero if used on d.c. circuits, giving the false impression of absence of voltage. It is important to ensure that voltage testers/indicators used for “proving dead” are suitable for both a.c. and d.c. operation.

A voltage indicator from Martindale Electric

Among the considerations for those commissioning and maintaining installations is that of identifying d.c. circuits separately to a.c. circuits, so that appropriate test equipment and working practices can be selected. The basic colour-coding scheme harmonized by BS EN 60445, and included in BS 7671, does not assist installers and maintainers in distinguishing between conductors operating from a.c. and d.c. sources, and at different voltage bands. One example would be that a conductor identified only with the colour blue may be a mains neutral (N), or, in d.c. systems, a conductor which is either a mid-point (M), earthed mid-point (M), positive-earthed (L+) or negative-earthed (L-). A common-sense approach is to provide a means of identifying the function of circuits from over-marking cables and containment in which the conductors run. Alphanumeric marking can also be applied in addition to colour-coding on conductors themselves, and this better-distinguishes the function of the conductor as a.c. (L, N, L1, L2, L3 etc.), or d.c. (L+, L-, M), as well as providing information about the function of the conductor in the d.c. system (e.g. a conductor coloured blue, and labelled L+, is clearly distinguishable as a positive conductor in a positive-earth system).

Where the supply voltage is 200 V or above, the Plugs and Sockets (Safety) Regulations apply to plugs and socket outlets serving equipment for domestic and similar use. This legislation mandates the use of the BS 1363 plug and socket for the majority of applications; these are currently specified for a.c. installations only.

Designers should consider the impact of d.c. protective and functional earthing conductor currents. Since d.c. earth currents flow in predominantly one direction, electrolytic corrosion of structural steelwork that is buried or in contact with the ground, or earthed metalwork of buried services, may occur. This can be addressed by the selecting how the d.c. source of supply is earthed (e.g. selection of mid-point earth), and considering which means of corrosion prevention may be applied.

Extra-low voltage d.c. systems, whilst often providing a good solution to protection against electric shock, are not free from electrical safety hazards, and provisions of the Electricity at Work Regulations 1989 still apply. Where high current ELV supplies are used, faults can often lead to arcing and heating, and protective devices may fail to operate under certain conditions. Suitable fused test leads and instruments are recommended for testing and fault-finding.

Fixed battery installations should be designed to comply with the requirements of BS EN 50272-1 and BS EN 50272-2 along with BS 7671.

Another consideration with lower voltages is the impact of voltage-drop. At 300 V d.c., the maximum length a cable may be expected to carry its rated load current (without correction factors), to achieve a voltage drop less than or equal to 8 %, is in the region of a few tens of metres As with a.c. circuits, this assumes that circuit protection performance permits this distance. At 24 V d.c., these distances drop to around 3.0 m, 1.5 m at 12 V d.c., and less than 1.0 m at 5 V d.c. It is clear that, for distribution circuits operating at charging voltages of common devices (e.g. USB at 5 V d.c.), or at common battery-voltages, there is a trade-off between the cross-sectional area of conductors required, and the energy saving benefits that such a distribution system might bring. This is illustrated in Table 2 (see the PDF here) which shows the absolute maximum distances before 8 % volt-drop, for various cable types at a nominal voltage of 5 V, which is commonly used to charge mobile devices such as mobile phones, smart-phones, and tablets.

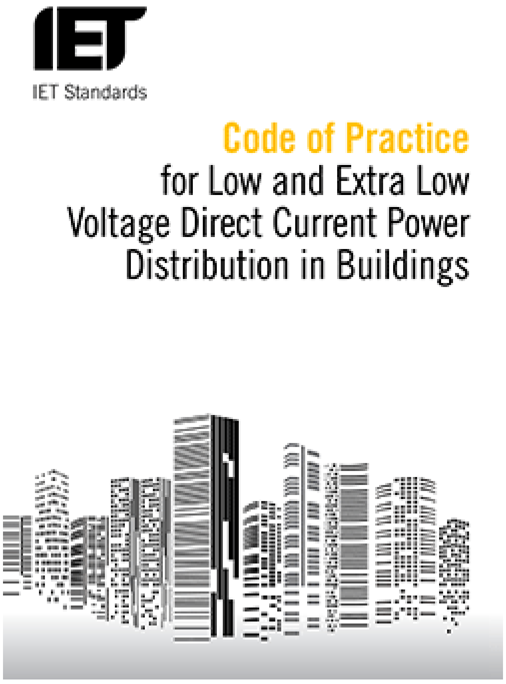
Providing power over small cross-sectional area control, data and signalling cables is not new. Audio systems have utilised so-called “phantom power” over a signalling pair for 50 years or more; similar well-established technologies are employed to provide camera power via coaxial cables in closed-circuit television systems. Intruder alarms provide power using multi-core cabling rated 1 A or less Ethernet standards have used cables carrying power for over 25 years, for example in the attachment unit interface carrying power to the medium attachment unit on coaxial Ethernet systems.

Recently, there is an increasing requirement for USB charging, and also multi-purpose device power using Power over Ethernet. This provides some new challenges. Heating is the primary consideration for Power over Ethernet systems. It is worth considering that existing cabling infrastructure may not originally have been designed with power delivery in mind. There are also some proprietary charging solutions that do not comply with the power delivery requirements detailed in the Ethernet and USB standards, and associated product safety standards.

Conclusion

The industry is likely to observe an increase in the requirements to design, install and maintain d.c. circuits at low voltage and extra-low voltage, and therefore must be prepared to respond to this requirement.

The IET's *Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings*, and associated Technical Briefing Practical considerations for d.c. installations (due to be published towards the end of 2015), provide invaluable sources of information to help design, installation and maintenance planning and preparation. They discuss most of the issues highlighted in the article.



Staying safe over the festive season

Sean Crotty, Communications Officer for London Fire Brigade, reminds us what we need to bear in mind over the festive season.

It's time once more to try and remember where you put the Christmas decorations – yes, the festive season is just around the corner. The chances are high that you may be requested to adorn client's houses with twinkling lights, motorised Santas and singing snowmen – the usual Christmas fare designed to get even the most cynical humbuggers among us in the festive mood.

However, faulty electrical appliances cause a fire nearly every day in London (339 in 2013/14), so please follow our seasonal safety tips below. We've included some useful tips to pass on to your clients – and for your safety in your own home.

Lights and decorations

If you're lighting the outside of a house, only use lights and decorations designed for exterior use. Expecting indoor-only products to take the brunt of the winter weather can lead to electric shocks and fire hazards.

All lighting appliances, used both indoor and outdoor, should be connected using a 30 mA RCD (residual current device) protected socket. This can be potentially life-saving in the event of an electrical fault.

Please remember the following steps:

- inspect all fairy lights, electric decorations and extension leads for signs of damage to leads, plugs, and lamps. Remember, the wattage rating of the replacement lamps must not exceed the maximum specified.
- if you need to use an extension lead make sure it's not overloaded. The combined wattage of all the devices plugged in cannot exceed the manufacturer's rating for the extension cable. Also, if it is a reel type lead, always fully unwind it off the reel before use to prevent possible overheating.
- always turn off all Christmas lights and decorations before going to bed or leaving the house. They can get hot as well, so always make sure they're not too close to decorations and other flammable materials.
- decorations can burn easily – so don't attach them to lights or heaters.

General tips for you and your clients

Chargers

Can't find your charger under a mountain of Christmas morning wrapping paper? Don't be tempted to use the wrong charger in new electrical gadgets. Earlier this year a family had a lucky escape when they used the wrong charger in a toy car left to charge overnight. An adult and child were sleeping at the time and thankfully a smoke alarm gave them an early warning and they were able to escape the fire unharmed.

Devastation caused by using the wrong charger on a toy car

General charger safety tips:

- never mix and match chargers; use only the right charger for the equipment you are charging.
- do not cover chargers when in use as they may overheat.
- once your equipment is charged, unplug it. Leaving it plugged in and switched on continuously could pose a risk.
- when replacing lost chargers, always buy from a reputable retailer to ensure that you are getting a genuine product which is suitable for the device.
- It can be tempting to buy a cheap charger from authentic looking sites on the internet. Our fire investigation experts carried out a range of tests on a number of widely available counterfeit iPhone chargers. They were shocked at how potentially dangerous these ifake chargers can be (click the link to see if you can spot the fakes!).

To avoid fake iPhone chargers:

- check that the plug pins finish is matt and uniform.
- where possible, check that the charger weighs over 40 grams.
- check that the colour of the text on the faceplate of the charger is light grey and not dark grey as often found on counterfeit chargers.
- check the position of the USB socket.

Keeping warm

A third of fatal electrical fires involve heaters and there have been 10 deaths in the last 5 winters. Ensure you keep heaters away from clothes, curtains and furniture and in a location where they will not get knocked over. Sit at least one metre away from a heater as it could set light to your clothes or chair, especially if you fall asleep.

Store electric blankets flat, rolled up or loosely folded to prevent damaging the internal wiring. Unplug blankets before you get into bed, unless it has a thermostat control for safe all-night use. Never use an electric blanket if you have an air flow pressure relief mattress, or use paraffin based emollient creams. Ask for non-flammable alternatives instead.

Wiring Matters
Your insight into BS 7671 www.theiet.org/wm

Interview with James Eade

James Eade has an unorthodox background in rock 'n' roll and events, yet is now a familiar face on the Wiring Regulations panels and related standards committees representing his industry. He also wrote the guidebook for the IET on temporary power entitled Temporary Power Systems: A guide to the application of BS 7671 and BS 7909 for temporary events *and has published a book about the lighting protocol DMX512. Wiring Matters asked how he forged such an unusual career path.*

You've been working in the entertainment industry for over 20 years now. How did you get into this line of work? Was it something you set out to do, or was it one of those 'falling into it' encounters?

I lit my first play at school when I was around 12 because it was a fun thing to do and we got to stay up late. The more I did it, the more I enjoyed it and I carried on through my school years, buying the only book on the subject back then written by a famous lighting designer, Francis Reid, and teaching myself. I wanted to pursue it at university, but in those days the only route into technical theatre was via drama courses at places like RADA. With those courses you studied drama and then specialised in technical theatre at the end, learning bits of everything backstage related. But I really didn't want to study the drama bit at all, so instead, I studied engineering at Coventry.

I spent more time than I probably should have done working at the Belgrade Theatre, as well as a bit of crewing for the Students Union events team. As it transpires, that served me well as it was akin to an unofficial apprenticeship and introduced me to the wider industry. During a show I would sit in the control room or at my follow-spot between cues, poring over the only industry magazine of the time soaking up tales of the industry at large. Unsurprisingly, and like most, I hankered after the touring lifestyle, taking bands around the world. After I graduated, I quickly landed a job through a friend with a rental company in London. There I learned about audio, video, more lighting and the production management side.

My career then progressed through a series of lucky breaks, working with the right people at the right time and taking opportunities as they presented themselves. Once you are 'in' the industry, it's so much easier to move around. By far the majority of people working in the business are freelance, so getting other work is usually by recommendation and word of mouth. Many of my contemporaries did fall into the industry though, often by helping out friends backstage or similar as a one off favour, then getting called again to help out on another event, then another…

I ended up as the part-time Technical Editor for Lighting&Sound International magazine and through that helped out the technical standards department of the Professional Lighting and Sound Association. That role is ultimately what led me to the involvement in standards and allied work.

It sounds glamorous and very rock 'n' roll – what is the reality?

Planes, hotels and venues are your usual surroundings. Occasionally you might be in a tour bus which is effectively your mobile bedroom, lounge and home for weeks on end. So, in short, it's far from glamorous. Sometimes you get a bit of down-time to explore the local area, but it's the exception rather than the rule. Closer to home it might be a muddy festival site, getting the modern equivalent of trench-foot in the British summer while trying to keep everything operating in torrential rain. Some people pay good money for mud therapy – we often get no choice and wish we had shares in wellington boot manufacturers instead. Having said that, it can be exciting and you do end up in all sorts of weird and wonderful places. Anyone working in the industry will have tales of getting stuck in customs or shenanigans in hotels and backstage. I couldn't possibly divulge too much detail in such a learned publication as Wiring Matters, but the work can be terribly diverse, with events like corporate sales conferences, motor vehicle launches or fashion shows being the mainstay for many, especially outside of the summer festival season.

To illustrate the diversity, many years before the Arab spring I was part of the lighting crew putting on a son-et-lumiere for Colonel Gadaffi in Libya. In complete contrast, a couple of months later I was part of the lighting crew working on Miss World in the Seychelles. We had time there to explore the island in between rehearsals and it was quite relaxed. So you just never know what the next phone call might bring or where it will take you.

BBC Proms in the park, with the stage in the middle and large video walls flanking it either side, displaying the BBC proms logo. The black hanging columns are speaker stacks. Image courtesy of Dave Roberts

But it's *why* we do it rather than *where* – it's not the glamour of being associated with a band or artiste as you don't often have cause to work with them directly, unless you actually design part of the show or work with the management. For me and many others the rewards come from making people happy and just enjoying the adrenaline rush from the excitement of the moment when it all goes live – hearing in your headset the words from the show-caller 'stand-by lighting cue 1' and you know there's no going back and it's all about to happen. Seeing thousands of excited audience members singing, dancing and (in theatre) performing a standing ovation is priceless and it's incredibly rewarding being a part of making that happen; it's a job satisfaction unsurpassed in my experience.

From a purely speculative point of view, I would imagine that you would have various challenges in this line of work – some technical, some potentially personality driven as you must work with some demanding figures. What is your biggest challenge?

I think the biggest challenge is, for many, staying in a relationship. You have to have a very understanding partner; with the irregular hours, different locations and different countries, Skype becomes your best friend. The relationships you have with your fellow crew are important too – you are thrown together and have to get on with each other in what can be, at times, testing circumstances. Patience and a happy 'can-do' helpful disposition are common attributes in successful people in this line of work.

And yes, there are artistic challenges too. It's not uncommon for designers to turn around at the last minute and want to make things bigger, brighter, louder or whatever. Generally though that is all completed in the rehearsals so the show gets polished before an audience sees it – if you have rehearsals that is; some shows you literally make up as you go along – or busking as it's known. But generally shows are always innovative in some respect, whether it's designers wanting to create an effect or stage that's not been done before, so the challenges are in the innovative engineering to achieve an objective.

In addition, there are usually the technical challenges when things stop working, and the law of sod dictates that it will always happen before curtain-up. For many electricians, pressure might be a site manager shouting at you because the second fix isn't finished and the client is coming around to inspect the works tomorrow. Having your 500 kVA twinset generators shutting down for no apparent reason half an hour before a show and 20,000 people knocking at the door wanting to come in is real pressure. The prospect of cancelling a show isn't an option that's entertained, so the skill is in making it happen somehow.

Recently I was inspecting a one-day festival in a London park. A popular band was in the middle of its set and suddenly the main 400 A circuit-breaker for the PA tripped for reasons unknown; there was a big thump from the speakers and it all went quiet. In situations like that all eyes are on you – it's not just the technical issues riding on it though. If you have an audience getting restless or annoyed that their favourite band has walked off unfinished, you may have a crowd control and subsequent security issue looming which can have potentially life-threatening consequences.

As such the challenge is to really understand the technology so you can fix these things. The phrase 'showstopper' has entered the English dictionary to mean an event that causes the show to stop, usually as a result of something pretty catastrophic. It is a testament to crews everywhere that it's still a rare happening and the phrase still carries appropriate gravitas.

I've noticed that you run training courses. What are the skills and expertise someone would need to enter into this line of work, and can you tell us more about the training you run?

A significant requisite to be successful is the ability to work effectively in a team. It is a unique culture and even has a language of its own to some degree; having spent some time in the army there are many parallels that can be drawn in that respect. In our case the objective is the show going live, on time and fully functioning. For tours the venues may be in different countries (or, indeed, continents) and the kit and crew will need to be moved in one or two days. For example, on a Sunday you could be doing a show in London, on Wednesday operating the same show with the same kit and crew in a venue in Spain. A whole culture and infrastructure has grown up to allow that to happen and it is more vocation than job to some degree, so the first rule for anyone entering the industry is that you have to be a very good team player and willing to put the hours in with good humour.

The technical skills would vary according to the role. Common themes would be an understanding of electrical safety principles and, for most disciplines, a working knowledge of IP networking is increasingly important. Other skills depend on the career path, whether it be audio, lighting, video, broadcast, rigging, automation or pyrotechnics etc.

When I started, the industry still had a bit of a 'them and us' mentality when it came to application of standards and related guidance. The events industry has matured over the years and is now comparable to something like the automotive sector in fiscal terms, with a contribution to the UK economy in the region of £40bn+ year. As a result, the industry takes such matters seriously and works hard to influence standards and legislation accordingly, and that's why I got involved in the various committees.

That sets the context for the courses I run – many are for production or venue managers and those in similar positions to understand their obligations with regard to the law and how that is achieved practically using standards like BS 7671 *Requirements for Electrical Installations* (the 'IET Wiring Regulations') and BS 7909 *Code of practice for temporary electrical systems for entertainment and related purposes*. Others are for technicians working with power who need to get to grips with the relevant standards and how they are applied, or to understand modern problems like power quality issues arising from the drive towards energy efficiency.

Typically, the available electrical courses are aimed at the traditional electrical contracting industries where such topics like leading power factors and harmonics are not usually a concern – or even taught. An event electrician needs to appreciate how these might stop the show, as well as understanding, for example, how to safely synchronise generators and run an 800 A three-phase supply around a muddy field. So teaching them how to size a length of twin-and-earth for an electric shower in a bathroom doesn't equip them with the right knowledge.

While both require electrical skill, the context and practical application is very different and that's the aim of my courses – to put the established standards in an appropriate language to help the candidates apply it in a practical fashion. The most popular is the Creative Skillset Certificate in temporary power systems which was developed by the industry and is being enforced by many organisations, including the three main UK broadcasters.

Some of the dimmer racks used on the TV program Top Gear. The left unit is a 48 x 3kW per channel dimmer and the left is a 72 x 5kW per channel dimmer. They are ready flight-cased so the lids are fitted on the front and back after use and the racks wheeled into the trucks. All the cable connections are on the rear, and the flexes plugged into the top of the racks are part of what is called the 'patch-bay'. Each dimmer channel has a socket on the top and so dimmer channels can be individually allocated to the different output sockets on the rear via the patch cables.

Are apprenticeships available?

That's an interesting question. Up until now there were few, if any, available, although in the past some broadcast companies operated their own internal versions for lighting crews and one or two do exist for technical theatre, but they are not necessarily linked to any national vocational qualifications. Generally people would apply for a job with a company and start at the bottom, loading trucks and packing flight cases before being allowed progressively more responsibility and the opportunity to get more technical experience.

However, the Association of British Theatre Technicians (ABTT) has been working with 14 other organisations and employers in a Trailblazer partnership and has been part of a successful bid to develop a new apprenticeship standard for the occupation of Creative Venue Technician at Level 3, which is nearing completion. This will give candidates a thorough grounding in all things related to presenting live performance whether for a live audience or for camera.

Essentially, people working in this role provide end-to-end technical services in a range of creative, cultural and community venues and the training touches on pretty much everything from old traditional – but still relevant – skills such as knot tying and splicing, through to working with the latest computer based stage automation systems. There are also the 'live' elements like cueing a show and learning to work with other production departments as well, so it's good coverage for working in various sectors such as theatre, television/broadcast and shows.

The hope is that candidates will, as part of the scheme, attain the Bronze Award from the ABTT which is the first step in a career backstage. When it comes to fruition it will be well received and very exciting for an industry that is ever more technically complex and also facing the pan-industry shortage of technical skills.

What standards and other references relate to this industry?

From an electrical view, the IET Wiring Regulations and the temporary power standard BS 7909 are the main ones if you're working in the UK – although you have to consider national standards if taking shows abroad as appropriate. If you look at the technology involved in the rest of a production, then it opens up a raft of other potentially applicable ones ranging from American National Standards Institute (ANSI) standards for lighting control protocols, machinery standards for stage automation, IT standards for the network infrastructure or the Institute of Electrical and Electronics Engineers (IEEE) and the Advanced Encryption Standard (AES) standards for audio, for example.

There are also a host of proprietary standards that are widely adopted in the industry. ArtNet, an open-source Ethernet based lighting protocol developed by Wayne Howell at Artistic Licence, is an example of a very widely adopted standard that readers may have come across in architectural installations. It was developed to overcome the limitations in channel count of DMX512 for stage lighting, and has now become a de-facto standard for most automated lighting and control desks. There are similar audio standards too, for example, CobraNet or Dante.

What installation are you most proud of?

There have been many events that I've been proud to be a part of. One that I and a colleague, Ron Bonner, were pleased with was a charitable concert in aid of a cancer charity. We pulled in all sorts of favours from rental companies and freelancers who gave their kit and time for free and helped raise some good money – such kindness was really appreciated and we had great fun putting it together.

Perhaps the most memorable though was a summer spectacular for a theme park involving the Royal Marines. Through that I met my wife and also managed to cause a collision between two of Her Majesty's boats, though the two events were unconnected.

You are a member of ABTT. Could you tell us more about the ABTT and your role in the organisation?

The ABTT is a charity that has a long history of supporting the backstage professionals in all things related to technical theatre, and a principle aim is to advance education in the technical arts. Part of that is the temporary and permanent electrical infrastructure and my role is to work with the Safety Committee to help members with guidance and resolving related technical issues.

The ABTT, along with the District Surveyors Association, the Chartered Institute of Environmental Health and the Institute of Licensing, developed guidelines for performing venues called *Technical Standards for Places of Entertainment*. We have to keep the electrical content of that up to date, whether it's about emergency lighting or updates in the IET Wiring Regulations.

A current project is reviewing the ABTT portable appliance testing guidelines to tie it in with the 4th Edition of the IET's *Code of Practice for In-Service Inspection and Testing*. Many theatres have their own equipment but will also rent equipment for long terms hires. As such, guidance on who should do the verification and how often is helpful, particularly as it's a more risk-based approach. It's big business too – at a venue like the Royal Opera House in London, for example, the lighting department alone has a stock of around 4,000 items of electrical hardware from lights to control equipment. On top of that, there are racks of extension leads in various capacities and lengths ranging from 16 A to 400 A and a team of four who are permanently dedicated to ensuring that all of it is in good order and ready for use.

A large part is representing the interests of members on standards panels and similar industry related technical forums. I ensure that comments are taken forward and changes are discussed and considered as appropriate. If a standard is to be effective, it has to be fit for purpose, so we have to be engaged to ensure it meets our needs as well as those of the more established sectors of the electrical industry.

A typical mains distribution unit. Along the bottom can be seen the single-pole connectors, each rated for 400A. There is a supply in and a loop-through to the next distribution unit. The outputs are a variety of BS EN 60309 ('ceeform' type) connectors in single and three phase, ranging from 16A to 125A. The protective devices are at the rear of the unit, and it sits on metal skids so can easily be transported using a forklift or similar.

You're going to be working closely with Wiring Matters over the coming year; could you tell us what we should expect from your series of articles?

Robin Townley (CEO of the ABTT) and I are aiming to reveal just some of the areas that ABTT members work in. We're planning to write about the different roles of those working with electrical infrastructure in a variety of event contexts, ranging from a resident theatre electrician, a production electrician on a show, an electrician involved in the temporary power at an event and a contractor who designs and installs the permanent electrical systems for performing venues. All are very different in their own way, yet all have the same ethos and culture.

The aim is that these articles will give an insight into the industry and hopefully entice some new apprentices. It's the nature of the backstage people to keep a low profile and work with quiet efficiency – this will be an opportunity to highlight the good work they do.

LED Lighting: street lighting case study

The exterior lighting systems market is undergoing rapid change as new disruptive technologies such as LED lighting and central management systems (CMS) come on to the market. With a perplexing range of technologies available, street lighting managers and engineers face a difficult task in driving forwards the appropriate specification, selection and implementation of technology that balances, on the one hand, overall project quality and cost, and on the other, the end-user expectations and minimum design requirements (as specified by standards).

Last year Transport for London (TfL) conducted a case study looking at how to improve the energy efficiency of street lighting in the Greater London area.

What was the project's objective?

TfL's overriding objective was to improve the energy efficiency of its street lighting while providing the right light, in the right place, at the right time. Climate change was a key factor in setting up the project, as the Climate Change Act 2008 targets a reduction in CO_2 generation of 34 % by 2020 and 80 % by 2050.

After reviewing the results of a number of pilot projects, and after monitoring developments in the LED lantern market and studying financial viability, TfL decided to install LED and CMS technology on the network.

Why use CMS?

A CMS would allow TfL to control and profile lighting levels across strategic traffic routes in Greater London.

Why use LEDs?

When the Climate Change Act 2008 targets are coupled with increased exposure to carbon tax, the introduction of energy efficient LEDs began to show significant advantages.

Why use both?

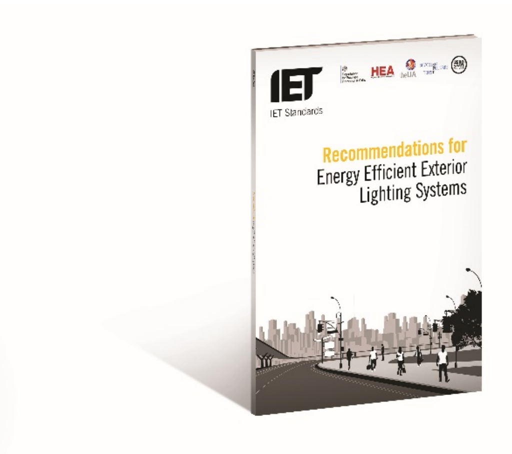
Combining CMS technology with LED lighting offers a flexibility of lighting control in terms of profiling and flexible lighting levels during public events or planned works. It also provides a safer white light solution for driving/pedestrian experiences and reduces maintenance costs across the network.

Figure 1 Example of lighting: a road and underpass

Figure 2 Example of lighting: a road in a residential area

The road ahead

So far CU Phosco have provided over 5,000 luminaires to the TfL network. The TfL project management team are working very closely with both client and contractor to facilitate the requirements of the project.



Working on a similar project?

If you are considering changing lighting to LEDs or other energy efficient lighting systems or are working on projects like this, then you should be consulting the IET *Code of Practice for the Application of LED Lighting Systems*. For exterior lighting, the IET has recently published *Recommendations for Energy Efficient Exterior Lighting Systems*. This new publication was developed by a working group of technical experts and end-users responsible for the management, specification and procurement of the exterior lighting systems market. It outlines many aspects of exterior lighting systems, including design, retrofitting, financial and asset management and performance requirements, as well as a good practice template.

These IET publications are great for reference for any energy efficient lighting. There is also a wealth of information on MyCommunity or you can visit the electrical site.

Interview with Geoff Cronshaw: contributor to the Student's Guide to IET Wiring Regulations

Geoff Cronshaw, Chief Technical Engineer at the IET, recently contributed Appendix A: Special Locations to the *Student's Guide to IET Wiring Regulations*. Wiring Matters caught up with Geoff at the Chichester Marina, where he explains his interest in special locations and his background in electrical engineering.

The *Student's Guide to the IET Wiring Regulations* is the latest publication from the IET and is intended to enhance and develop learners' understanding and use of the IET Wiring Regulations. The book is £19.00 or £12.35 for members and is available from the IET website or other retailers.

For more details about the IET's involvement with students, please see our previous Wiring Matters article.