

Commissioning Specialist Association

Grade 5 Thesis

Modular Wiring  
In The Construction Industry



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# Modular wiring

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# Modular wiring

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### 1. What is modular wiring?

Modular wiring is not a new concept in the construction industry and has been around for some 25 years or so.

Modular wiring is a pre-fabricated wiring system that is simply plug and play.

A series of drawings will be created and individual lengths of cables will be manufactured off site and provided containing the correct number of conductors (sometimes additional conductors for future use). These are then installed on site by competent but not necessarily fully qualified operatives in line with the drawings for a complete working system.

Modular wiring can consist of Low Voltage and Extra low voltage including controls cabling within 1 conduit, they can be armoured or *non-armoured* and are distributed around the building from the distribution board to lighting and power distribution boxes and finally to the accessories. (see figure 1)

### 2. The benefits of modular wiring are:

Labour costs are minimised due to

- Less containment being installed
- Basket tray installed instead of timely trunking and conduit systems
- Competent operatives installing apposed to fully qualified electricians
- Plug in terminations utilised therefore screw in terminals reduced to a minimum therefore reducing maintenance.
- Less plant required on site due to less man hours and minimal on site manufacturing.
- Pre-tested off site and certified minimising the possibility of faults (not eliminating the need to test on site)

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### 3. Where modular wiring would be used?

Modular wiring is becoming standard in most fast track construction projects including Commercial, Healthcare, Educational, Leisure, Residential and retail.

The List is endless as for every type of installation there could be a design for modular wiring.

### 4. Different types of modular wiring.

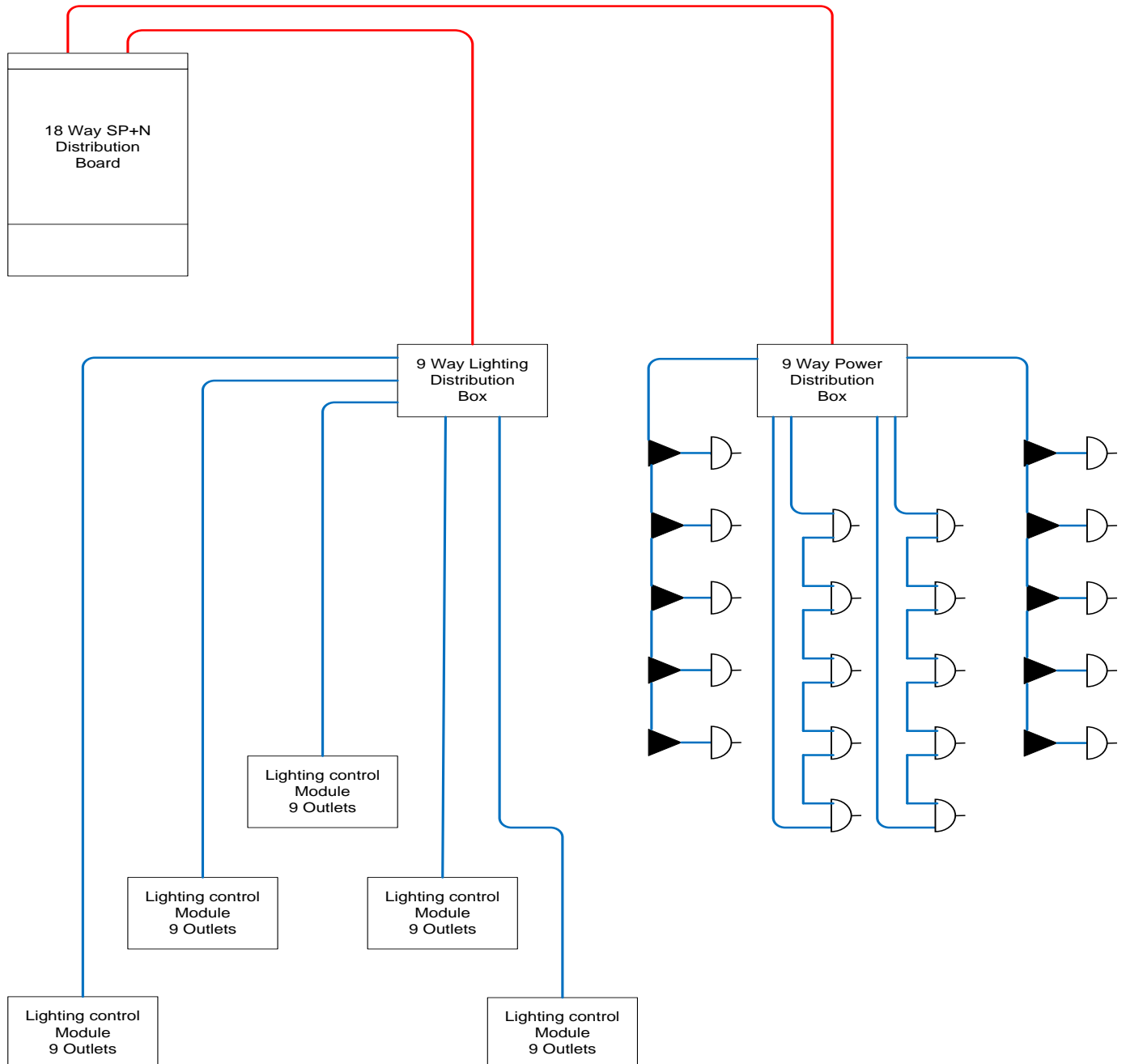
There are many types of modular wiring:

- The most basic being flexible cable with pre-fitted plugs utilised above ceiling grids to interlink between luminaires. The luminaires are also pre-fitted with plugs during the manufacturing process.
- Fully modular systems comprising distribution boards fitted with one or more multi-circuit plugs being interconnected with multi-circuit armoured flexible conduits to Distribution boxes and in turn feeding individual power circuits and lighting control modules. (see illustration 4.1)
- Fire resistant systems are available for the distribution of life safety systems including fire fighting lift supplies, smoke clearance systems and supplies, sprinkler systems etc.
- Plug and play fire alarm systems are available with no need for any site terminations.

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Illustration 4.1



# Modular wiring

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### 5. Cost comparisons of traditional and modular wiring

BSRIA have carried out a case study “Innovative M&E Installation ACT 5/2000 – Data sheet 5.14” based on the findings using a single zone lighting system as the basis of the study:

Observations confirmed that the installation times were reduced by up to 66% in comparison to traditional methods.

Calculations confirmed that results of up to 12% cost saving could be achieved in comparison to traditional methods.

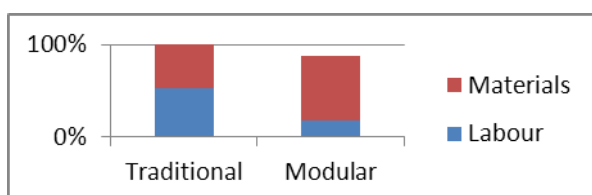
#### Installation time comparison for a single zone lighting distribution system incorporating nine luminaires and one switch.

Activity description:	Total time – best practice (mins)	
	Traditional	Modular
Main run from distribution board to distribution box (12m)	85.30	51.00
Install lighting control box (inc measure, mark and fix)	9.00	5.00
Connect lighting control box to distribution box (6m)	52.50	27.00
Install switch drop cable (1.5m)	54.70	8.00
Run cable between 9 light fittings spaced at 1.5m	209.90	48.00
Connect cables to light fittings	45.00	16.00
<b>Total duration (mins)</b>	<b>456.4</b>	<b>155.00</b>
	<b>Time saving</b>	<b>66%</b>

The study above was based on a traditional method of 3 core PVC/PVC cables installed within 25mm conduit fixed to the underside of the building fabric with saddles spaced at 1.5m centres in comparison to modular wiring with the light fitting connected in a daisy chain formation with the cables supported from the ceiling grid using k-clips.

If the modular wiring cables are laid directly on top of the ceiling grid the time saving can be increased to 80%, although not a best practice this method is used on a large proportion of installs.

As well as saving the labour time in this illustration the labour rate can also be reduced by 70-80% by using electrical improvers or supervised trainees.



Installation cost	Traditional	Modular
Labour	52%	18%
Materials	48%	70%
<b>Total</b>	<b>100%</b>	<b>88%</b>

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### 6. Testing requirement (differing views in the industry)

Initial verification is required to confirm the installation has been designed and constructed in accordance with BS 7671.

Chapter 61 of BS 7671 states the requirements for “initial verification” as far as reasonably practical, an inspection shall be carried out to verify:

- All installed electrical equipment and materials are of the correct type and comply with the applicable British Standard or equivalent appropriate to the intended use of the equipment.
- All components selected and erected in accordance with the regulations
- No visible damage or defect as to impair safety.

All modular wiring must be tested in accordance with BS7971 latest revision.

There are currently views that the modular wiring is tested and certified at the factory and that on site testing is not a requirement.

Once modular wiring has been sent to site and installed it becomes the installation the following must then be carried out (preferably by a competent person in possession of city & guides 2391):

- A visual inspection to ensure there is no visible damage to installed components.
- Continuity of circuit protective conductors (this proves an earth is present at all points throughout the installation ensuring it is safe to energise).
- Continuity of ring final circuits (Not normally part of modular wiring, however they can be if the designer requires them)
- Insulation resistance to ensure there is no damage to the insulation (damage may occur in transit or during installation)
- Polarity this is normally inadvertently picked up during continuity of circuit protective conductors and later during the earth loop test (although the components are tested for polarity at the factory I have personal experience of crossed polarity and crossed live and cpc conductors proving the need for testing)
- Earth loop impedance is very important to prove the fault path is adequate to disconnect the supply in fault conditions. The supply must disconnect in a given time to ensure the maximum touch voltage does not exceed 50V (the maximum safe voltage).

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All testing should be carried out in line with booklet IEE Guidance Note 3. This gives a full list and detailed description of how to carry out visual inspections and tests to comply with BS7671.

Below are actual responses from both ECA and the NICEIC, these demonstrate the difference of opinion in regards to testing of modular wiring. I would always insist all parts of the installation whether fixed wiring or modular plug and play are tested and inspected in their entirety.

Calculation would be regarded as a correct method to BS7671 so long as the R1+R2 is a measured value as installed and not various lengths added together.

Response from the ECA when asked the question “does modular wiring require testing after installation?”

*“On initial verification all points on an installation have to be tested to ensure that all the relevant requirements of BS7671 have been met. I know that some manufacturers of modular wiring have been suggesting that their products do not need to be tested on site as they are type tested at the factory. This is simply not the case, the fact that it is plugged together does not mean that the requirements of the Standard have automatically been met. As you correctly point out the maximum loop impedance for instance needs to be verified to ensure that the disconnection time has been achieved, there are also inspection requirements - has the product been correctly installed, undamaged, properly fixed etc. the list goes on.”*

*“So in short all of the wiring needs to be inspected and tested during construction and on completion to comply with the requirements of Chapter 61 of BS7671.”*

Response from the NICEIC when asked the question “does modular wiring require testing after installation?”

*It would need to be verified from the off-site results that the disconnection times are achieved at the furthest point. I assume that these off-site results are available and include the R1+R2 results that will allow the calculation of Zs to be determined.*

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### 7. Recent Projects I have been involved in that contain modular wiring

- **Spinningfield Manchester: 3 & 4 Hardman Square and 2 & 3 Hardman Street:**

These Projects were fully modular systems comprising distribution boards fitted with one or more multi-circuit plugs being interconnected with multi-circuit armoured flexible conduits to Distribution boxes and in turn feeding individual power circuits and lighting control modules including lighting control cabling.

- **Central Manchester University Hospitals:**

This Project was a fully modular wired system with the final terminations made into the distribution boards in a traditional manor, these in turn using metallic armoured modular cable fed the individual power circuits and lighting control modules.

- **BSF Lancashire schools: 7 No. new build schools:**

These Projects were of the traditional wiring method with the exception of the lighting circuits. The lighting circuits were installed in a traditional manner to the area served where the fixed wiring terminated at a ceiling rose, from the ceiling rose flexible cables with pre-fitted plugs were utilised above ceiling grids to interlink between luminaires. The luminaires were also pre-fitted with plugs during the manufacturing process.

- **Blackpool Victoria hospital:**

This Project was a fully modular systems comprising distribution boards fitted with one or more multi-circuit plugs being interconnected with multi-circuit armoured flexible conduits to Distribution boxes and in turn feeding individual power circuits and lighting control modules including lighting control cabling. Due to final cable runs being non-armoured short lengths of earthed metallic conduit were used to provide mechanical protection.

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### 8. Adding to existing circuits

Modular wiring makes it simple to add additional points or accessories to existing circuits it is a simple case of plug and play.

In practice this could lead to overloads, fires and electric shock if carried out by un-qualified persons or the design is not recalculated.

Prior to alterations all changes should be taken through a design process, preferably by the manufacturer. This is to ensure that earth fault path is adequate and that the loadings are correct.

Undersized cabling could be introduced or rings broken resulting in two undersized radials from an oversized miniature circuit breaker.

On one project that I have been involved with the Electrical contractor has handed over spares to the client on completion, this has included pieces of unused modular wiring, I believe this to be bad practice as unless the client is a qualified electrician and able to review the design the introduction of the components could be dangerous.

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### 9. Health & Safety

The law requires that contractors:

- Manage your work – plan, manage and monitor your construction work so it is done safely and without risks to health;
- Provide information and training to your workforce – about, for example risks, precautions and rules; and
- Co-operate with the principal contractor (PC) to implement the construction phase plan and manage project risks.

Health and safety is greatly improved as manufacturing takes place in a controlled environment away from site therefore:

- Reduced labour requirements on site minimising the risk of injury
- Minimal working at height (statistically slips, trips and falls are most likely to result in a Major injury or possible death)
- Reduced on site fabrication minimising hand injuries etc.

Safety issues that could still be issues remain as:

- The systems are “plug and play” and very easy for the end user to add additional lengths of cable and components, it must be stipulated that any expansion of systems have to be designed prior to works taking place and a minor works certificate issued on completion of the works by a competent person.

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### 10. Conclusion

Modular wiring is the future of construction to enable the construction of large projects in minimal timescales at a reduced cost with increased safety.

Less containment is required due to the modular wiring being its own containment therefore there is only the need for a carrying system, this can be baskets, trays or by clipping to the building fabric itself.

Less labour is required on site providing cost savings by reduced supervision and lower qualified operatives required for the installation.

Cost savings by the reduction of plant on site due to the reduced labour and minimised working at height.

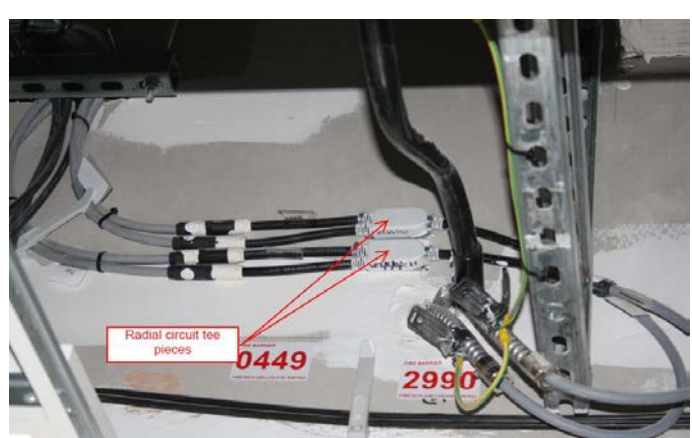
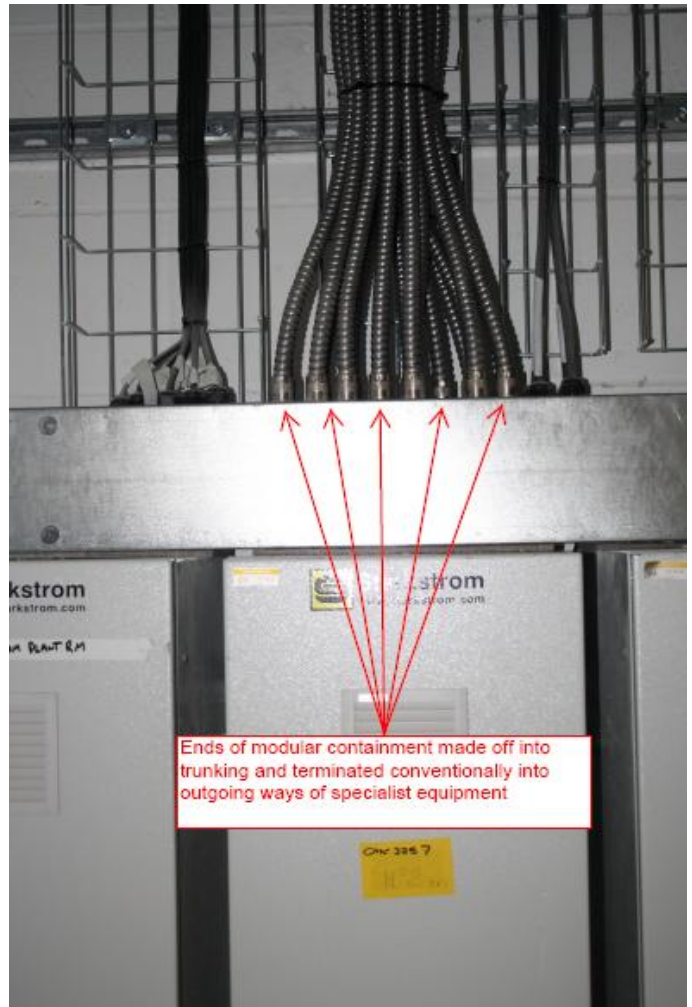
Reduced risk of injuries on site by reducing the working at height time and the number of operatives required on site.

Testing time is kept to a minimum by reducing faults and the need for fault finding by of site testing.

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Actual photo's from Blackpool Victoria Hospital



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