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CLIPSAL
INTEGRATED SYSTEMS

Handbook

C-Bus Hardware Installation

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CE

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Contents

CE

Scope

This handbook aims to provide an installer of C-Bus with the basic knowledge needed to install C-Bus products. Appropriate licenses and a technical trade background is required.

This handbook is aimed at people who wish to install C-Bus hardware, but do not know much about C-Bus.

Learning Outcomes

By the end of this module, you should have an understanding of the basics needed to install C-Bus products including:

- C-Bus fundamentals
- mains voltage supply
- cable segregation
- circuit protection
- cable testing
- wiring relay loads
- C-Bus dimmer
- single network topology.

1.0

C-Bus Fundamentals

This chapter will explain the fundamental properties of C-Bus. These properties reflect on the way that C-Bus units are installed. The fundamentals include:

- C-Bus network topology
- C-Bus cable type
- C-Bus voltage
- C-Bus current per network
- maximum C-Bus cable length
- distance between C-Bus units
- maximum number of C-Bus units
- network impedance.

1.1 C-Bus Installation Rules

There are a number of basic rules you must follow when installing C-Bus products. These rules are listed in Table 1.

Rule	Description
C-Bus Network Topology	C-Bus units are wired in Daisy Chain or Star configuration. **Do not wire C-Bus units in loop configuration.**
C-Bus Cable Type	All C-Bus Networks use an Unshielded Twisted Pair (UTP), Cat-5 (cable) as the communications medium. The Clipsal catalogue number for this product is 5005C305B.
C-Bus Voltage	The standard C-Bus voltage should be 36 V DC (this may vary slightly). It is recommended that the voltage be no lower than 25 V DC.
Maximum C-Bus Current per Network	The C-Bus Cat-5 (cable) must not carry current in excess of 2 A.
Maximum Cable Length per C-Bus Network	The maximum distance of C-Bus cable on a C-Bus network must not exceed 1 km.
Maximum Distance Between all Units	The maximum distance of cable between all C-Bus units, must not exceed 1 km.
Maximum Number of Units per Network	As a rule of thumb, the amount of units on a C-Bus network, must not exceed 100 units. In practice, this may be less, depending on how much current is being drawn by the C-Bus units.
Network Impedance	The network impedance of the C-Bus network must be between 400 Ω and 1.4 kΩ. This can be achieved by adding or removing a network burden.

Table 1: C-Bus parameters.

2.0

Mains Voltage Supply

The mains supply to a C-Bus device is just as important as the C-Bus supply. Unfortunately mains power cannot be controlled by an end user, so it is important to know how mains voltage may effect a network.

2.1 Mains Voltage

The mains voltage is simply the supply for powered C-Bus units, and various loads controlled by C-Bus.

C-Bus units are available in two different voltage formats (identified by different part numbers). The accepted mains voltages are:

1) 240 V AC @ 50 Hz
2) 110 V AC @ 60 Hz.

NOTE Please ensure that the C-Bus products you purchase are designed to suit the supplied mains voltage in your country.

2.2 Inverter Supply

Many C-Bus units that use mains power, are designed to operate from a sinusoidal mains voltage waveform. If an Inverter Supply (that produces a square wave voltage) is used, C-Bus units may not operate as expected or may become damaged.

2.3 Uninterruptible Power Supply

An Uninterruptible Power Supply (UPS) may be used, if the output voltage and frequency are within acceptable limits for C-Bus units (that require mains power). These limits are:

- that the UPS must operate between the voltages 190 V and 265 V
- that the UPS must maintain a frequency of 50 Hz or 60 Hz, ±3 Hz
- the frequency may only vary by 3 Hz over 1 minute.

NOTE C-Bus Dimmers are the only C-Bus units that are effected by the shift of voltage and frequency.

3.0

Cable Segregation

When installing C-Bus units, you will find that many units have:

- mains voltage terminals
- 36 V DC C-Bus connections.

Care must be taken to adequately segregate the 240 V AC wiring from the C-Bus wiring.

It is strongly recommended, that mains voltage cabling must be fixed in the distribution board. Fixing mains cables can be achieved by using cable ties or trunking as required by local cabling rules.

Care must be taken not to allow copper strands to enter DIN unit apertures. To stop copper strands from entering RJ45 sockets, fit rubber bungs to all unused sockets (3 rubber bungs are usually supplied).

For additional information on wiring cable segregation, please consult Appendix 1.

3.1 Wiring Within C-Bus Enclosures

Where more than one Cat-5 cable enters the switchboard, care must be taken to ensure that any joins made between multiple Cat-5 cables, are effectively insulated with no exposed C-Bus terminals.

NOTE Consider terminating multiple C-Bus Cat-5 cables outside the switchboard, and one C-Bus cable into the Distribution board (see Figure 1).

By utilising RJ45 connectors on a C-Bus Cat-5 (cable), you can ensure that the mains voltage is not exposed to any C-Bus connectors. This provides adequate segregation between C-Bus and mains voltage.

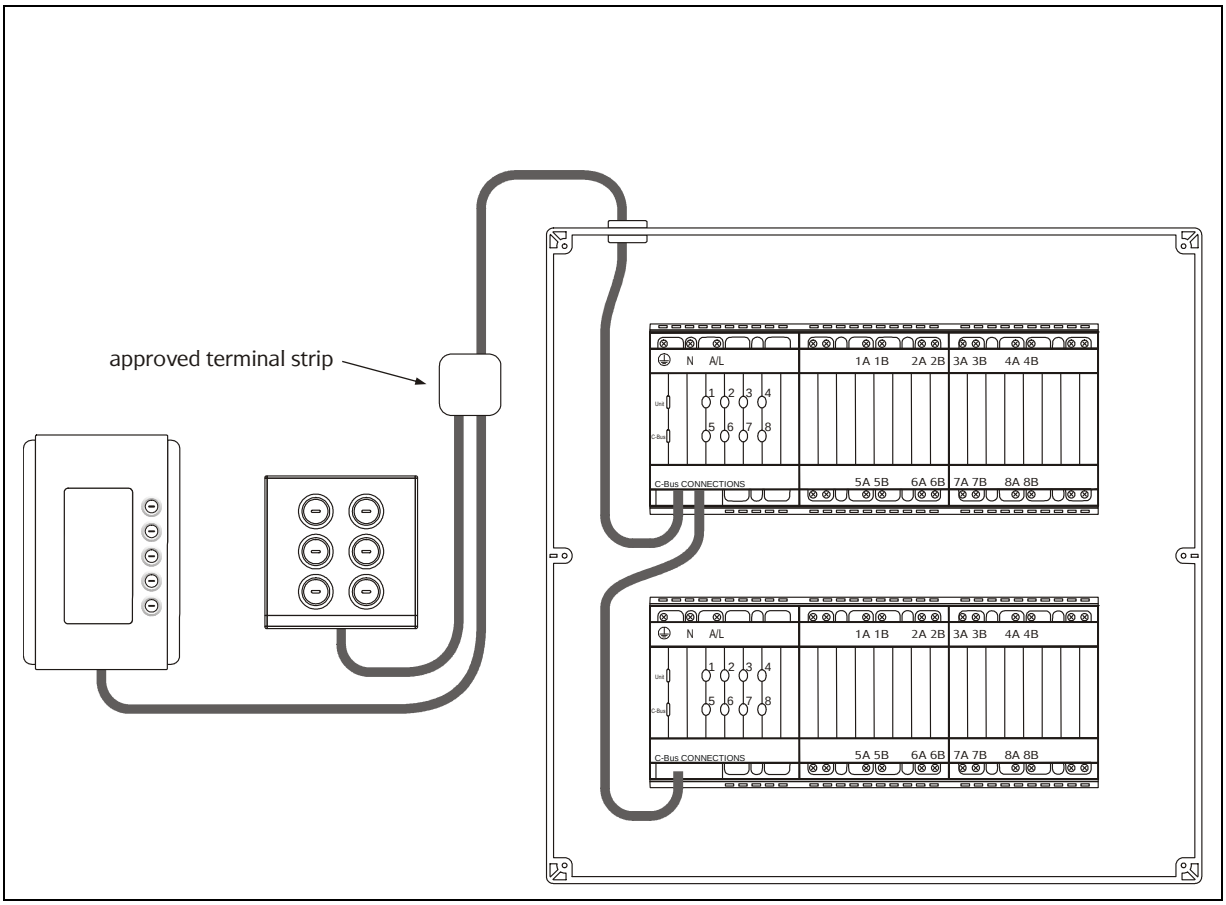


Figure 1: Terminating multiple C-Bus Cat-5 cables to enter a distribution board.

Below is an example of a wired distribution board. Please take note that:

- all mains cables are fixed using cable ties
- a single C-Bus cable entering the enclosure
- all C-Bus connections made via RJ45 connectors.

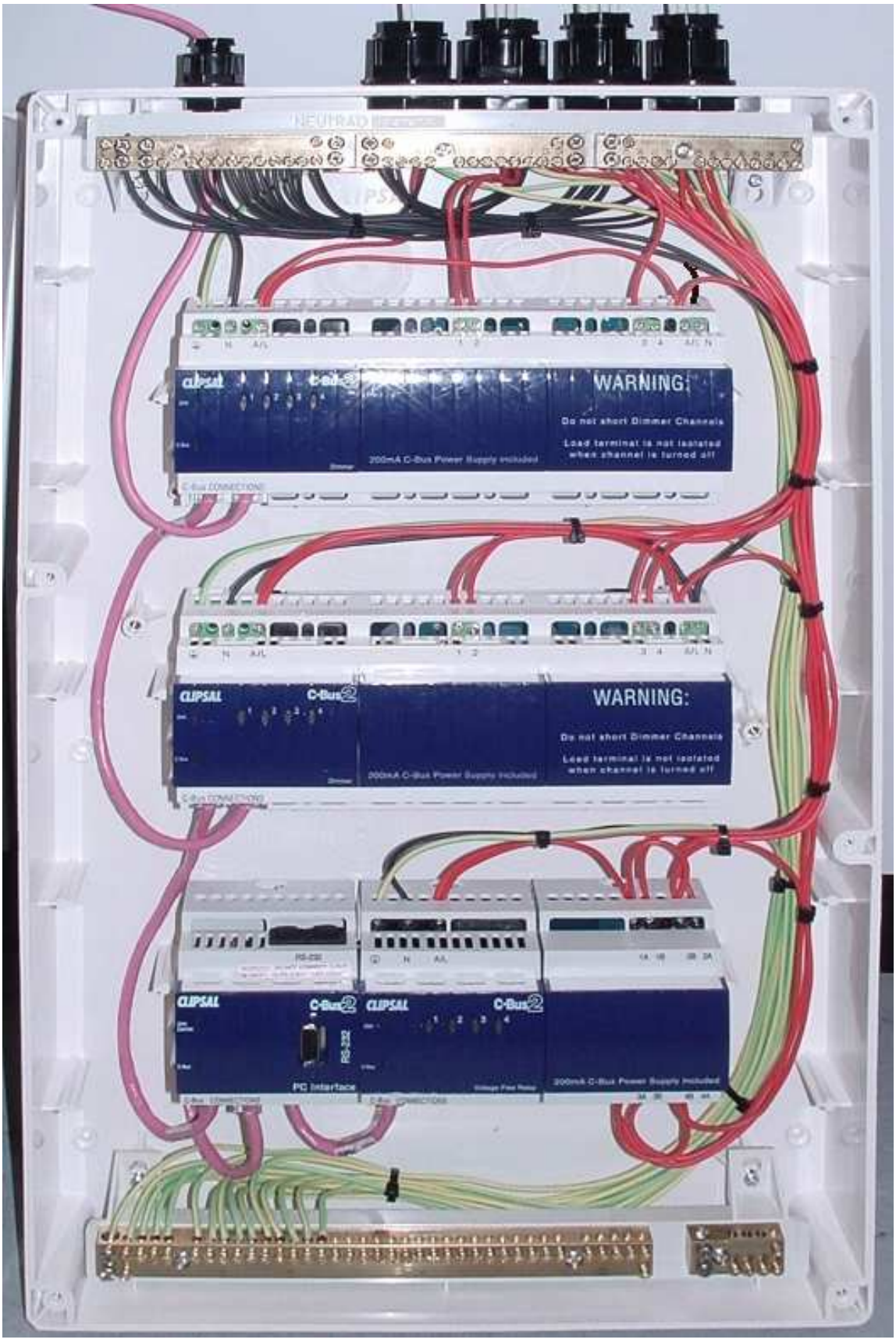


Figure 2: A sample of an enclosure wiring.

3.2 Field Wiring

When wiring the C-Bus Cat-5 cable in the field (outside of the distribution board):

- that you maintain a minimum of 150 mm separation between C-Bus and mains cable, when running C-Bus cable in parallel with mains.
- ensure that C-Bus always crosses mains cable at a 90 degree angle, with at least 60 mm of separation.

Securely anchor both Cat-5 and mains voltage cable in switchboards. This provides an additional safety margin against contact between loose mains conductors, and the C-Bus 36 V DC wiring.

A total of less than 1000 m of C-Bus Cat-5 cable must be used per C-Bus network.

4.0

Circuit Protection

All C-Bus output units consist of electronic components that may be damaged by surges, short circuits and overvoltages.

It is recommended that overvoltage protection should be used in the mains switchboard. If the C-Bus Cat-5 cable is routed between buildings or used in an outdoor installation, then protection must be used on the C-Bus cable as well.

4.1 Miniature Circuit Breakers

Miniature Circuit Breakers (MCB's) can be used on:

- the Input side of a C-Bus output unit
- the output side of a C-Bus output unit.

4.1.1 Input side of C-Bus output unit

To protect the mains voltage cable, an overvoltage protection device (such as the Clipsal 970 series) should be installed across each active C-Bus power supply on each C-Bus output unit (as in Figure 3 & Figure 4).

4.1.2 Output side of C-Bus output unit

To protect the C-Bus dimmer unit and meet the safety requirements of IEC60669-2-1, a MCB should be installed in each output channel (as in Figure 3 & Figure 4).

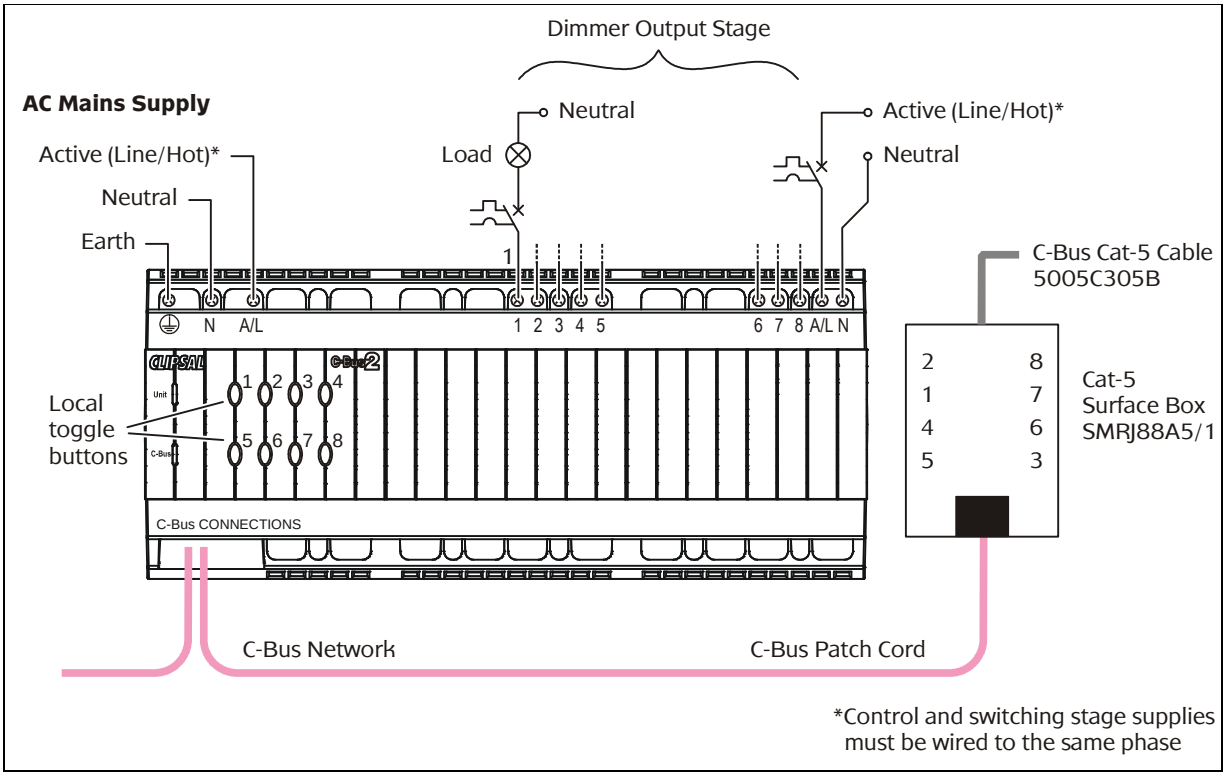


Figure 3: C-Bus 8 channel DIN Rail dimmer (L5508D1A).

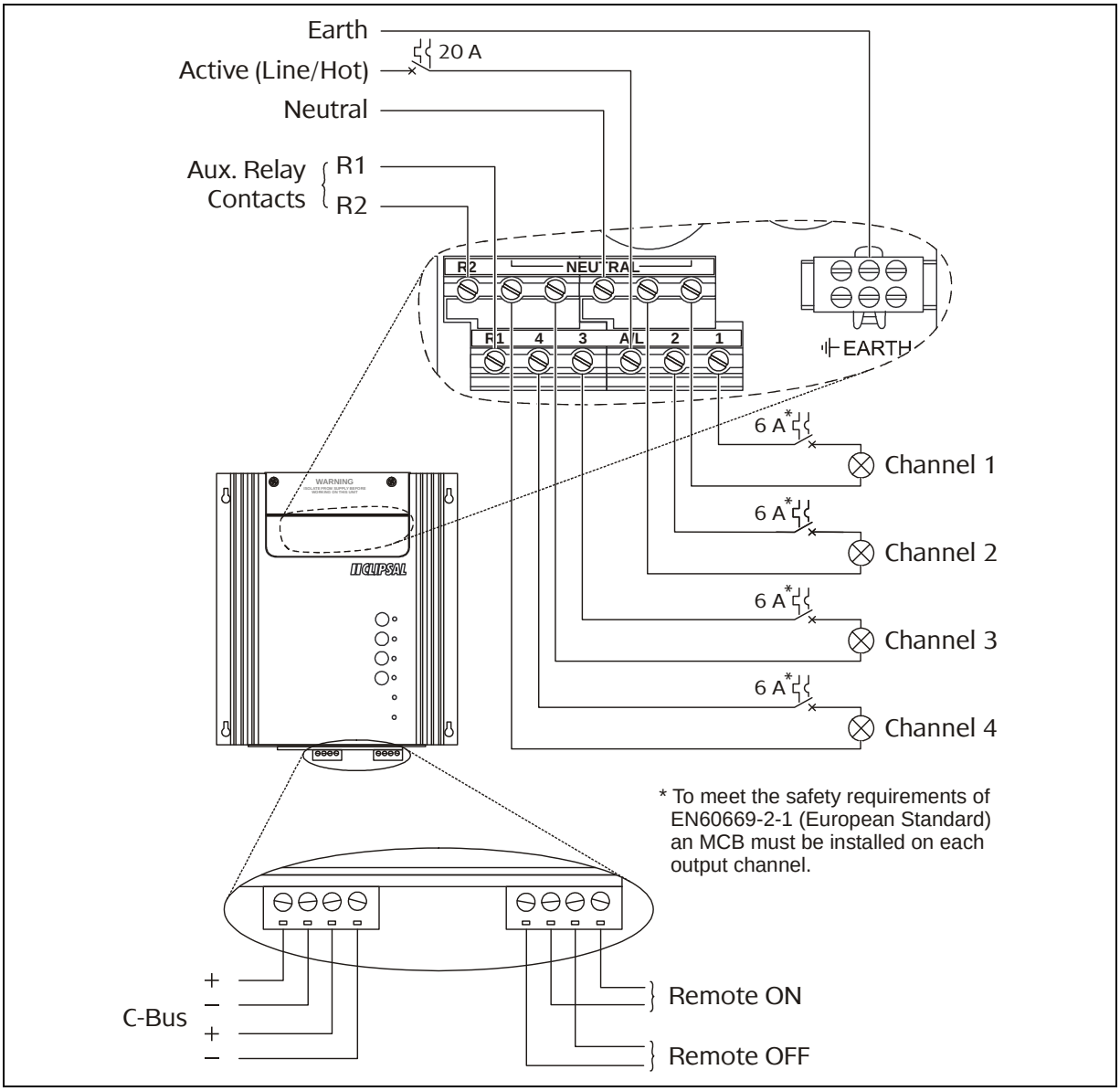


Figure 4: C-Bus 4 channel professional dimmer (L5104D5).

4.2 HRC Semiconductor Fuses

HRC Semiconductor Fuses can be used instead of MCB's to protect the mains voltage cable and the C-Bus dimmer unit.

4.3 Protecting C-Bus Mains

Table 2 lists the MCB's or fuses to be used on the input side of C-Bus output unit.

C-Bus Output Units		Catalogue Number	Max load per Unit	MCB/Fuse range per Phase
Dimmer Modules	DIN Rail Series	L5508D1A or L5508D1AP	8 A	8 A *
		L5504D2A or L5504D2AP	8 A	8 A *
	Professional Series	L5104D5	20 A	20 A *
		L5102D10	20 A	20 A *
		L5101D20	20 A	20 A *
	High Power Professional Series	L5112D10B2	3 × 40 A	3 × 40 A *
		L5112D12B2	3 × 48 A	3 × 50 A *
		L5112D16B2	3 × 64 A	3 × 80 A *
		L5112D20B2	3 × 80 A	3 × 80 A *
Voltage Free Relay		55xxRVF	N/A	N/A

Table 2: Protection device fitted to the Input side of C-Bus units.

* The MCB/Fuse range for the input side of a C-Bus output unit, should be suitable for the incoming supply.

4.4 Protecting C-Bus Loads

Table 3 lists the MCB's or fuses to be used on the output side of C-Bus output unit.

C-Bus Output Units		Catalogue Number	Max load per Channel	MCB/Fuse per Channel
Dimmer Modules	DIN Rail Series	L5508D1A or L5508D1AP	1 A	1 A *
		L5504D2A or L5504D2AP	2 A	2 A *
	Professional Series	L5104D5	5 A	6 A *
		L5102D10	10 A	10 A *
		L5101D20	20 A	20 A *
	High Power Professional Series	L5112D10B2	10 A	10 A *
		L5112D12B2	12 A	12 A *
		L5112D16B2	16 A	16 A *
		L5112D20B2	20 A	20 A *
Voltage Free Relay		55xxRVF	10 A	N/A

Table 3: Protection device fitted to the output side of C-Bus units.

* The MCB/fuse range for the output side of C-Bus output unit should be suitable for protecting each individual output channel.

5.0

Cable Testing

For reliable operation of C-Bus, is it recommended that both the mains cables and C-Bus cables are checked. This will ensure that cabling conforms to standard C-Bus installation practices.

This chapter will look at:

- mains cable testing
- cable sizes
- C-Bus cable polarity and pairing
- cable jointing.

5.1 Mains Cable Testing

Megger testing the insulation of the mains voltage cable, should be carried out before connecting any C-Bus products.

Clipsal Integrated Systems (CIS) recommends that C-Bus products be disconnected from the mains cabling before megger testing. This will ensure a correct reading.

5.2 Cable Sizes

The table below lists the mains voltage and load cable sizes:

C-Bus Output Units		Supply Cables (A & N)	Load Cables (A & N)
Dimmer Modules	DIN Rail Series	2.5 mm^2 or 2x1.5 mm^2	1.5 mm^2
	Professional Series	4.0 mm^2 or 2x2.5 mm^2	4.0 mm^2 or 2x2.5 mm^2
	High Power Processional Series	6.0 mm^2	4.0 mm^2 or 2x2.5 mm^2
Voltage Free Relay		2.5 mm^2 or 2x1.5 mm^2	

Table 4: Cable sizes.

5.3 C-Bus Cable Polarity and Pairing

The C-Bus network uses Unshielded Twisted Pair (UTP), Category 5 data cable. Clipsal manufacture a cable for C-Bus use exclusively (Cat. No. 5005C305B). This has a pink insulation, so that there is no confusion between blue data cable and pink C-Bus Cat-5 cable (the Cat-5 cable also tested for insulation resistance).

The following conductors of the Cat-5 cable must be used to make the C-Bus connections:

- orange + blue C-Bus +
- orange & white + blue & white C-Bus –

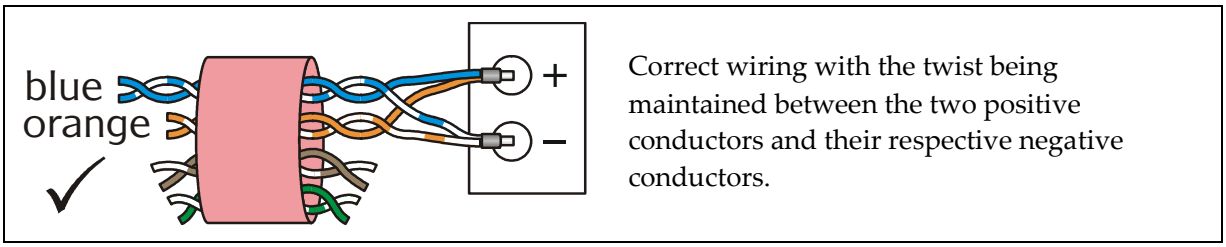


Figure 5: Correct pairing of C-Bus conductors.

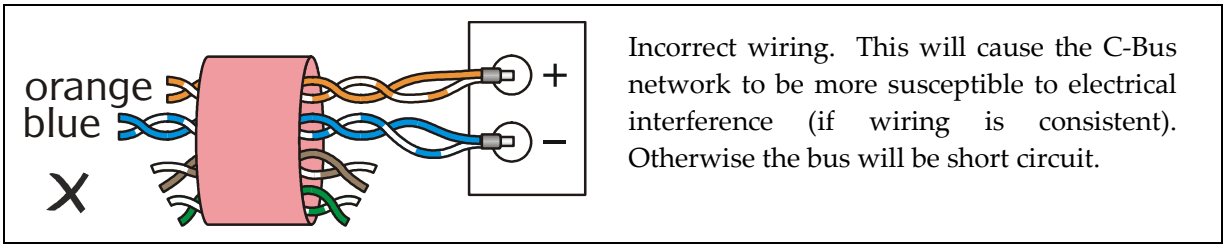


Figure 6: Incorrect pairing of C-Bus conductors.

The use of Cat-5 UTP minimizes the coupling of external magnetic fields onto the cable, thus reducing interference on the C-Bus cable.

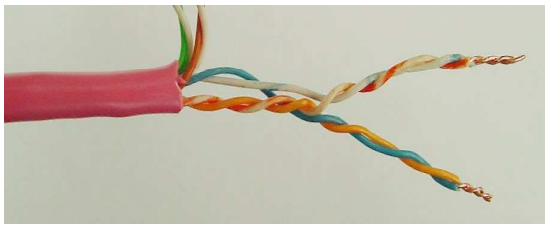
The two wires for each of the positive and negative rails of the C-Bus cable decreases the wire's resistance. Putting a wire in parallel with another wire of the same resistance, you will effectively halve the resistance. This then decreases the potential voltage drop that may be lost over long lengths of cable.

The mains side of C-Bus is wired in accordance the relevant standards that apply in your region. C-Bus cable is run and connected with similar rules that govern data cabling.

5.4 Cable Jointing

Cat-5 (cable) is most commonly single strand 0.2sq mm copper in each conductor. The following are the recommended termination and jointing techniques for installing a C-Bus network.

Care must be taken when twisting the conductors together, so the wires don't break (Figure 7). Care must also be taken to ensure all core wires are secure.

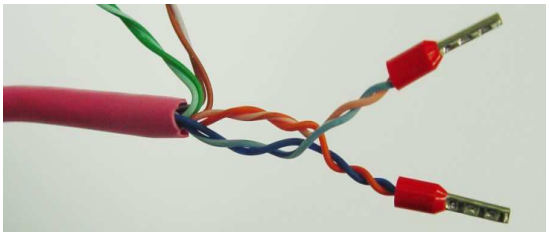


Conductors Twisted Together

- Maximum 2 conductors.
- Over twisting may cause wire to break.

Figure 7: Conductors twisted together.

By using a small bootlace or ferrule crimps, the Cat-5 conductors can be securely held (Figure 8). Depending on the size of the crimp used, more than one crimp may be held in a terminal.



Conductors Crimped Together

- Maximum 4 conductors.

Figure 8: Conductors crimped together.

Soldering the conductors together shrinks back the insulation, making short circuits between conductors more likely (Figure 9). Over time solder will cold flow away from the point of pressure causing an intermittent or high resistant joint.

Conductors Soldered Together

- Not recommended.
- Joint will become loose over time.

Figure 9: Conductors soldered together.

A RJ45 plug is also another approved way of terminating C-Bus to C-Bus output units. The pin-out for the RJ45 is as shown below in Table.

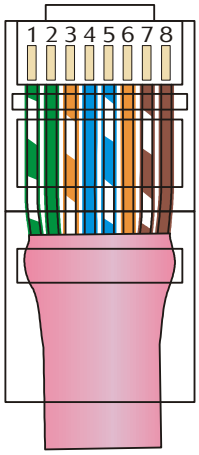
Pin	Connection	Colour	Clip Facing Down
1	Remote Override ON	Green/White	
2	Remote Override ON	Green	
3	C-Bus Negative (-)	Orange/White	
4	C-Bus Positive (+)	Blue	
5	C-Bus Negative (-)	Blue/White	
6	C-Bus Positive (+)	Orange	
7	Remote Override OFF	Brown/White	
8	Remote Override OFF	Brown	

Table 5: Pin Out for an RJ45 C-Bus termination.

6.0

Wiring Relay Loads

It is important not mix different output voltages on the channels of a C-Bus Relay (SELV and LV).

The voltage classifications are:

- Safety Extra Low Voltage (SELV): (< 50 V AC or <1 20 V DC)
- Low Voltage (LV): (50 – 1000 V AC or 120 – 1500 V DC)
- High Voltage (HV): (1000V AC or 1500 V DC)

The ranges above are a reference, please refer to your local authority standards.

6.1 Voltage Connections

When wiring loads to C-Bus relays it is stongly recommended, that each channel on the unit fall into only one of the following classifications:

- Safety Extra Low Voltage (SELV)
- Low Voltage (LV)
- High Voltage (HV)

Figure 10 shows 24 V DC (which is SELV) and 240 V AC (which is LV) being connected to the same dimmer.

WARNING This is not the correct wiring for this application. It is recommended to use a separate relay unit for each voltage classification you want switched.

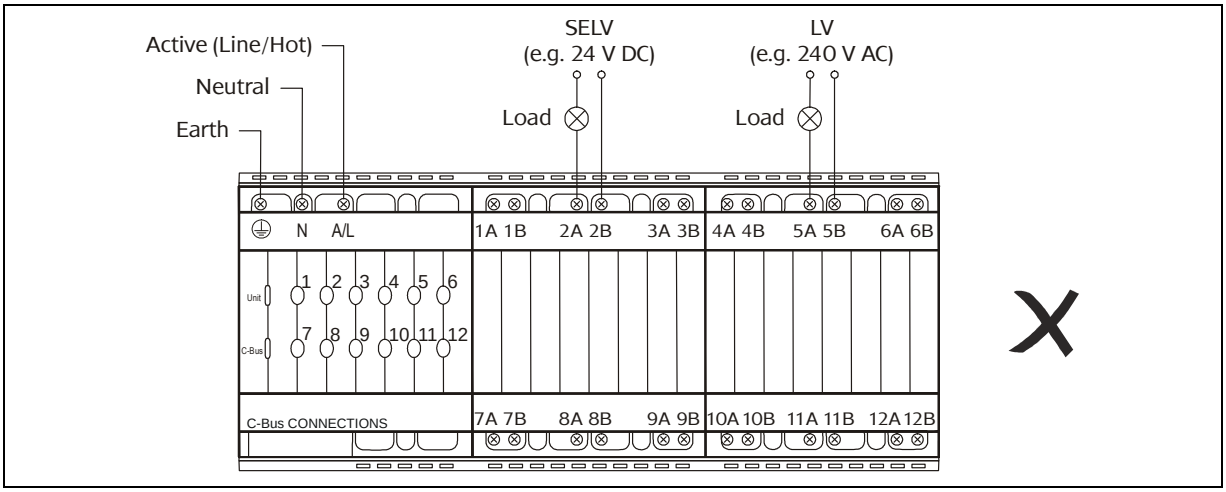


Figure 10: Incorrect mixed voltage classification.

The correct wiring for a C-Bus relay is shown in Figure 11 and Figure 12.

Figure 11 shows 2 different voltages being switched by two relays. Although they are both different voltages, they both fall into the SELV classification.

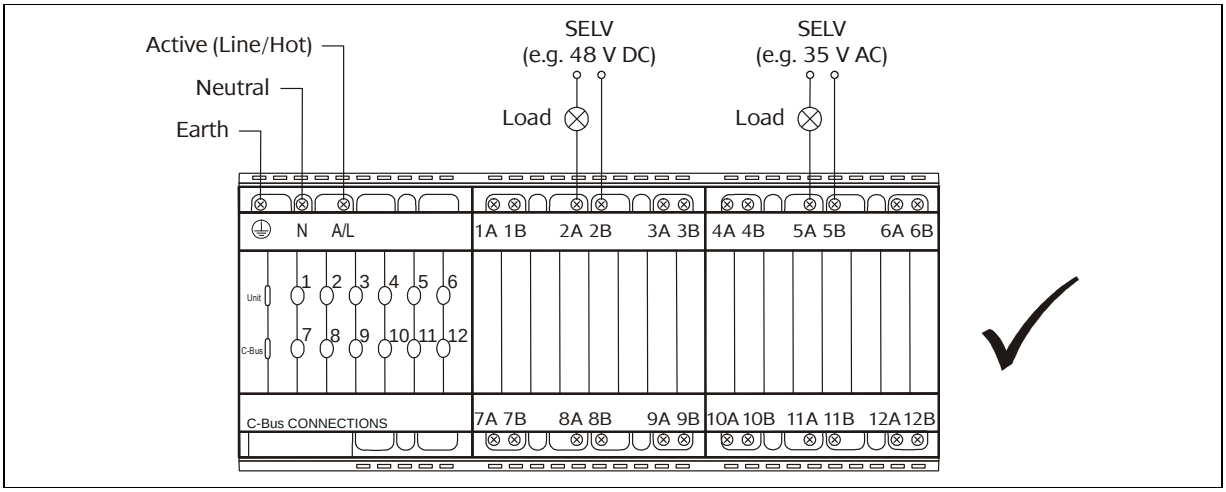


Figure 11: Correct voltages mixed.

Figure 12 shows 2 different voltages being switched by two relays. Although they are both different voltages, they both fall into the LV classification.

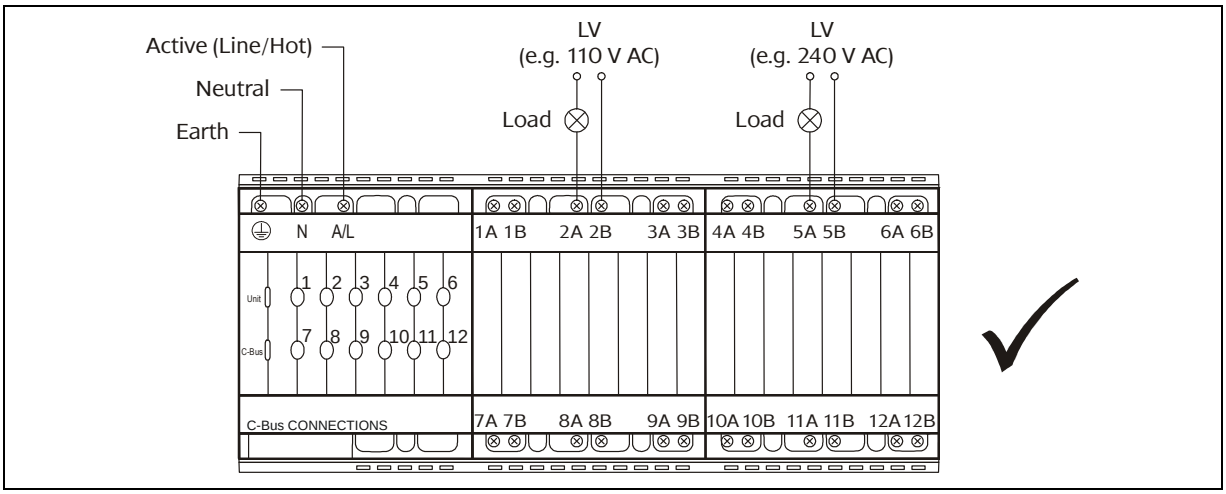


Figure 12: Correct voltages mixed.

7.0

C-Bus Dimmers

C-Bus wired dimmers are leading edge phase control dimmer for incandescent & low-voltage lighting application (iron core and electronic transformer). Electronic Transformers must be suitable for leading edge technology.

7.1 Dimmer Phase Connections

Mains voltage supply to the Control and Switching Stages of the C-Bus DIN Rail dimmers are not internally connected.

CAUTION

Both must be wired from the same voltage phase. Do not cross the neutral connections.

Figure 13 shows the correct way to wire a C-Bus DIN Rail dimmer, with the same phase being looped between the voltage supply and the switching supply.

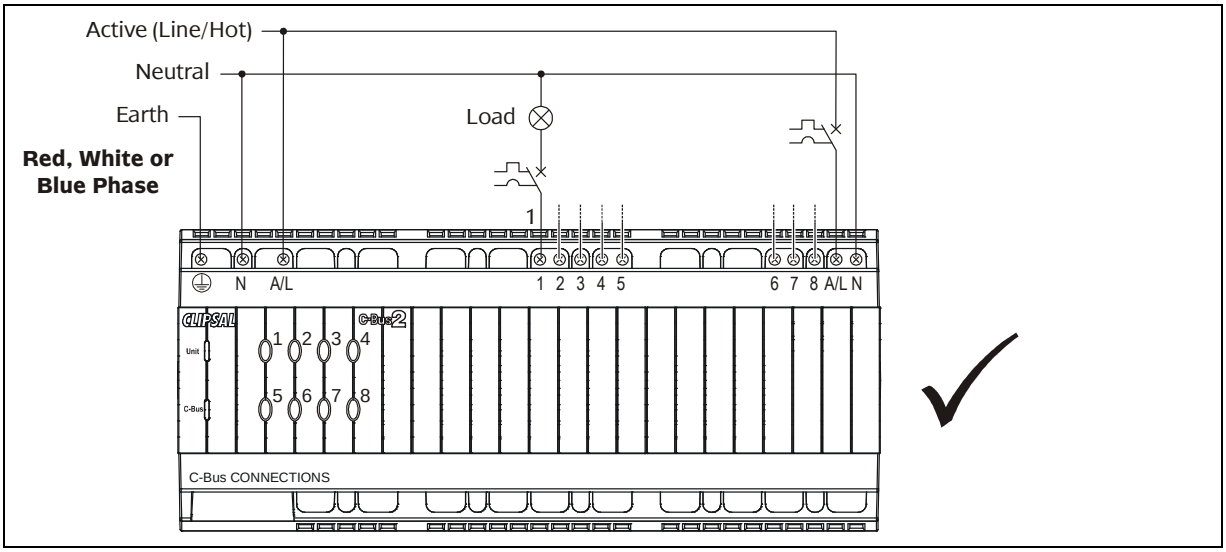


Figure 13: Correct wiring, with the same phase.

Figure 14 shows the incorrect way to wire a C-Bus DIN Rail dimmer, with the different phases being used on the voltage supply and the switching supply.

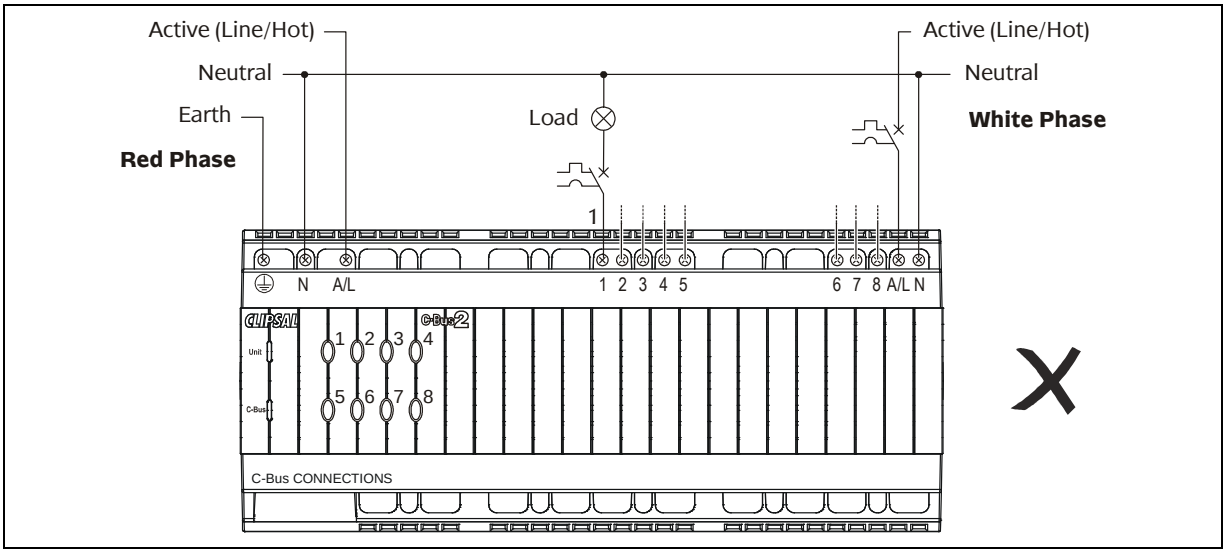


Figure 14: Incorrect wiring, due to different phases.

8.0

Single Network Topology

All C-Bus units may be wired in daisy chain, star or a combination of both configurations, ultimately all conductor connections are parallel. When Clipsal uses the term location daisy chain or star, it simply refers to the physical positions of units & the way cables are physically run. A closed ring configuration must not be used.

8.1 Daisy Chain Topology

The daisy chain wiring configuration (shown in Figure 15), is basically a run of units, connected with its positive and negative terminals in parallel.

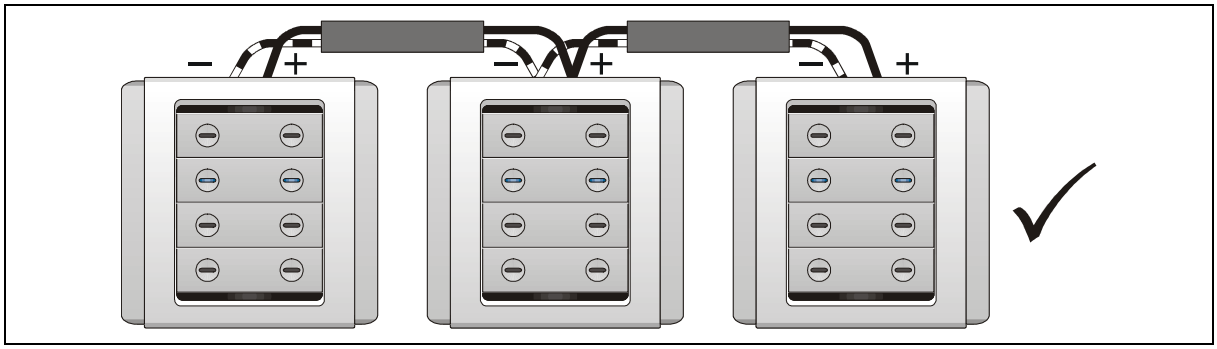


Figure 15: Correct daisy chain topology.

8.2 Star Topology

Figure 16 shows some input units wired in a star configuration. This is basically a run of units, connected with multiple wires coming into the positive and negative terminals in parallel.

If two or more cable runs branch off from a single point, it is referred to as a star configuration.

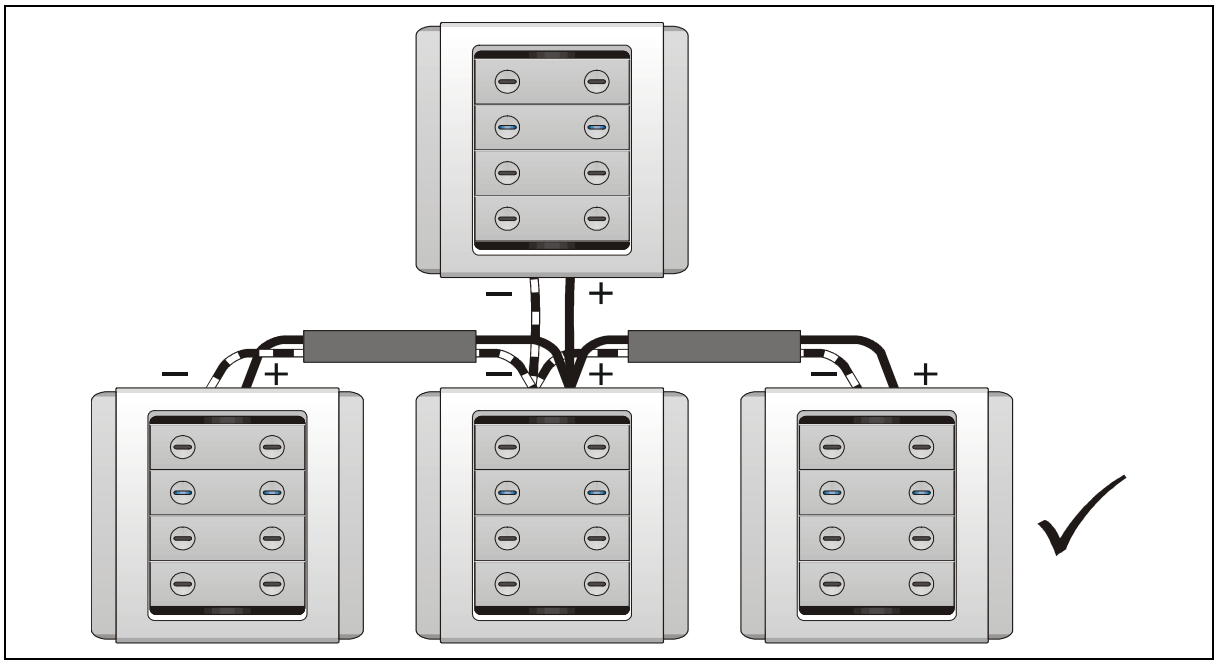


Figure 16: Correct star topology.

8.3 Closed Loop Topology

A loop configuration must not be used. Wiring the C-Bus network in this configuration is not necessary and will cause the C-Bus network to act unexpectedly.

Figure 17: Incorrect closed loop topology.

Appendix 1

MAINTAINING SEPARATION BETWEEN 240 V MAINS WIRING AND C-BUS Cat-5 UTP CABLE

The C-Bus DIN range of products has proved to be very popular. They offer cost effective performance. Their small 'footprint' and DIN clip mounting was designed to allow them to be mounted into switchboards and consumer units.

With all C-Bus units that have mains as well as 36 V DC bus connections care must be taken to adequately separate the 240 V AC wiring from the bus wiring. Within the confines of a switchboard this will require the use of the C-Bus pink Cat-5 UTP which has mains rated insulation in its outer sheath.

Wiring practices vary from installer to installer, some times the mains cable entering the switchboard is double insulated sometimes it is single insulated. Even where it is double insulated, the outer insulation must be stripped back to allow the connections of the mains wires to the DIN units power supply and output terminals.

Where the Pink C-Bus Cat-5 cable enters the switchboard, if it then plugs straight in to a DIN module no problems with isolation between it and any single insulated mains cable can be expected. The 300 mm pink Cat-5 patch leads supplied with all DIN units should then be used to loop in and out of any other DIN units in the enclosure.

Where more than one pink Cat-5 cable enters the switchboard care must be taken to ensure that any join made between multiple Cat-5 cables is effectively insulated with no exposed terminal screws etc.

It may be worth considering terminating multiple C-Bus Cat-5 cables outside the switchboard so that you can bring just one pink Cat-5 straight in to the RJ socket on one of the DIN units.

The Mains rated pink insulation will allow the C-Bus Cat-5 cable to be run closer to mains wiring than would be allowed under normal circumstances. It is still good practice to keep them as far apart as possible and cross at 90 degrees to give the greatest margin of noise immunity both within the confines of the switchboard and around the installation.

Most importantly, securely anchoring both pink Cat-5 and mains cables in switchboards will give additional safety margin against inadvertent contact between loose mains conductors and the C-Bus 36 V DC wiring.

All of these issues are covered by the wiring regulations, there is an obligation for an installer to ensure that wiring is not carried out in a dangerous manner. While the safety and protection of equipment users is of the highest importance the product warranty will also be effected should a failure be found to be caused by poor wiring practice. In addition the isolation between mains and C-Bus wiring is one of the key checks made during a CIS Approved Installer site visit.