C-Bus Lighting Control via the C-Bus PCI

Quick Start Guide

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CHANGE HISTORY

Date	Change Reference	Comments
31 Jan 03	-Draft 0.1	Original
5 Jun 03	1	Addition of Licence warning
5 Jun 03	1.1	Formatting update
23 Sep 03	1.2	Added e-mail address. Parts of commands that are substituted made more consistent.
30 Oct 03	1.3	Add Safety / Life Support Policy Statement
30 Oct 03	1.4	Correction to Table Of Contents re previous addition
8 Dec 03	2.0	Was previously the Public Release

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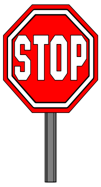
1 SCOPE

1.1 Purpose

This document is a quick guide to allow third parties to achieve simple control of C-Bus lighting devices, without reading the full protocol document set.

This describes the messages to exchange with a Clipsal C-Bus PC Interface (PCI) to achieve simple control of lighting devices, on the C-Bus Lighting Application.



The C-Bus messages described in this publication are a subset of the complete definition, sufficient for most common types of lighting control.

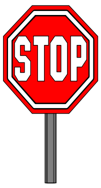
Complete definitions of all C-Bus messages, along with required behaviour of devices, is published in the full protocol document set.

1.2 C-Bus Interface Compatibility

The C-Bus Enabled Program defines six (6) levels of C-Bus compliant interface. The information presented here meets all of the requirements for a level 1 interface and most of the requirements for a level 2 interface.

1.3 Assumptions

In the description of C-Bus messages that follows, Lighting Applications are assumed to use the C-Bus Lighting Application Address ($38).



If the installation uses a different Lighting Application Address, the value "38" that appears in the examples can be changed to the address used in the installation.

C-Bus APPLICATION ADDRESSES ARE NOT ARBITRARY.
Lighting devices MUST use Application Addresses in the range $30 to $5F only. Use of addresses outside this range may cause some C-Bus equipment to malfunction and may void warranties.

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2 TERMS USED

2.1 Abbreviations

MMI	Multi-point to Multi-point Information. (A highly efficient status reporting technique used in C-Bus.)
PCI	PC Interface. (Clipsal catalogue number 5100PC or 5500PC)

2.2 Definitions

The following terms, when used in this document, have the meanings shown below:

Application	A well-defined set of behaviours for one or more devices connected to a C-Bus network.
Network Variable	A network wide control variable maintained and/or controlled by C-Bus units. Within the Lighting Application, a Network Variable is called a Group Address Variable (GAV), and its value is called a Group Address Level.
Unit	Something attached to a C-Bus network that performs an end-user function.

2.3 Notation

Information is shown in several different typefaces:

Helvetica	The descriptive text of this document
Helvetica Bold	Headings in this document
Helvetica Bold Italic	Important notes as part of this document
`Courier`	Data received FROM the C-Bus PC Interface
`Courier Italic`	Data received FROM the C-Bus PC Interface showing something that will vary depending on circumstances
`Courier Bold`	Data transmitted TO the C-Bus PC Interface
`Courier Italic Bold`	Data transmitted TO the C-Bus PCI Interface that is to be substituted with values that depend on the users requirement
`<Courier In Braces>`	A token naming a common ASCII character, for example `<cr>` means the Carriage Return character
$nn	A number prefixed by $ indicates that the number is hexadecimal

3 SAFETY / LIFE SUPPORT POLICY

Clipsal Australia Pty Ltd does not support or recommend use of C-Bus as the primary means of communicating safety related information.

Notification of safety related information using C-Bus, as a secondary function, is acceptable provided the source of the information has some other means of alerting personnel to the safety related condition.

In this context, safety related information means any information, alarm, alert or similar which if not presented could result in a hazard to personnel.

4 C-BUS CONCEPTS

4.1 Groups

C-Bus loads are arranged into logical groups in the C-Bus Lighting Application. Each Lighting Group:

- Has a unique address, in the range $00 to $FE, known as the Group Address;
- Can be controlled from anywhere in the network;
- Can have zero or more associated keys, spread across any of the key input units; and
- Can have zero or more associated electrical loads, spread across any of the output units.

The value of the Group Address is referred to as a Level.

There are only three (3) commands used to control C-Bus Lighting groups:

a. On: A shorthand that sets the level of the group to $FF

b. Off: A shorthand that sets the level of the group to $00

c. Ramp: Changes the level of the group to a target level, at a given rate.

4.2 Acknowledgment

Each command sent to the C-Bus PCI is acknowledged. To allow decoupling of serial receive and transmit processing, the PCI provides a simple means of tagging a command:

> At the end of each command sent to the PCI, and just before the <cr>, place any single lower case alphabetic character, in the range “g” to “z”.

The PCI will acknowledge the command by returning the lower case letter used, followed by a confirmation character.

Possible confirmation characters, and their meanings are:

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.	Positive acknowledgment. The command was successfully transmitted into the C-Bus network.
#	Negative acknowledgment – too many retries The PCI was not able to successfully transmit the command into the C-Bus network, because there were too many retries.
$	Negative acknowledgment – corruption The PCI did not attempt to transmit the command into the C-Bus network, because it was corrupted. The PCI found that the calculated checksum did not match the supplied checksum.
%	Negative acknowledgment – loss of C-Bus clock The PCI was not able to successfully transmit the command into the C-Bus network, because the C-Bus synchronising clock disappeared at some time during the transmission attempt.

4.3 Checksums

Checksums are used throughout C-Bus to provide an error detection capability.

All C-Bus checksums are calculated as the 2 's complement of the modulo 256 sum of the preceding bytes.

In other words:

a. Sum all of the bytes (the hex character pairs);

b. Find the remainder when the sum is divided by 256;

c. Take the 2's complement (invert the bits and then add 1) of the remainder.

This checksum has the property that when the bytes including the checksum are summed modulo 256, the result will always be zero if the check passes, and non-zero indicates the presence of an error in the data stream.

The PCI checksums are performed on the hexadecimal data (the ASCII character pairs).

For example, suppose the following Lighting command is to be sent to the PCI:

`\0538007988`

Summing the bytes: $05 + $38 + $79 + $88 = $13E. Modulo 256 ($100), this is $3E.

The checksum (2's complement and add 1) = $C2.

Checking: $05 + $38 + $79 + $88 + $C2 = $200, which is $00 modulo 256 ($100).

This command would be sent as:

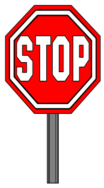
`\0538007988C2g<cr>`

5 INITIALISATION

5.1 Default PCI Properties

By default, the PCI operates with the following serial communication properties:

Data Rate:	9600 bits / second
Data Bits:	8
Parity:	None
Start bits:	1
Stop bits:	1



It is possible to change the data rate of the C-Bus PCI, though normal Clipsal products never make this change.

However, some third party devices (eg security systems or automation controllers) are known to change the PCI data rate. If this has occurred, the ONLY reliable method of resetting the data rate is to power cycle the PCI.

5.2 PCI Setup

Before information can be sent to and from C-Bus, via the PCI, a small amount of initialisation of the PCI must be performed.

This initialisation sets up the PCI for appropriate error checking and data validation modes, and allows monitoring of C-Bus messages.

This initialisation assumes that the C-Bus installation uses the default C-Bus Lighting Application address of $38.

5.2.1 MMI Messages Not Required

If C-Bus MMI reports are not needed, the following command lines **must** be sent to initialise the PCI, where <cr> is the Carriage Return character (ASCII character 13). Inputs are shown bold, responses normal.

~~~<cr>
A3210*38*g<cr>
    g.322100AD<cr>
A3420002g<cr>
    g.3242008C<cr>
A3300059g<cr>
    g.86xxxx00323000yy<cr>

If the C-Bus lighting application is not $38, substitute the correct address in place of the *38* in the second line shown above.

5.2.2 MMI Messages Required

If C-Bus MMI reports are needed, send the first 3 command lines, and replace the last command line shown above (in bold) with the following:

A3300079g<cr>

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6 TRANSMITTING C-BUS LIGHTING CONTROL COMMANDS

6.1 Transmit an ON Command

Issue the following command string to the C-Bus PCI:

`\05380079`*`ggzzc`*`<cr>`

Where "***gg***" is replaced by the hexadecimal group number to turn on, "***zz***" is replaced by the hexadecimal checksum, calculated as described in section 4.3, and "***c***" is the confirmation character to be returned in the acknowledge.

6.2 Transmit an OFF Command

Issue the following command string to the C-Bus PCI:

`\05380001`*`ggzzc`*`<cr>`

Where "***gg***" is replaced by the hexadecimal group number to turn off, "***zz***" is replaced by the hexadecimal checksum, calculated as described in section 4.3, and "***c***" is the confirmation character to be returned in the acknowledge.

6.3 Transmit a RAMP TO LEVEL Command

Issue the following command string to the C-Bus PCI:

`\053800`*`rrggttzzc`*`<cr>`

Where "***gg***" is replaced by the hexadecimal group number to ramp, "***tt***" is replaced by the hexadecimal level to ramp to (the terminal level), "***zz***" is the checksum, calculated as described in section 4.3, and "***c***" is the confirmation character to be returned in the acknowledge.

The "***rr***" byte codes the ramp rate, and is chosen from:

$02	Instantaneous
$0A	4 s ramp rate from min to max or max to min
$12	8 s ramp rate from min to max or max to min
$1A	12 s ramp rate from min to max or max to min
$22	20 s ramp rate from min to max or max to min
$2A	30 s ramp rate from min to max or max to min
$32	40 s ramp rate from min to max or max to min
$3A	1 min sec ramp rate from min to max or max to min
$42	1.5 min ramp rate from min to max or max to min
$4A	2 min ramp rate from min to max or max to min
$52	3 min ramp rate from min to max or max to min
$5A	5 min ramp rate from min to max or max to min
$62	7 min ramp rate from min to max or max to min
$6A	10 min ramp rate from min to max or max to min
$72	15 min ramp rate from min to max or max to min
$7A	17 min ramp rate from min to max or max to min

C-Bus levels are given as a byte in the range $00 to $FF (0 to 255 decimal). The C-Bus installation software refers to levels as a percentage. The following algorithms can be used to convert between raw levels (range 0 to 255) and percentage levels:

<u>Convert from percent (0-100) to decimal (0-255)</u>

Decimal = truncate ((percent * 255) / 100)

<u>Convert from decimal (0-255) to percent (0-100)</u>

Percent = 100 * truncate (decimal + 2) / 255)

7 RECEIVING C-BUS LIGHTING CONTROL COMMANDS

7.1 Receiving an ON Command

If the C-Bus PCI detects a lighting ON command on its local network, it will forward this from its serial port. The information received will be either:

`05`*`ss`*`380079`*`ggzz`*`<cr>`

or

`05`*`ss`*`38010079`*`ggzz`*`<cr>`

In this message, the component bytes have the following meanings:

05	Indicates a lighting message has been received.
ss	The unit address of originator. Can be ignored.
38	The lighting application address. If a non-default lighting application is being used this may have a different value.
00 or 0100	This byte should always be 00. In the alternate format, the first byte could be 01, followed by 00. If the first byte is not 00 or 01, DISCARD the message.
79	Lighting ON command.
gg	The Lighting Group Address number being switched on.
zz	The checksum of the preceding bytes, calculated according to section 4.3.

7.2 Receiving an OFF Command

If the C-Bus PCI detects a lighting OFF command it will forward this from its serial port. The information received will be:

`05`*`ss`*`380001`*`ggzz`*`<cr>`

or

`05`*`ss`*`38010001`*`ggzz`*`<cr>`

In this message, the component bytes have the following meanings:

05	Indicates a lighting message has been received.
ss	The unit address of originator. Can be ignored.
38	The lighting application address. If a non-default lighting application is being used this may have a different value.
00 or 0100	This byte should always be 00. In the alternate format, the first byte could be 01, followed by 00. If the first byte is not 00 or 01, DISCARD the message.
01	Lighting OFF command.
gg	The Lighting Group Address number being switched on.
zz	The checksum of the preceding bytes, calculated according to section 4.3.

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7.3 Receiving a RAMP to LEVEL Command

If the C-Bus PCI detects a lighting RAMP to LEVEL command it will forward this from its serial port. The information received will be:

05*ss*3800*rrggttzz*<cr>

or

05*ss*380100*rrggttzz*<cr>

In this message, the component bytes have the following meanings:

05	Indicates a lighting message has been received.
ss	The unit address of originator. Can be ignored.
38	The lighting application address. If a non-default lighting application is being used this may have a different value.
00 or 0100	This byte should always be 00. In the alternate format, the first byte could be 01, followed by 00. If the first byte is not 00 or 01, DISCARD the message.
rr	Lighting Ramp command, chosen from the set shown in section 6.3.
gg	The Lighting Group Address number being ramped.
tt	The level being ramped to (the terminal level).
zz	The checksum of the preceding bytes, calculated according to section 4.3.

7.4 Receiving other Commands

It is possible in some circumstances for other commands to be received. There are two cases:

Case 1.

05*ss*38*nn*....*zz*<cr>

If the "*nn*" byte is NOT 00 or 01, then the entire message should be discarded.

Case 2.

05*ss*3800*cc*....*zz*<cr>

or

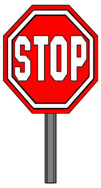
05*ss*380100*cc*....*zz*<cr>

If the "*cc*" byte is NOT the ON, OFF or a valid Ramp code, then the entire message should be discarded.

8 INTERPRETING THE MMI

The C-Bus PCI will also forward regular lighting MMI messages. These messages show, in brief form, the state of all lighting groups in the network.

By default MMI messages will appear about every 3 seconds, though this interval can be changed when the C-Bus network is commissioned.



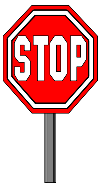
MMI messages can be ignored if desired.

The format reported is known as “Standard Format”, and the information returned looks like:

```
D8380068AA014055055000100000001400000000000000000000CF
D8385800000000000000000000000000000000000000000000098
D638B000000000FF000000000000000000000000000000043
```

This reply codes the binary status of all 256 possible groups in application 38, the standard C-Bus Lighting Application.

Each line of the MMI starts with a byte of value ($C0 + the number of character pairs to follow).



If MMI messages are to be ignored, then any line from the PCI that has the first byte with value ≥ $C0 can be ignored.

In this example reply, the line is interpreted as:

D8: Indicates that there are $D8 - $C0 = $18 = 24 character pairs (ie 48 characters) to follow.

38: The Application Address being reported.

00: The starting group number for this line of the report (this changes for the subsequent lines of the report)

The subsequent bytes code the group values. Each byte codes 4 consecutive groups, using 2 bits per group, in order from least to the most significant bit pairs:

Bit Number

7 6	5 4	3 2	1 0
Grp N+3	Grp N+2	Grp N+1	Grp N

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The bit coding used is:

00 = This Group Address does not exist in the network

01 = This Group Address is ON (Level is > 0)

10 = This Group Address is OFF (Level = 0)

11 = This Group Address is in the ERROR state

Therefore, continuing the bytes in the example:

68: group 0 does not exist, group 1 = OFF, group 2 = OFF, group 3 = ON

AA: group 4 = OFF, group 5 = OFF, group 6 = OFF, group 7 = OFF

01: group 8 = ON, and groups 9, 10, 11 do not exist

etc

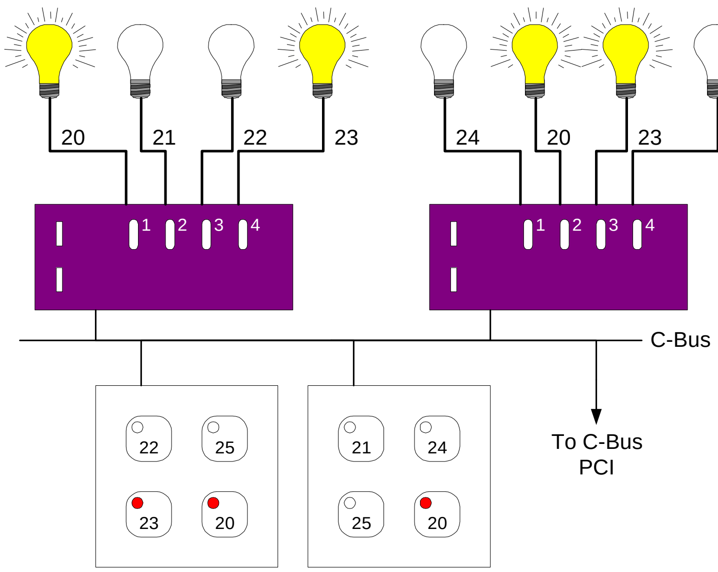
The second line of output for the status report has exactly the same format, but starts the report group “58” (hex).

The third line is a slightly shorter, but is otherwise the same, and starts reporting from group “B0” (hex).

9 EXAMPLE

An example is given for controlling several lights on a C-Bus system. The lights are arranged in groups, controlled by standard C-Bus key input units.

The network configuration is shown below. Each lighting circuit, and each switch, is labelled with the lighting group number.



This diagram shows that Lighting Group Addresses can span multiple C-Bus key units and output units. Keys and output circuits can be allocated to any available Lighting Group Address. The same Lighting Group Address number can be used in many places, and everything under the control of that Group Address will remain synchronised.

9.1 Control Examples

To turn on Lighting Group Address $21, issue the command:

`\053800792129g<cr>`

To turn off Lighting Group Address $21, issue the command:

`\0538000121A1g<cr>`

To ramp Lighting Group Address $21 to level $7F (50%), using the 4 second ramp rate, issue the command:

`\0538000A217F19g<cr>`

9.2 Monitor Examples

Unit $0B transmits an ON command on group $20, PCI returns:

`050B380079201F<cr>`

Unit $0B transmits an OFF command on group $20, PCI returns:

`050B3800012097<cr>`

Unit $0B transmits a RAMP instantaneously to level $48 on group $20, PCI returns:

`050B38000220484E<cr>`