

Handbook

C-Bus Analysis

Revision Number: V1.0

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V1.0 April 2006

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Scope

This handbook has been designed to provide a C-Bus installer or programmer with basic diagnostic skills, needed to analyse a C-Bus installation. A fundamental technical background is required.

It is preferred that the installer or programmer has attended a C-Bus Basic Training Course, before using this handbook.

To get the most out of this manual, be sure to read all chapters carefully.

Learning Outcomes

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

- the various tools used in the analysis of a C-Bus network
- the effect of 3rd party devices on a C-Bus network
- the construction of the C-Bus clock waveform
- the effect of a network burden on a C-Bus network
- the effect of C-Bus devices on a C-Bus network
- the effect of various voltage conditions on a C-Bus network
- the effect of C-Bus cable length on a C-Bus network
- the effect of mains voltages on a C-Bus network.

1.0

Analysis Tools

There are a number of various tools and software packages that may be used to analyse a C-Bus Network. These tools include:

- C-Bus Network Analyser
- Multimeter
- Cathode Ray Oscilloscope
- C-Bus Diagnostic Utility
- HyperTerminal.

These tools may be used to assess the correct operation of a C-Bus Network, so that the customer is left with a flawless installation.

1.1 C-Bus Network Analyser

The C-Bus Network Analyser (5100NA) is a tool, which is used to analyse the conditions of an existing network. To use it, simply connect it to C-Bus via the terminals provided. Wait for five seconds and all of the LED's will come on. This indicates that the Network Analyser is functioning correctly.



Figure 1: The C-Bus Network Analyser.


Each LED on the Network Analyser indicates a certain condition. These conditions are listed below.

LED	Status Of LED	Check / Action
Power Available	Off / Flash	Check C-Bus power is available. If Led flashes add power supply.
Clock Not Present	On	Check the PC Interface and Bridge connections.
Excess Voltage	On	Remove C-Bus Power Supply Units.
Remove Burden	On	Remove Network Burden.
Add Burden	On	Add Network Burden.
Excess Cable	On	Reduce Cable Length or split Network

Table 1: Network Analyser Indicators

The push button on the Network Analyser, adds a Network Burden to the C-Bus network. This Network Burden is found inside the Network Analyser, and will be removed as soon as the push button is released. This function is used to test to see if the network impedance is within its tolerance.

If the Add and Remove Network Burden LED's are flashing alternately, then this indicates that the network is within a stable tolerance.

 **NOTE** When the C-Bus Network Analyser is connected to any C-Bus Network, it temporarily disturbs all C-Bus communications on the bus and causes temporary instability.

1.2 Multimeter

The Multimeter is one of the most versatile and easily accessible measurement instruments. It has a number of functions, which can test a C-Bus network for unexpected behaviours using the:

- Ohm Meter
- DC Voltage Meter
- AC Voltage Meter
- Audible Continuity Test.

When using a Multimeter, remember to test the C-Bus Network at various points by using successive approximation. This will help identify any unexpected conditions along the C-Bus network.

1.3 Cathode Ray Oscilloscope

A Cathode Ray Oscilloscope (CRO) is another vital tool used in C-Bus Network Analysis. It is more complicated to use than a multimeter, but it allows the user to perform advanced readings and measurements, that would be unable to achieve using other measurement instruments.

A CRO will be able to view the:

- C-Bus clock
- AC voltage waveform
- DC voltage waveform
- waveform frequency and period
- MMI Communications
- effect of a network burden
- any other unexpected behaviour of the C-Bus clock.

Many digital CRO's have an 'auto scale' feature, which takes the C-Bus waveform and optimises it for the most accurate readings. Unfortunately all analogue CRO's do not have this function to take measurements, the user must know exactly to use this instrument.

With a mains rated probe or a current probe, a CRO can also be used to check mains voltage and current on the mains part of a C-Bus Network.



NOTE Care must be taken when taking mains voltage measurements with a CRO, due to live exposed mains cables. Only a fully qualified electrician should take these measurements.

1.4 Diagnostic Utility

The C-Bus Diagnostics Software allows the user to set the mode of a C-Bus Interface (serial or Ethernet), to send or receive C-Bus commands. This allows the programmer or installer to observe the C-Bus network traffic.

The Diagnostic Utility generates a list, which shows the transmitted data and received data. Transmitted data is the data sent by the user to C-Bus via the C-Bus interface. Received data is the data which is generated by a unit on the C-Bus network.

The C-Bus Diagnostic Utility is available for a free download from the downloads page, on the Clipsal Integrated Systems website.

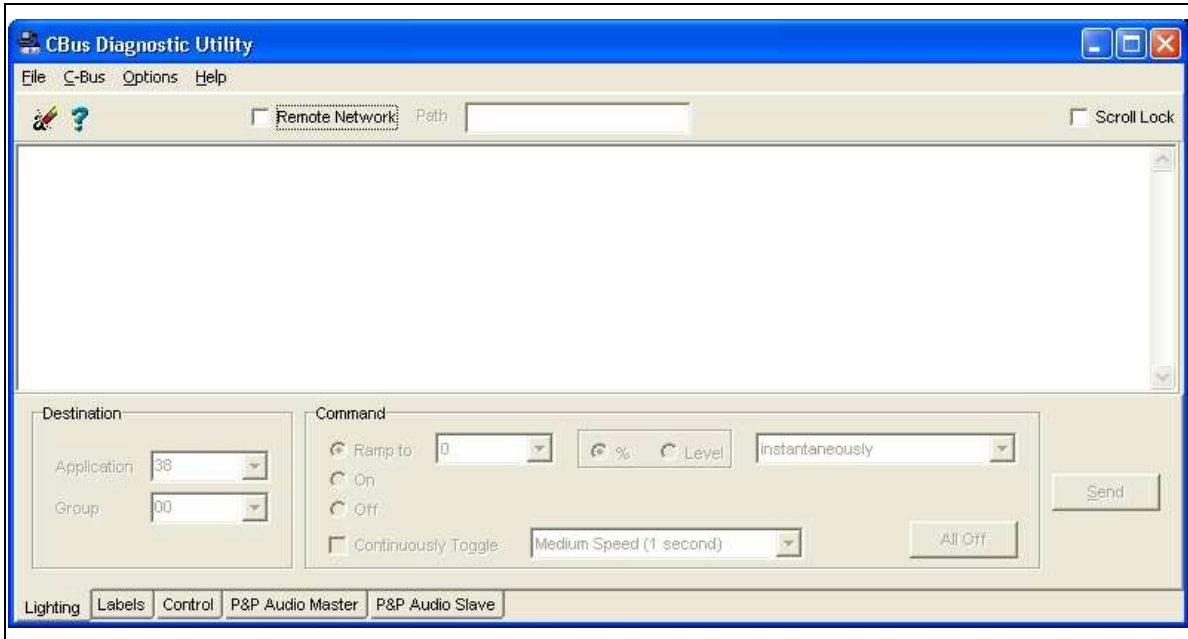


Figure 2: The C-Bus Diagnostic Utility software.

1.4.1 Diagnostic Utility Setup

To set up the software for use, follow the steps below:

- 1) Click on the 'Options' menu
- 2) Select 'Program Options'
- 3) Select the appropriate C-Bus interface parameter and click the 'OK' button
- 4) Click on the 'C-Bus' menu
- 5) Select 'Connect C-Bus.'

Once the software has successfully connected to a PC Interface, a similar message to Figure 3 will appear.



Figure 3: The Information window indicates successful connection to C-Bus.

1.4.2 Using the C-Bus Diagnostic Utility

The C-Bus Diagnostic Utility can be used to:

- set the C-Bus interface into various modes
- perform Installation, Application and Level MMI's
- identify any C-Bus unit on the network
- get the PC Interface Data
- monitor C-Bus commands via the Traffic Analyser
- control C-Bus with the Command Generator.

For further details on how to use the C-Bus Diagnostic Utility, consult the help files in the software.

1.5 HyperTerminal



When using HyperTerminal, please consult a CIS Representative or a Technical Support Officer for help. It is strongly recommended that HyperTerminal is only used by experienced C-Bus installers or programmers. It should only be used as a last resort in diagnosing cosmetic faults on a C-Bus Network.

HyperTerminal can be a vital tool when analysing communications along a C-Bus Network. It can monitor the C-Bus protocol and read commands sent down the network. It also allows you to type in commands to send through the bus.

1.5.1 HyperTerminal Setup

HyperTerminal can connect to a:

- PC Interface
- C-Bus Network Interface.

To connect to a PC Interface, select the relevant COM Port in the 'Connect To' window, and configure the COM Port properties to:

- Bits Per Second: 9600
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

To connect to a C-Bus Network Interface, select TCP/IP (Winsock) in the 'Connect To' window. The 'Host Address' is the IP Address of the C-Bus Network Interface, and the 'Port Number' is the Port Number of the C-Bus Network Interface.



In the Property setting it would be best to enable "Send line ends with line feeds," and "Echo typed characters locally," in the ASCII Setup page. This will allow the user to see everything that is typed in, and everything that is sent to the computer.

1.5.2 Smart Mode



Entering random strings should not be done unless familiar with the C-Bus protocol. Sending bogus strings onto C-Bus may damage the firmware of various units, voiding all warranties.

There are several modes that a C-Bus Interface can be put into by using HyperTerminal. Generally for this type of application, Smart Mode is used. Smart Mode allows HyperTerminal to display and send C-Bus protocol.



NOTE The C-Bus Interface will only go into Smart Mode, if the C-Bus Interface's firmware is V3.0 or later. Firmware version V3.0 was implemented October 1999.

To put the C-Bus Interface into Smart Mode, type in the pipe characters (eg. |||) followed by a Carriage Return (Enter).

1.5.3 Sending C-Bus Commands



When sending C-Bus commands from HyperTerminal, ensure that there are no errors. If an incorrect character is typed in then simply press enter (carriage return) and start again.



NOTE This example is assumed that the C-Bus Group Addresses 00 on the Lighting Application is being used.

Before you begin to analyse the network using HyperTerminal, put the PCI into Smart Mode. To turn a group address on type in "\05380079XX," where XX is the C-Bus group address in hexadecimal addressing. This string is then followed by a carriage return (Enter Key).

On completing this you should see that group address physically turn on. To turn off the same group address, type in "\05380001XX." Once again after completing this, the designated load should turn off as shown in Figure 4.

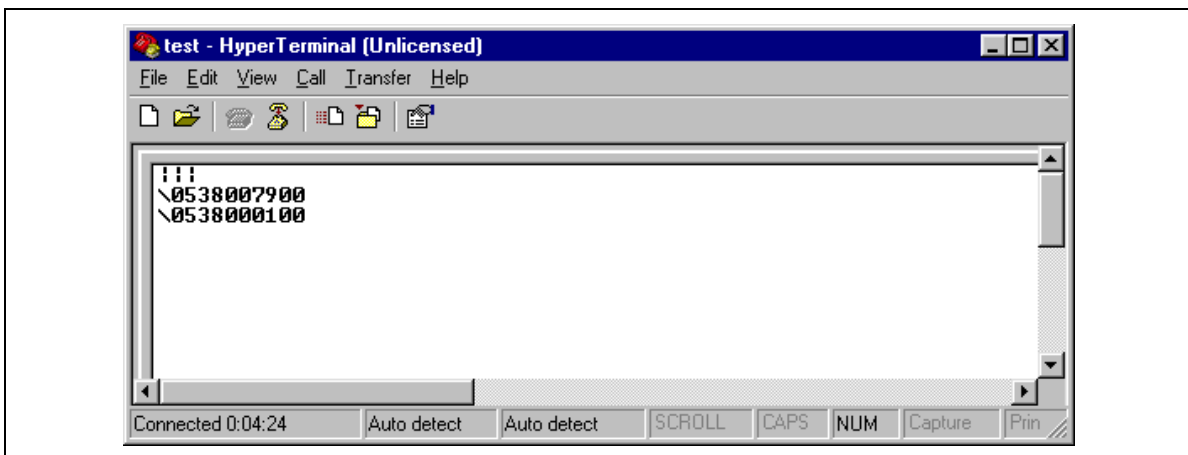


Figure 4: Sending C-Bus commands.

1.5.4 Receiving C-Bus Commands

To receive C-Bus commands, ensure that the C-Bus Interface is in smart mode.

Once in smart mode, if any C-Bus unit on the network generates a C-Bus command, a C-Bus string will appear in HyperTerminal as shown in Figure 5.

**NOTE**

By receiving commands a user can determine which unit is generating the C-Bus command. In the string 050138007900XX where XX is a checksum, 01 is the Unit Address from where the command generated.

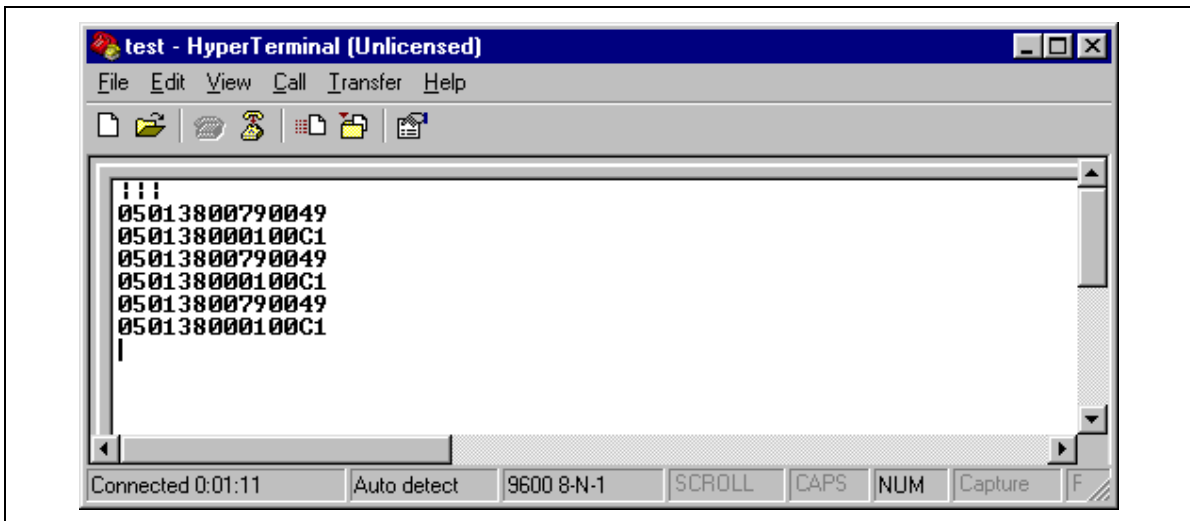


Figure 5: Receiving C-Bus commands.

2.0

3rd Party Devices

Before analyzing a C-Bus network for correct operation, check for any third party devices connected to the C-Bus network. Awareness of any 3rd party devices is important, because the devices may interfere with normal C-Bus operation.

2.1 Typically Used 3rd Party Devices

Before analysing a C-Bus network for correct operation, check for any third party devices connected to the C-Bus network. Third party products include devices such as:

- AMX
- Crestron
- Concept Panel
- and many others.

2.2 Identifying 3rd Party Device Interference

If the C-Bus network behaves unexpectedly on a network that has 3rd party interfaces attached to it, then remove the devices to test the integrity of the C-Bus network. If the problem is no longer there, then the integration with the third party device is causing the unexpected behaviour.

3.0

C-Bus Clocks

A Cathode Ray Oscilloscope (CRO) is used to view the C-Bus clock on a C-Bus Network. The C-Bus clock is a 5 V AC pulse that is superimposed onto a 36 V DC C-Bus Voltage.

It is recommended that there be more than one C-Bus clock enabled on each Network to provide a fully redundant C-Bus Network. The C-Bus clock can be enabled on:

- Any C-Bus Unit with a PCI Simulator eg. C-Touch, PCI, Telephone Interface etc.
- Any C-Bus output device.

When analysing the C-Bus clock with a CRO, there are a number of things to look for:

- A single C-Bus clock pulse with a period of 2 ms or 500 Hz
- That the C-Bus clock's amplitude measures 5 V AC
- A clean waveform (no noise or hum on it)
- That the discharge time of the positive cycle does not decay over a long time
- The rising edge of the negative cycle is almost perfectly vertical
- That there is no ringing on the waveform.
- That there isn't much overshoot on the positive part of the waveform.

3.1 Old C-Bus Clock

Figure 6 is an example of the typical C-Bus clock. It is a 5 V p-p square waveform. This waveform will vary, depending on the cable capacitance on the network. A large cable capacitance will increase the discharge time on the positive cycle of the waveform. To reduce the discharge time of the positive cycle of the clock, simply add a Network Burden.

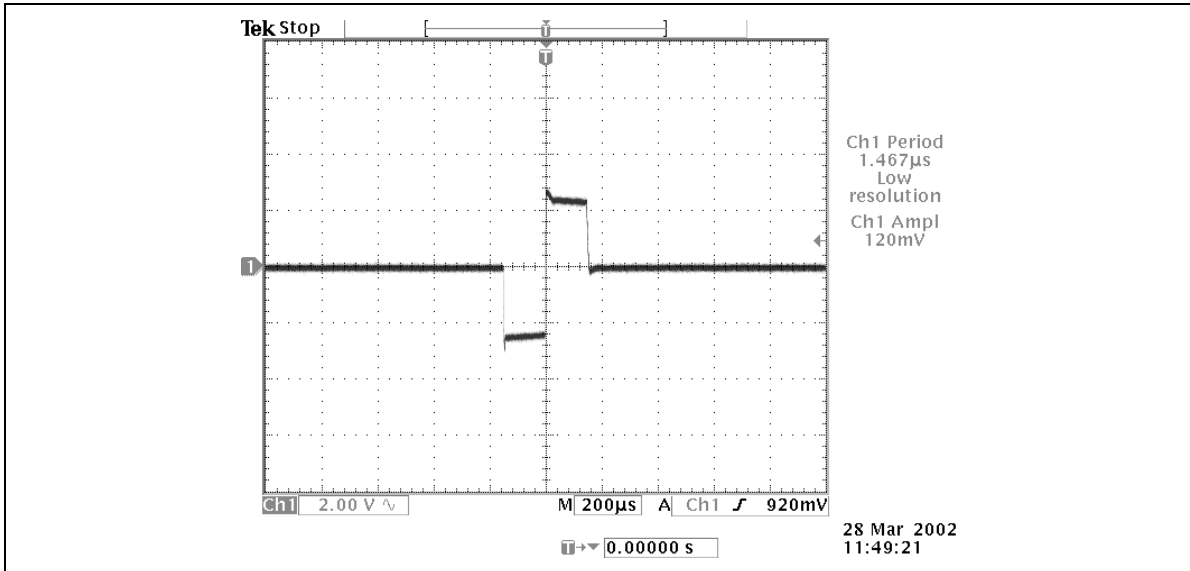


Figure 6: Old C-Bus clock waveform.

3.2 New C-Bus Clock

Figure 7 is an example of the new C-Bus clock which is found on most new units. Note that the waveform has more of a rounded appearance, rather than a square wave.

The new circuitry of the C-Bus clock, enables the C-Bus unit to have a better control over the rise and fall of the clock. It also has the ability to handle the cable capacitance of larger networks better. This results in less overshoot, ringing or waveform distortion.

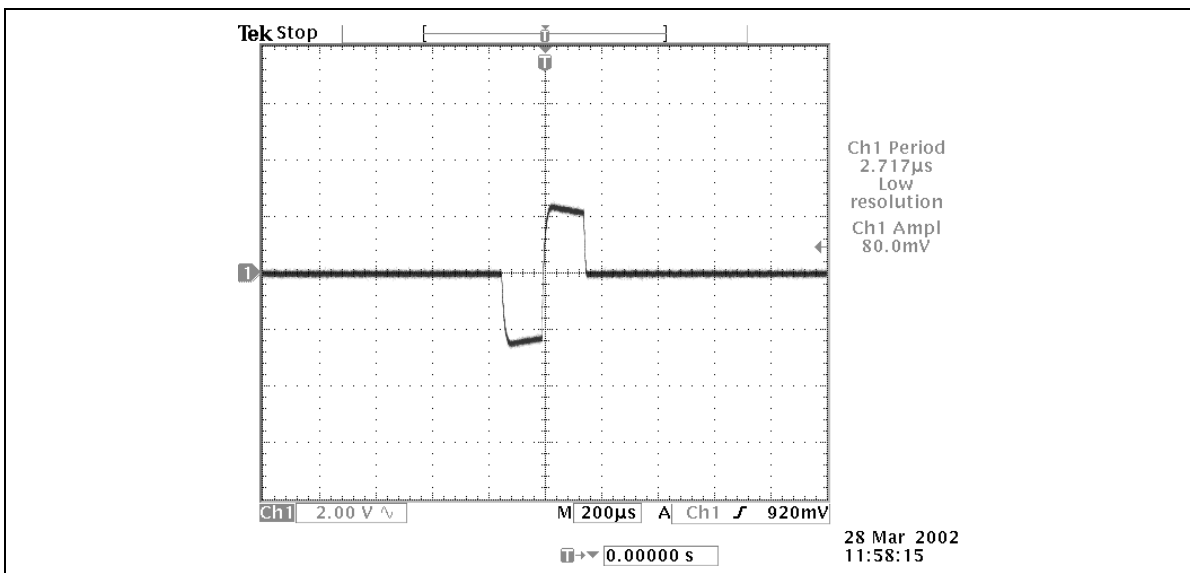


Figure 7: New C-Bus clock waveform.

3.3 No C-Bus Clock

If there is no active C-Bus clock enabled on the C-Bus network, then there will be no communications. There is an algorithm in the C-Bus units that checks to see if a C-Bus clock has been enabled. If there is more than one clock enabled on the C-Bus Network, then the C-Bus units will see this and disable as many clocks as needed. This process is automatic and usually takes any time between 1 second to around 2 minutes (depending on the network characteristics).

It is recommended that no more than 3 C-Bus Clock be enabled. This will avoid communication delays after the C-Bus Network is powered up.

3.4 MMI Status Check

Whilst examining the C-Bus Network with a CRO, notice the waveform has communications data sent along the bus approximately every 3 seconds as shown in Figure 8. This 3 second data transmission is the status report interval. The data transmission can be determined by SR Interval (Status Report Interval), in the graphical user interface of most C-Bus input units.

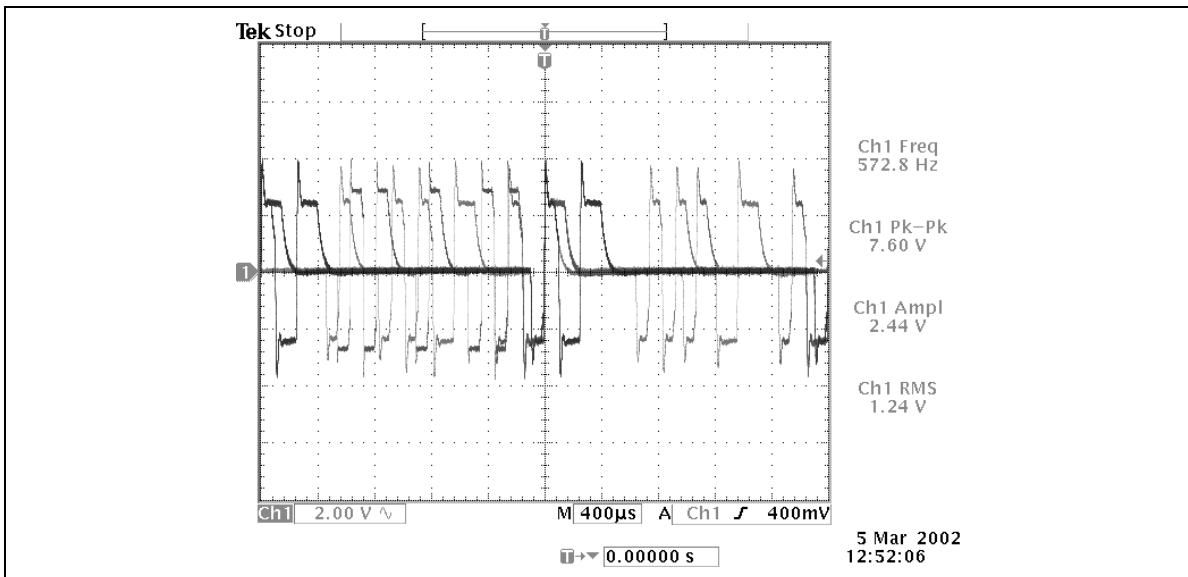


Figure 8: MMI status check waveform.

This is how C-Bus communicates and is a normal operation. Every time the network sends data onto the bus, the MMI (Multipoint to Multipoint Instruction) will check that all group addresses are in sync.

A similar waveform will be displayed on the CRO if:

- a command is being sent on the bus
- a scan of the network is performed by Toolkit or C-Gate (the data transmission will be much more intense).

4.0

Network Burden

A Network Burden applies a standard impedance to a C-Bus Network. It consists of a 1 k Ω 0.6 W resistor in series with a 10 μ F 50 V capacitor.

The Network Burdens may be hardware or software, and should only be used to limit the network to an impedance between 400 Ω and 1.5 k Ω .

4.1 Construction

A network burden consists of a 1 k Ω 0.6 W resistor in series with a 10 uF 50 V capacitor as shown in Figure 9.

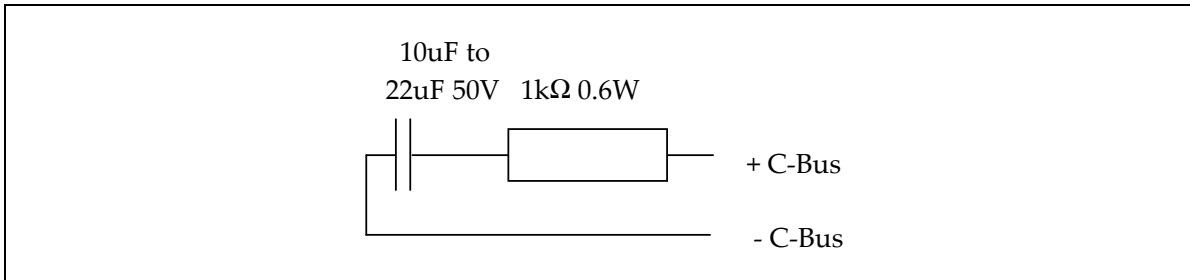


Figure 9: Construction of a network burden.

The Network Burden may be hardware or software, and should only be used to limit the network impedance to be between 400 Ω and 1.5 k Ω .

4.2 Hardware Burden

The Hardware Burden comes in an RJ45 package (5500BUR). The hardware burden is designed to be connected to any Din Rail units. It can be manually added or removed.

Ensure that when a hardware burden to a C-Bus network a click is heard, indicating that the connection between the network burden and the RJ45 socket is secure.

4.3 Software Burden

The Software Burden can be enabled and disabled from the Toolkit Software or Learn Mode.

When using a software burden make sure that it is enabled at Unit Address 01. Check all units for an enabled software burden to make sure only one burden enabled in the GUI. There may be multiple software burdens enabled on various units due to poor programming.



If you have a burden enabled at Unit Address 01 and you change its Unit Address, the burden is still active. In the global tab of the GUI, the burden setting will be enabled, but greyed out. To disable it, you will need to change the Unit Address back to 01, or disable it through Special Function Mode (see Learn Mode Application Notes).

The number of burdens on a C-Bus network is dependant on the construction of the network. Typically all networks will need one network burden to function correctly. In some instances, no burden may be needed. This is common when the network has approximately 60 C-Bus units.

5.0

C-Bus Units Per Network

As a rule of thumb, it is generally accepted that a single C-Bus network should not exceed a unit count of 100 units. However, there is an exception to this.

There are two factors that effect how many units may be connected to C-Bus Network. They are:

- network impedance
- current consumption.

5.1 Network Impedance

The C-Bus network impedance is an important parameter that affects the way a C-Bus network operates. As mentioned in Chapter 4, the ideal network impedance is between 400 Ω and 1.5 k Ω .

Usually Clipsal Integrated Systems will specify 100 units per network, because 100 C-Bus units will bring the network impedance to its limit. Unfortunately 100 units may not be a realistic unit count, due to the current consumption of the bus.

5.2 Current Consumption

The maximum current consumption of the bus affects the operation of C-Bus. A maximum of 2 A is allowed per C-Bus network. This is the equivalent of 10 Din Rail units with onboard power supplies.

To calculate the maximum number of C-Bus units allowed on a C-Bus network, add the current consumption of all the Input, System Support Units and Outputs without power supplies (the current consumption can be found on the label of the C-Bus unit). The total current of all of the calculated devices must not exceed 2 A.

5.3 C-Bus Calculator

The C-Bus Calculator is found in Toolkit. It is a useful tool that calculates the characteristics of the C-Bus network that is being programmed. In Toolkit, each C-Bus network will have a unique calculation. To view the calculations:

- 1) add all C-Bus units to the database in Toolkit (including stand alone power supplies)
- 2) place the Catalogue Number of each unit into the corresponding Graphical User Interfaces in Toolkit
- 3) click on the desired network in the project manager, to view the calculations.

The main pane will then list the parameters that the C-Bus Calculator has calculated, as shown in Figure 10.

Item	Value
Current Consumption	134mA
Current Supply	0mA
Impedance	15000ohms
Units Calculated	6
Units Not Calculated	5
Result	1 power supplies required 1 burden required

Figure 10: The Toolkit C-Bus calculator.

6.0

C-Bus Units Per Network

At any point in the Network, the voltage across a C-Bus Unit must be in the range of 15 V DC to 36 V DC inclusive. However, a C-Bus voltage as low as 15 V DC, may cause unstable communications. As a rule of thumb, it is strongly recommended that the average C-Bus voltage be no lower than 20 V DC.



When designing a single network topology, evenly distribute C-Bus Power Supplies along the network. This will ensure minimal voltage drops over the C-Bus cable.

Low C-Bus Voltage may be due to: -

- not evenly distributing C-Bus power supplies
- not using the correct C-Bus cable
- poor termination of C-Bus cable, causing multiple high resistance joints
- not using the correct pairs of the Cat-5 (cable)
- not enough power supplies on the network
- too many C-Bus units on the network
- faulty C-Bus power supply.

6.1 Short Circuit To Earth

When approaching a C-Bus network for the very first time it is important to check C-Bus cable has not been shorted to earth.

Using a multimeter on the DC Voltage setting, place the negative probe onto true earth and the positive probe onto the negative C-Bus rail. The multimeter should read roughly -15 V DC .

Following this, place the negative probe onto true earth and the positive probe onto the positive C-Bus rail. The multimeter should read roughly $+15\text{ V DC}$. As C-Bus utilises a floating bus voltage.



If the C-Bus is shorted to earth in any of these two tests, the multimeter will roughly read **NOTE** either $+30\text{ V DC}$ or -30 V DC .

Therefore when the multimeter probes are placed directly across the terminals of C-Bus, the multimeter should read approximately 30 V DC .

6.2 Short Circuit

A short circuit on a C-Bus Network is a result of an incorrect installation. A short circuit will cause the C-Bus voltage to drop to 0V at the point of the short. However, there may be a rather small voltage on the bus at other points. The symptoms of a short on a C-Bus Network would be:

- all LED's on input units are off
- all C-Bus indicators on output units are off
- the C-Bus Voltage is 0 V .

The most common short circuit conditions are results of:

- incorrect C-Bus pairs used on installation
- loose C-Bus terminations shorting to another potential
- moisture partially shorting two terminals
- foreign objects shorting C-Bus terminals.

One of the first tests that should be conducted to identify a short circuit condition, is to take voltage measurement using a multimeter. A short circuit condition should indicate that there is 0 V on the C-Bus network.

6.3 Open Circuit

An open circuit condition is yet again another symptom of an incorrect installation. An open circuit may cause units on a particular side of the C-Bus Network not to operate. However, if there are power supplies and C-Bus clocks enabled on both sides of the open circuit, both sides of the break will operate as two separate C-Bus networks.

Finding an open circuit may be difficult to diagnose because some parts of the C-Bus network may still be operational. Finding an open circuit is most commonly found by using successive approximation. This means that the C-Bus network will be broken into sections for testing. Successive approximation, may be executed by following the steps below:

- 1) break the network at the half way point
- 2) identify which half of the network is not operating as expected
- 3) take the half of the C-Bus network that is not operating correctly and half it again
- 4) identify which part of the network is not operating as expected
- 5) continue this process until the open circuit had been found.

6.4 Insufficient Power Supplies

A C-Bus network that has insufficient C-Bus power supplies is result of incorrect network design. If the amount of C-Bus units is consuming more current than the C-Bus power supplies can provide, then the C-Bus voltage will be low. This can be rectified by adding more power supplies to the C-Bus network(ensuring the current on the C-Bus network does not exceed 2 A).

C-Bus units are designed to operate from the C-Bus Power Supply with a nominal loaded output voltage of 36 V DC. As more C-Bus units are added to the network, the output voltage of the C-Bus power supply starts to decrease. Voltage will also drop over large lengths of cable. This voltage drop is proportional to the cable length and the current consumption.

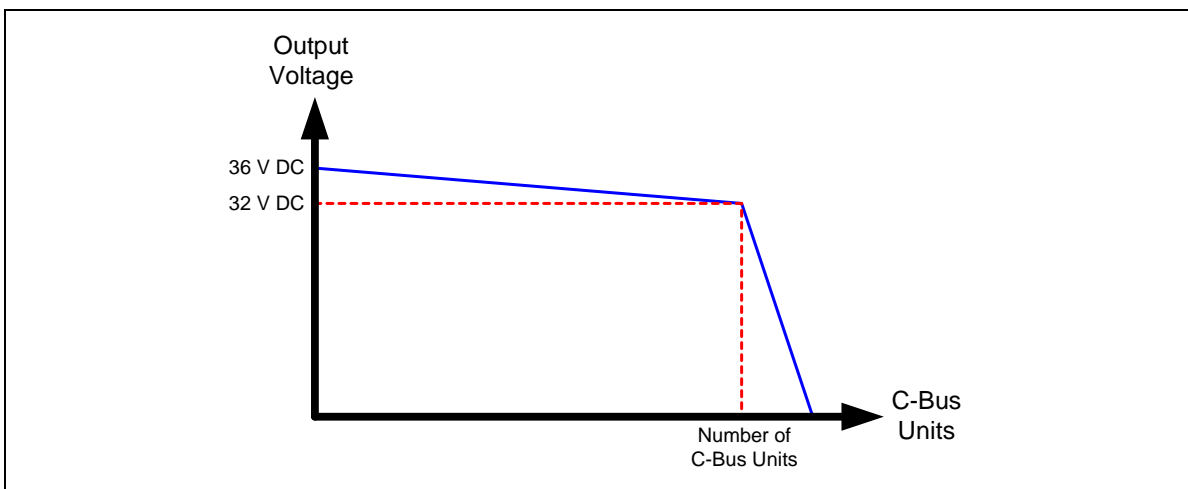


Figure 11: Maximum number of C-Bus units per power supply.

7.0

C-Bus Cable

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.

The C-Bus cable is coloured pink so it is easily identifiable, in comparison to any other Cat-5 (cable) eg. Ethernet. The cable has a mains rated insulated outer sheath. This allows the cable to be safely wired into a distribution board where mains are present.

7.1 Cable Pairs

The following conductors of the CAT-5 (CABLE) cable must be used to make the C-Bus connections:

- Orange & Blue: (+) Positive C-Bus Rail
- Orange / White & Blue / White: (-) Negative C-Bus Rail



Using the correct pairs increases immunity to electro-magnetic interference. This means
NOTE that the C-Bus cable is less susceptible to picking up noise.

7.2 Cable Length

On a C-Bus Network, there must be no more than 1000 metres of C-Bus Cat-5 (cable) used. This is determined by the propagation delay of the C-Bus communications, and the total cable capacitance of 100 nF. Large cable lengths can introduce effects on the network such as: -

- a drop in voltage
- an increase in cable capacitance.

The voltage drop will occur because the Cat-5 (cable) has a resistance of 90Ω per 1000 meters. To minimise the amount of voltage drop along large lengths of cable, evenly space out the C-Bus power supplies along the C-Bus Network.

A high cable capacitance is a result of large lengths of Cat-5 (cable). This will cause the C-Bus clock to distort. This is easily rectified by adding or removing a Network Burden (this may vary with different C-Bus Networks).

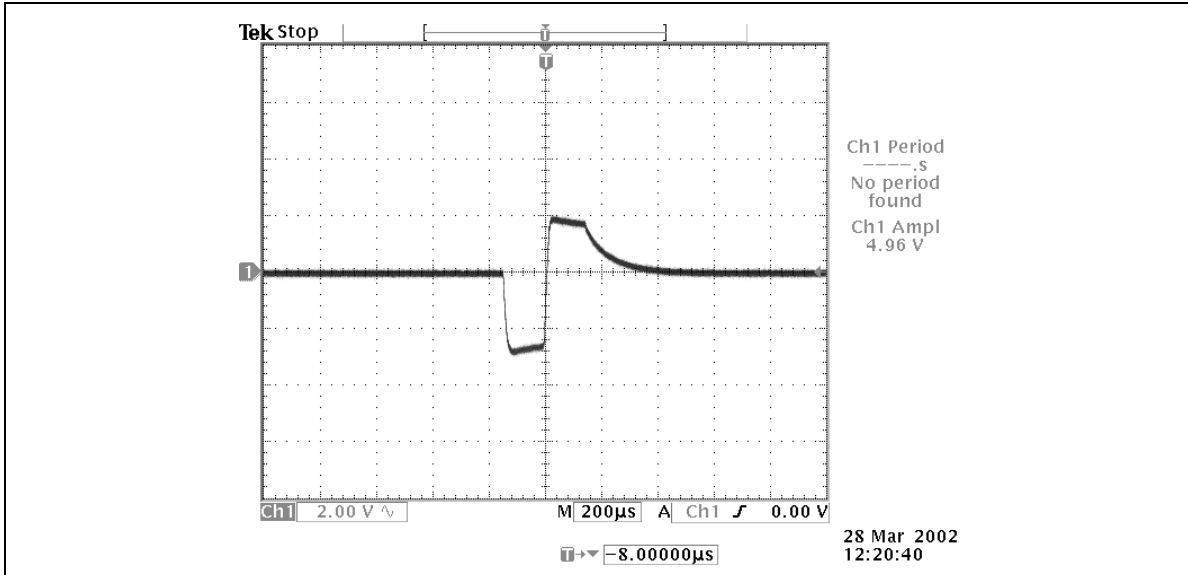


Figure 12: The effect of cable length on a C-Bus clock.

7.3 Cable Current Rating

The maximum amount of current allowed to flow onto the Cat-5 (cable) is 2 A. This is a limitation of the cable. If 2 A is exceeded then you will run the risk of damaging the C-Bus cable. Therefore if high resistance joints are at both ends of a length of C-Bus cable, the cable will only be able to carry 1 A instead of 2 A.

8.0

Mains Voltage Supply Conditions


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.

8.1 Isolated Generators

All C-Bus units that are mains powered are designed to operate from a sinusoidal voltage waveform. If an Inverter Supply (that produces a square wave voltage) is used, then C-Bus units may not behave as expected and may damage the C-Bus unit.

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.

8.2 Brownouts

A brownout is a condition where a lower than normal mains voltage, is being supplied by the local energy utility. A power line voltage reduction of 8 to 12 % is usually considered a brownout. Unfortunately Clipsal Integrated Systems has no control over a brownout, as it is usually caused by the local energy supplier.

During a brownout, electronic equipment may experience errors due to an erratic power supply. Other electronic equipment may function poorly or not function at all.

Most C-Bus units (with power supplies) use switch mode power supplies, which are more immune to mains voltage changes. If the mains input voltage decreases, the output will remain the same voltage.

C-Bus Professional Series Dimmers do not use switch mode power supplies. If the mains voltage on a C-Bus Professional Series Dimmer drops, the output of that power supply will drop by the same percentage.

8.3 Overvoltages And Transients

All C-Bus units consist of electronic components that may be damaged by overvoltages and transients. C-Bus does provide some level of protection to units, but not enough to protect them from large inrush currents or lightning strikes.

It is recommended that overvoltage protection is used in the distribution board, to protect the C-Bus units from overvoltages and transients. If the C-Bus cable is routed between buildings or used in an outdoor installation, then protection must be used on the Cat-5 (cable) as well.

9.0

Analysing A C-Bus Network

When analysing a C-Bus network, there are a series of questions that an installer or programmer should ask their selves. These questions relate to:

- 3rd Party Interfaces
- C-Bus Clocks
- Network Burdens
- C-Bus Units
- C-Bus Cable
- C-Bus Power Supplies
- C-Bus Cable Runs.

This chapter identifies some of the questions each C-Bus installer or programmer should be asking them selves, when analysing a C-Bus network.

9.1 Third Party Interfaces Questions

Before testing the C-Bus network, ensure all third party devices are disconnected from the C-Bus network. This will remove the possibility of the third party devices causing problems. Questions that will assist in analysing the C-Bus networks are:

- 1) Are there any third party devices connected to the C-Bus network?
- 2) If so, what devices are connected?
- 3) Does the C-Bus network operate correctly once the third party device has been removed?
- 4) Is the function of the third party interface clearly understood?
- 5) What is the function of the third party interface?

9.2 C-Bus Clock Questions

If no C-Bus clock is enabled on a C-Bus network, then there will be no communications. Questions that will assist in analysing the C-Bus networks are:

- 1) Is the C-Bus LED on the DIN Rail units on?
- 2) How many clocks are enabled on the C-Bus Network?
- 3) How many active clocks are there?
- 4) Are the units with the C-Bus clock enabled on them, physically located near each other?
- 5) Are there any clocks enabled on Network Bridges (5500NB) or C-Bus Network Interfaces (5500CN)?

9.3 Network Burden Questions

Check all C-Bus devices for Hardware Network Burdens. Also check for Software Network Burdens, by using the latest version of Toolkit software. Questions that will assist in analysing the C-Bus networks are:

- 1) Does the C-Bus Calculator in Toolkit indicate that a Network Burden is needed?
- 2) How many hardware burdens are connected to the C-Bus network?
- 3) Have you checked all the C-Bus distribution boards for hardware Network Burdens?
- 4) Is the hardware burden used supplied Clipsal Integrated Systems?
- 5) What type of hardware Network Burden is being used (RJ45 or Flying Lead)?
- 6) How many software Network Burdens are enabled?
- 7) What is the unit type and unit address, of the unit with the software enabled Network Burden?
- 8) Using toolkit, check the Global tab of each C-Bus unit, to see that there is a Software Network Burden enabled.
- 9) Have you looked on the Status tab in Toolkit (and clicked the Update Status button) for each C-Bus unit, to see if there is a Software Network Burden enabled?

9.4 C-Bus Unit Questions

The following may be used to analyse how the C-Bus units affect the C-Bus system requirements. Questions that will assist in analysing the C-Bus networks are:

- 1) Including C-Bus Power Supplies, how many C-Bus units are connected to the network?
- 2) Add up the current consumption of each C-Bus unit on the C-Bus Network. What is the total current consumption for all these units?
- 3) Are there enough C-Bus Power Supplies to provide current for all the units on the network?

9.5 C-Bus Cable Questions

The following may be used to analyse any possible wiring problems. Questions that will assist in analysing the C-Bus networks are:

- 1) Has the recommended Cat-5 (cable) been used?
- 2) When running the C-Bus cable in parallel with 240 V mains cable, is there a minimum segregation of 150 mm at all times?
- 3) When the C-Bus needs to cross 240 V mains cable, does it cross at a 90° angle with 60 mm segregation?
- 4) What pairs of the C-Bus cable have been used for the positive and negative rails of C-Bus?
- 5) Have any junctions been made on the C-Bus cable (using junction boxes etc)?
- 6) What is the exact length of the C-Bus cable, including patch leads?
- 7) Has the C-Bus cable been checked for broken conductors?
- 8) Has the C-Bus cable been checked for high resistant joins?
- 9) Has the C-Bus cable been checked for open circuits?
- 10) Has the C-Bus cable been checked for short circuits?
- 11) Has the C-Bus cable been checked for closed loops?
- 12) Does any of the C-Bus cable run underground, either in conduit or buried directly? If yes, then does the installation of this cable meet national wiring standards?

9.6 C-Bus Power Supply Questions

The following will help to identify any possible problems related to power supplies. Questions that will assist in analysing the C-Bus networks are:

- 1) What is the mains voltage measured on the C-Bus power supplies?
- 2) How many stand alone C-Bus Power Supplies are there on the network?
- 3) How many on board C-Bus Power Supplies are there on the network?
- 4) Add up the current that each C-Bus Power Supply provides. What is the total current supplied by all C-Bus Power Supplies?
- 5) Are the C-Bus Power Supplies concentrated in one general area?
- 6) Are the C-Bus Power Supplies evenly distributed throughout the installation?
- 7) Are there any old C-Bus Power Supplies (5100PS)?

9.7 C-Bus Cable Run Questions

The following will allow the analysis of problems with cable runs. Questions that will assist in analysing the C-Bus networks are:

- 1) Is the network a standard daisy chain configuration?
- 2) If using a star configuration, how many branches are there on the network?
- 3) Are any of the voltages on all of the branches below 20 V DC?
- 4) What are the lowest voltages (measured on C-Bus units) on each C-Bus cable run?
- 5) Are any of the voltages on all of the branches above 36 V DC?
- 6) What are the highest voltages (measured on C-Bus units) on each C-Bus cable run?