

## **C-Bus Training Course**

## **C-Bus Hardware**

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## Scope

This manual provides an overview of various units used in a C-Bus network. A fundamental technical background is required.

The manual covers:

- system support devices
- input units
- output units
- C-Bus indicators.

It is an ideal preparation before attending the C-Bus Basic Training Course.

## Learning Outcomes

By the end of this module, you should have an understanding of:

- system support devices and their uses
- operations for system support devices
- basic calculations used to predict voltage drops over large cable runs
- input units and their uses
- output units and their uses
- recalling operations for the output units by using the manual provided.

## 1.0 System Support Devices

C-Bus system support devices are units which support the operation of a C-Bus network. They are used to:

- program C-Bus
- generate C-Bus voltage
- offer multi-network connectivity.

### 1.1 Power Supply

The C-Bus power supply is a switch mode device, which means it is efficient and compact. It converts mains voltage into a usable C-Bus voltage of 36 V DC. It is the C-Bus power source, providing power to each unit on the network.

The C-Bus system operates at an Extra Low Voltage (ELV) level. The minimum voltage required by each device on the bus is 15 V DC. However, a voltage this low may cause communication to be unstable. Therefore, it is strongly recommended that the C-Bus voltage be at least 20 V DC.

The resistance of a typical C-Bus Unshielded Twisted Pair (UTP) conductor is 90  $\Omega$ /km. The typical current requirement of a C-Bus device is 18 mA. Therefore, if one device is connected to the end of one kilometre of C-Bus cable (Figure 1), the voltage drop would be  $90 \times 18 \times 10^{-3}$  or 1.6 V.

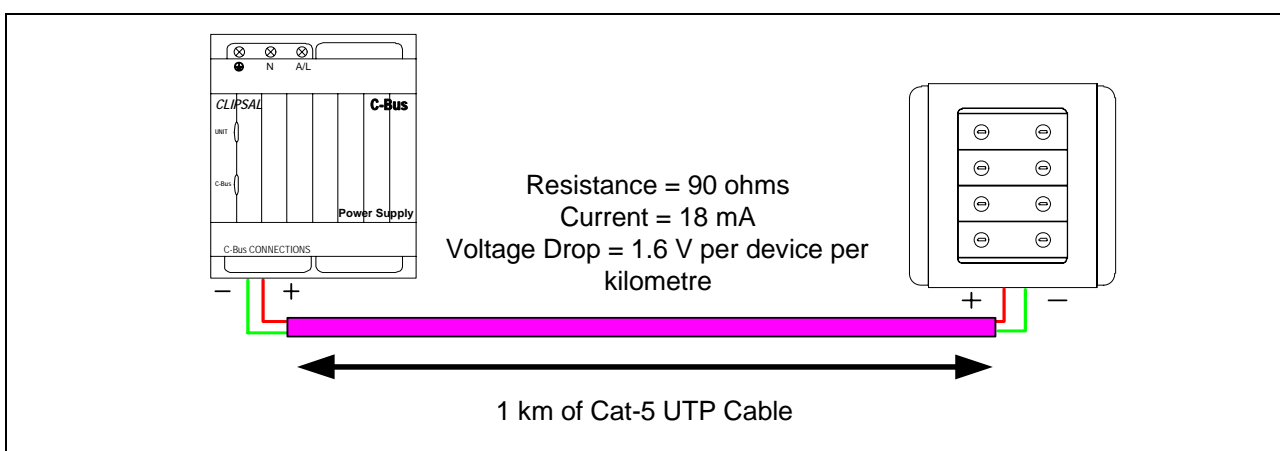


Figure 1 - Voltage drop over one kilometre of C-Bus cable (Approximately 18 mA per device).

In an installation, power supplies should be distributed evenly along the C-Bus, rather than just at one end, in order to minimise system voltage drops.

### Number of Required Power Supplies

The number of power supplies needed in a C-Bus installation depends upon:

- the power supply output current
- the number and type of devices on the network
- the location of the devices in relation to the power supplies.

While the first two points are easily measured, the third is more subjective. Power supplies should be placed to minimise voltage drop across the network, reducing power loss. As a general rule, one power supply is required for every 17 C-Bus units that draw 18 mA each.

### Output Current Limiting

One of the many advantages of the C-Bus ELV is that connections can be made while power is applied to the network. (This applies to 36 V C-Bus input units, but not units with mains voltage connections such as dimmers and relays). Should a short circuit occur on the C-Bus, the power supply current limiting and overload protection feature, provides protection from damage for an indefinite period of time.

### AC Output Impedance

C-Bus messages are voltage pulses which are superimposed over the DC power supply voltage. This requires a high AC impedance to be present at communication frequencies. The power supply has a special output stage that provides this impedance. General purpose off-the-shelf power supplies are not suitable for C-Bus installations.

## 1.2 Network Bridge

A network bridge is a special linking unit that allows communication between two or more C-Bus networks, while maintaining electrical isolation.

A C-Bus network bridge allows:

- relaying of messages between networks, allowing units on multiple networks to be programmed and monitored from a central location
- transmission of commands which allow input units on one network to control output units on another. Units across several networks can be assigned the same Group Address to provide this high level of control.

A C-Bus network bridge has several limitations:

- The Multipoint to Multipoint Interrogation\* (MMI) status report cannot be transferred across a bridge. This means that an input unit controlling an output unit in another network, cannot automatically correct itself.
- A bridge can only send messages to its two adjacent networks plus one other. This limits inter-network control when bridges are used in cascade form.
- The maximum number of bridges that can be cascaded is six (in series). A star network topology is recommended for most installations, and is required to interconnect more than seven networks.

A network bridge consists of two functionally and electrically independent systems. Each system consists of a communication interface and microcontroller, powered by the ELV C-Bus power from the networks to which it is connected.

Each Network Bridge provides optically isolated communication between sub-networks, so the reliability of the overall system will not be impaired by introducing bridges. Refer to the illustration in Figure 2.

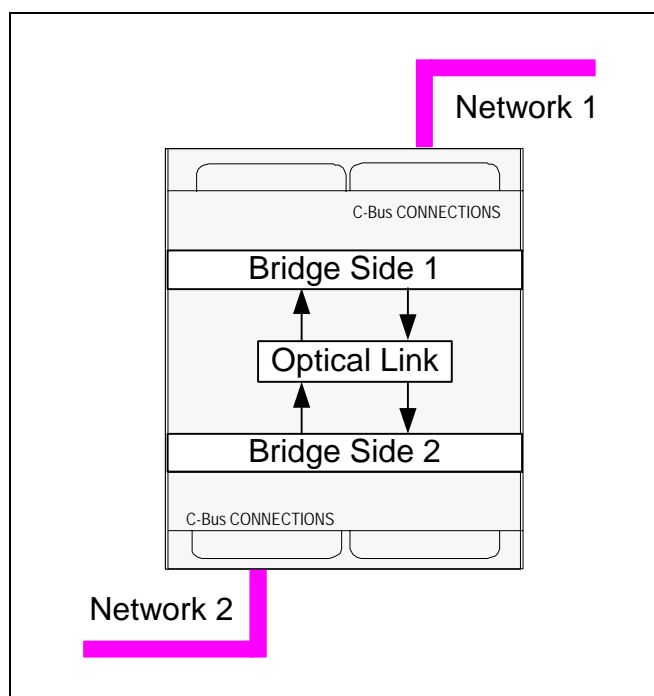


Figure 2 – Construction of a network bridge

\* The Multipoint to Multipoint Interrogation (MMI) Wired C-Bus uses a status reporting system (known as an MMI), which provides automatic detection and correction of discrepancies between the states of grouped inputs and outputs. This status reporting occurs at periodic intervals. Increasing the frequency of status reporting decreases the response time in which errors are corrected. However, it increases the amount of network communication traffic. If different status report values exist in the same network, the smallest value is used. The default value is 3 seconds.

### 1.3 PC Interface

A PC Interface provides a communication path between a personal computer and a C-Bus network (see Figure 3). With a PC Interface and the C-Bus Toolkit software, you can:

- program and issue commands to C-Bus units
- monitor a C-Bus network, logging network activity.

A C-Bus PC Interface can:

- generate a system clock for synchronised data transmissions
- apply a network burden to the C-Bus network.

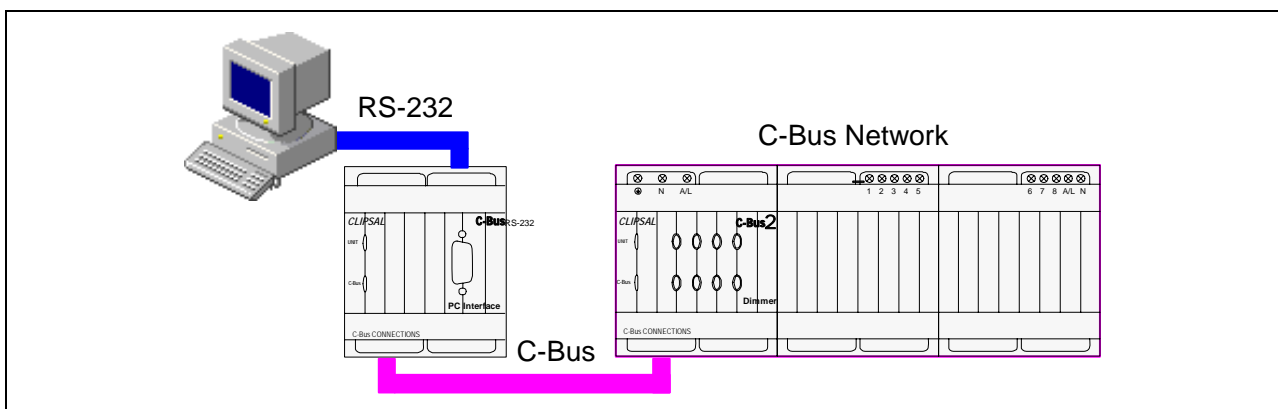


Figure 3 – A PC interface lets you connect a computer to the C-Bus network

**Note:** A C-Bus Network Interface serves the same function as a PC Interface, but connects to a PC using an Ethernet connection rather than an RS-232.

The C-Bus PC Interface uses a proprietary ASCII command language for communicating with a PC. Detailed protocol information is available to approved applicants, from Clipsal Integrated Systems (CIS). Please contact a CIS representative for more details.

## 2.0 C-Bus Input Units

C-Bus input units respond to certain stimuli (such as touch, ambient light conditions, temperature and infrared radiation), by sending messages to appropriate output units in a predetermined way.

There are various types of input unit:

- wall switches (1, 2, 4, 6 or 8 channel), as shown in Figure 4
- light level sensors
- PIR occupancy sensors
- temperature sensors
- real time clocks
- auxiliary input units
- infrared receivers
- scene controllers
- touch screens.

Input units can be used to:

- control lighting conditions manually or as a response to changing light levels
- control air conditioning according to ambient temperature
- respond to human presence by sending commands to security and access systems
- send IR commands to third party devices.

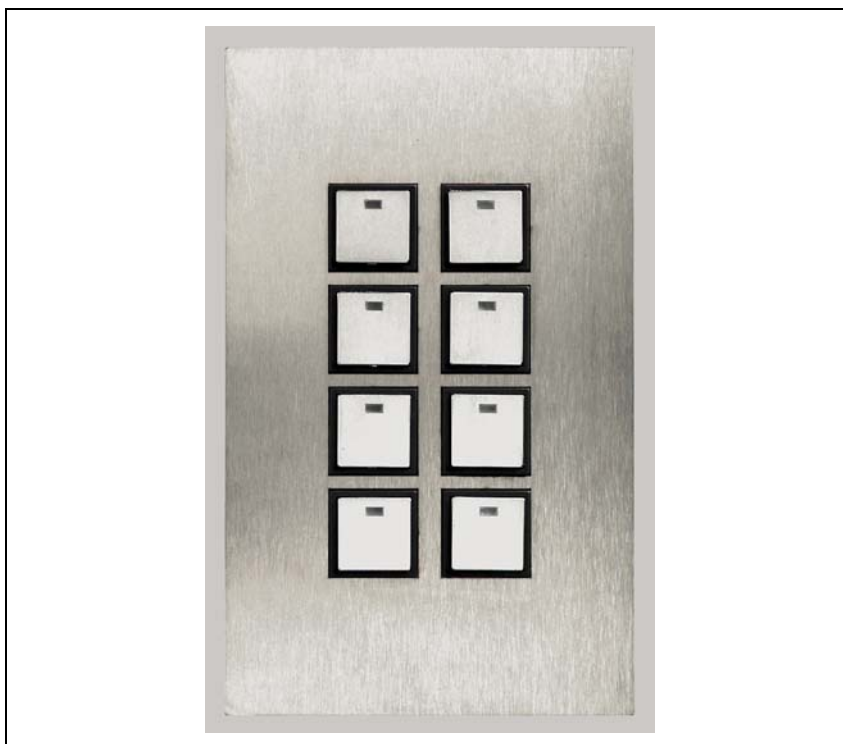


Figure 4 – A "Reflection" 8 button wall switch

## 2.1 Operation of Input Units

Any network needs to have input and output capabilities. Therefore, input units are a fundamental building block of a C-Bus system.

Input units can only broadcast three types of commands on a C-Bus network. These are:

- on commands
- off commands
- ramp to (level) commands.

When a button is pressed on a wall switch, a message is sent across the C-Bus network for an output unit to perform one of the three functions above.

An input unit can also perform timing functions. A press of a button starts a timer, and a command is sent to an associated output unit. After a programmed time interval (of up to 18 hours), another command is sent to cancel the previous (depending on the unit's programming).

One of the main features of C-Bus (and the reason the system is so effective), is its self-checking ability. At regular intervals an input unit issues a request over the network for a status report. In response to this request, output units with the same Application Address broadcast their status in the form of an MMI\*. This allows inputs assigned to the same Group Address to compare and synchronise their status. If the comparison disagrees, the input unit may take corrective action. This corrective action could be as simple as updating its own indicator to match the status of the output, or issuing a command for the output unit to change its state.

\* MMI (Multipoint to Multipoint Interrogation).

## 2.2 Pressing a Button

If you press a button on a wall switch, one or more messages may be transmitted over the C-Bus network. The message transmitted depends on:

- how the unit is programmed
- how long you pressed the button.

A change in ambient lighting, temperature level or the detection of infrared energy may be used instead of a physical button press, to trigger a response in some input units. Such units include light level sensors, temperature sensors and PIR occupancy sensors.

## 2.3 Sending Input Messages

When a C-Bus input or output unit receives a message, it performs a function described in Table 1. Any internal timers (input units only) on the same Group Address will be forced to cancel.

<b>On</b>	A unit's internal level is set to maximum and its status is set to on.
<b>Off</b>	A unit's internal level is set to zero and its status is set to off.
<b>Ramp To Level</b>	A unit's internal level is set to the level contained in the message. Output dimmer units ramp to the new level. Two possible status levels exist: <ul style="list-style-type: none"> <li>• If the new level is zero, the status is set to off.</li> <li>• If the level in the message is not zero, the status is set to on.</li> </ul>
<b>Timer Options</b>	Interval timers reside on input units. When activated, time is decremented in one second intervals. The maximum timeout range is 18 hours, 12 minutes and 15 seconds (65,535 seconds). Upon reaching a count of zero, the timer will send an expiry command message.

Table 1 – Command function types performed in response to a C-Bus message

### 3.0 C-Bus Output Units

C-Bus output units are used to control external loads. They switch these loads in response to messages received from associated input units. Output units can be programmed in various ways, to suit the need of various installations.

There are various types of output unit:

- voltage free relays
- voltage free changeover relays
- Professional Series dimmers
- DIN rail dimmers
- DSI Gateway
- analogue outputs (0 to 10 V DC)
- infrared transmitters.

#### 3.1 Voltage Free Relay

The C-Bus 55xRVF Series Voltage Free Relays are relay-switching devices designed to be mounted in electrical switchboards or similar enclosures (an example is shown in Figure 5). For ease of installation, they are DIN rail mounted, measuring 12 DIN modules wide.

Several independent voltage free relay contacts are provided for general switching applications. The series includes units with 10 A rated relays for resistive, inductive (lighting loads) or fluorescent loads. There is also a 20 A version.

Units are available with or without a 200 mA C-Bus power supply, for powering other C-Bus units connected to the network.

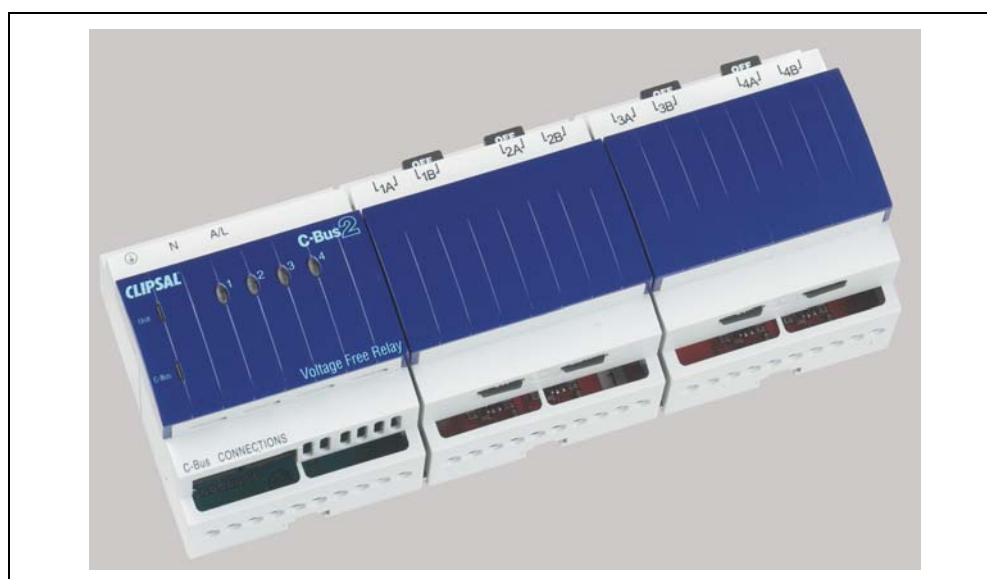


Figure 5 – A Four Channel Voltage Free Relay

### **3.2 Voltage Free Changeover Relay**

A C-Bus L5504RVFC Series Voltage Free Changeover Relay is used in an application where changeover contacts are required. These units are typically used to operate three-speed motors and two-way motor control devices, such as motorised blinds, shutters, curtains and skylights.

Four independent voltage free, changeover relay contacts are provided, each with normally open, normally closed and common terminals. They are available with or without an internal C-Bus power supply. Units with a power supply are capable of supporting other C-Bus units (200 mA capacity).

Voltage free changeover relays are suitable for use with resistive, inductive, fluorescent and incandescent loads.

### **3.3 Professional Series Dimmer**

The Lx510xDx Professional Series Dimmers are C-Bus output units suitable for dimming resistive and low voltage loads in lighting applications. Each channel is load rated between 5 and 20 A (depending on the unit's model).

Housed in an all aluminium heat sink, the dimmers have been designed for fast installation, with features such as keyhole mounting, front and rear cable access, ample termination space for mains cabling, and removable terminals for C-Bus and override connections. They have independent dimmable channels, operating from a single-phase mains voltage. They operate with any mains frequency in the range 47 to 53 Hz or 57 to 63 Hz, and will automatically resynchronise when this frequency varies.

Professional Series Dimmers draw 18 mA from the C-Bus network when not connected to the mains supply. With mains voltage connected the dimmers provide up to 60 mA to the C-Bus network.

### **3.4 DIN Rail Series Dimmer**

The DIN Rail Series Dimmers are C-Bus output units suitable for dimming incandescent and low voltage lighting. They feature eight leading edge, phase controlled dimming channels. Each channel has a load rating of between 1 and 2 A (depending on the unit's model).

The dimmers are capable of controlling incandescent and low voltage lighting (utilising iron-core and electronic transformers, compatible with leading edge dimmers).

Two product variants are available. One incorporates a 200 mA C-Bus power supply used to source current to the C-Bus network. The other is an economical model with the same features and performance, but does not include the power supply.

### **3.5 DSI Gateway**

A DSI Gateway is a DIN rail mounted C-Bus output device, designed for controlling ATCO-Tridonic DSI dimming ballasts, or an equivalent product that uses the DSI protocol standard.

DSI Gateway units incorporate eight independent control channels, for switching and dimming fluorescent luminaries. They are designed to control up to 100 DSI dimming ballasts per channel, allowing up to 800 electronic ballasts to be connected to one DSI Gateway unit.

The DSI Gateway is capable of detecting faulty lamps connected to its terminals (depending on the ballast used). When this occurs, the DSI Gateway will shut down the channel, and the corresponding channel LED indicator flashes at a slower rate (approximately four times per second).

### **3.6 Analogue Output Unit**

The DIN rail mounted Analogue Output Unit provides analogue voltage control signals. These can be used to drive most types of 0 to 10 V electronic dimmable ballasts used in the lighting industry.

The 0 to 10 V signal may be used to control other equipment with this standard control input voltage. The signal direction ranges from 0 to 10 V, as the C-Bus ramping level increases from 0% to 100%.

The Analogue Output Unit operates in response to commands from C-Bus input units. The output terminals can be assigned to any combination of group addresses, providing multiple output control. Four analogue outputs are provided for independent control of up to four devices, with a common reference connection.

This unit requires power from a mains AC supply with Earth.

### **3.7 Infrared Transmitter**

The Infrared Transmitter unit is a C-Bus output unit that controls third party devices using infrared signals. The unit is typically used to control audiovisual equipment such as TVs, DVDs and VCRs. Other infrared capable devices such as motorised blinds and air conditioning units can also be controlled.

A specialised software tool, the C-Bus Infrared Commissioning Application (CIRCA), is provided for programming the unit. The CIRCA software allows the user to select infrared codes, and assign C-Bus events to trigger their transmission. The same configuration can be uploaded to multiple units without having to be reprogrammed.

A high speed programming cable is required to program this unit.

## 4.0 C-Bus Indicators

All C-Bus Output Units (apart from the Infrared Transmitter) have three types of indicators that serve a common purpose. Figure 6 and Table 2 show the location of the indicators on a C-Bus output unit, together with their explanation.

For the specific functions of various indicators, please see the relevant installation instructions that come with the C-Bus units.

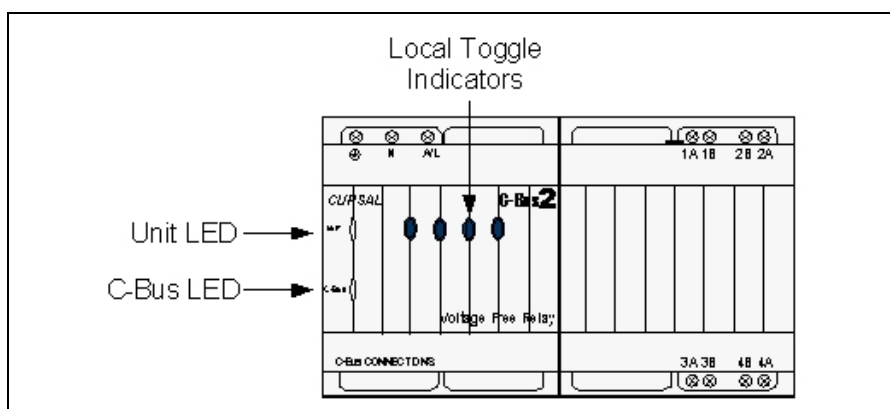


Figure 6 – C-Bus output unit indicators

<b>Unit LED</b>	This LED indicates the status of the individual unit, and whether mains power is present. If the Unit LED is flashing with a 90% on duty cycle, it indicates that a local or remote override has been toggled.
<b>C-Bus LED</b>	This indicator shows the status of the C-Bus network at that particular unit. If the indicator is off, either no C-Bus clock or voltage is detected.
<b>Local Toggle Indicators</b>	The Local Toggle Indicators show the status of each channel on the particular output unit. Each Toggle Indicator is also a switch, which allows each individual channel to be manually controlled. These indicators are also used in Learn Mode.

Table 2 – Explanation of C-Bus output unit indicators

The Unit and C-Bus indicators are found on most system support devices and some input units.