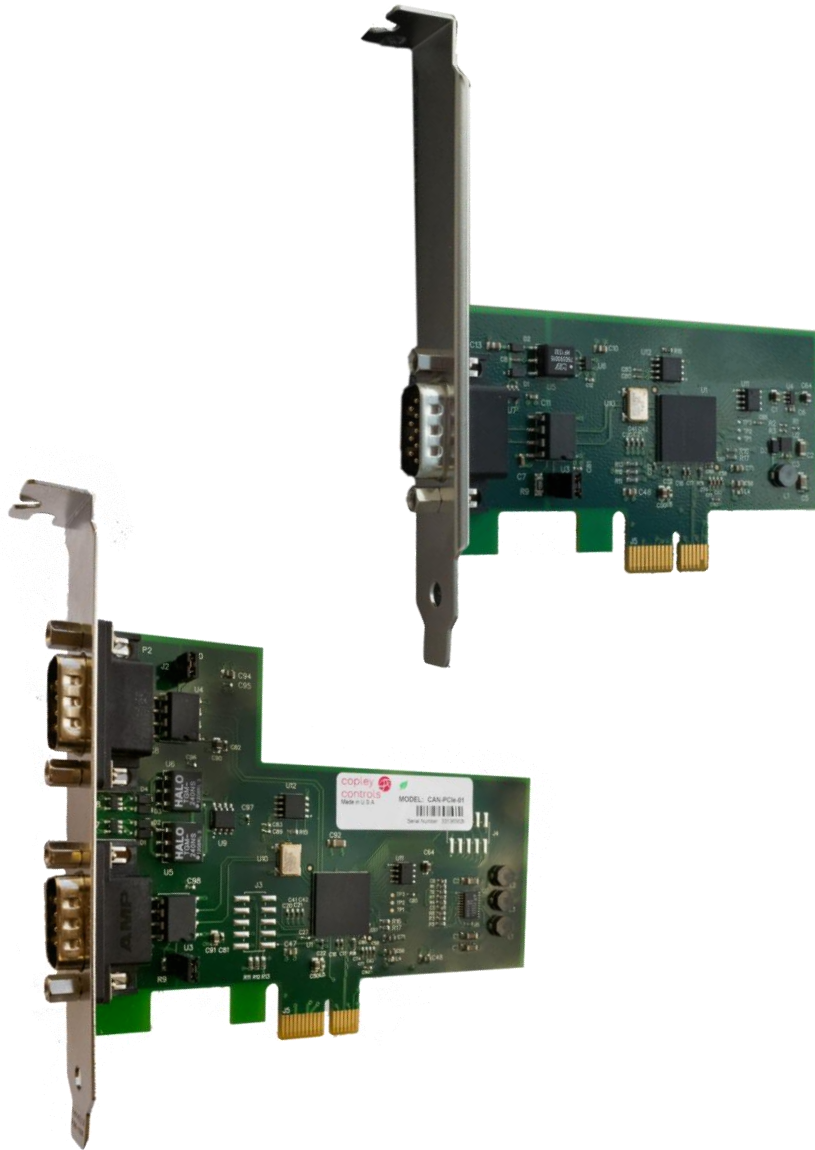




CAN-PCle-01 ***CAN-PCle-02*** ***User Guide***



Revision 00
March 9, 2015

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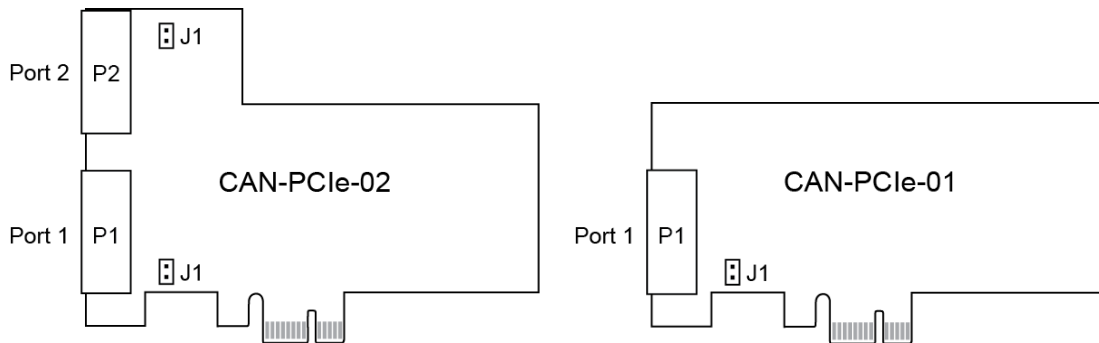
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Hardware description and installation

The CAN-PCIe-02 is a dual channel CAN interface card for the PCI express bus. The CAN-PCIe-01 is a single channel version sized to fit in a half height PCI express chassis. A full size bracket is also provided for the CAN-PCIe-01, so it can be used in either a full height, or half height PCI express chassis.

On the dual channel card, the bottom CAN connector (i.e. the one located closest to the motherboard when the card is installed) is port 1. The upper connector is CAN port 2. The card includes 120Ω termination resistors on board. The jumper adjacent to each CAN port connector is used to enable these termination resistors.

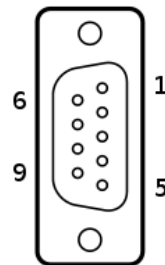
When the jumper is in place, the CAN bus is locally terminated. When the jumper is removed the on board termination resistor is not used. Proper termination of the CAN bus is very important for the proper functioning of the network. For more details, see the section later in the document on proper [CAN bus wiring](#).



The card uses a single lane PCI express connector to interface with the host computer. The card can be installed in any PCI express slot on the host PC, both single lane slots and multi-lane slots will work equally well. To install the card in the host PC, power down the PC and insert the card into any free PCI express slot. We recommend that a screw be used to secure the bracket to the host chassis.

CAN connector signals

Pin	Signal
1	No connection
2	CAN_L
3	CAN_GND
4	No connection
5	No connection
6	CAN_GND
7	CAN_H
8	No connection
9	No connection



Driver Installation

Windows

The Windows driver for the CAN-PCle cards supports Windows XP and later versions of the operating system on both 32-bit and 64-bit systems. To install the driver, first download the most recent driver file from the Copley Controls web site:

http://www.copleycontrols.com/Motion/CanFiles/CopleyCanDriver_1.22.zip

The driver is distributed as a zip file and must be extracted before it can be installed. Extract the file into a folder on your desktop or other location where it can be easily found.

To install the driver, restart the PC with the CAN card installed. You must have administrator privileges to update drivers in Windows, to install the driver log onto the PC using an account which has these privileges.

When the PC is first started with the CAN card installed, it may pop up a “New Hardware Found” wizard. The driver can be installed through this wizard by selecting the folder in which the driver files were extracted. This wizard does not always show up for all versions of Windows, so we will detail a more reliable way to install the driver using the Device Manager. This method can also be used to upgrade an existing driver.

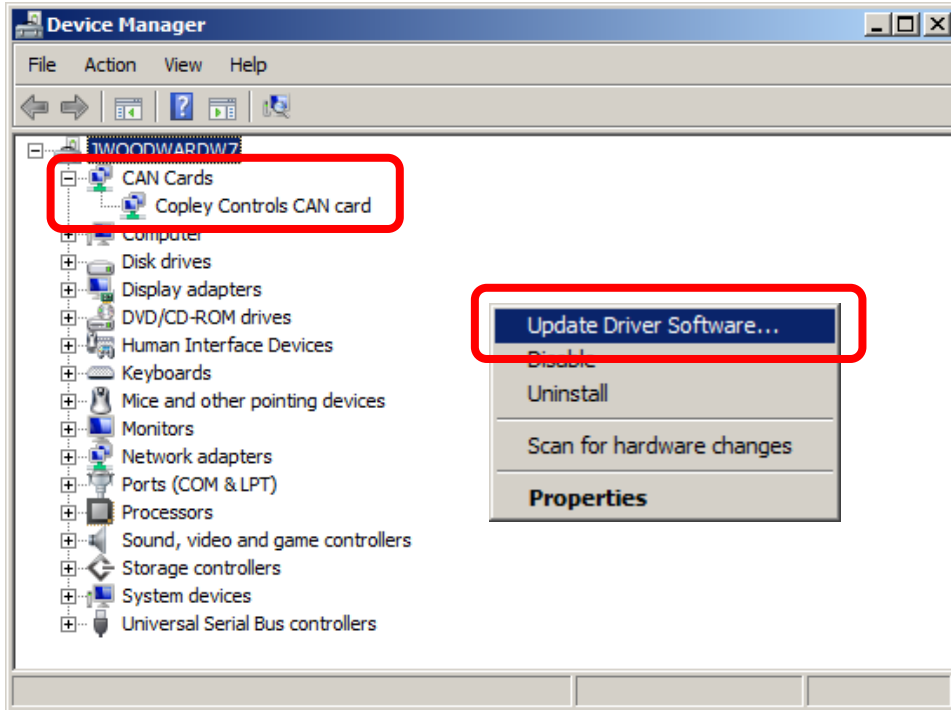
There are several ways to start the Device Manager program on Windows. One way is to press the 'Start' button at the bottom of the screen, and enter the following command in the text field at the bottom of the startup list:

mmc devmgmt.msc

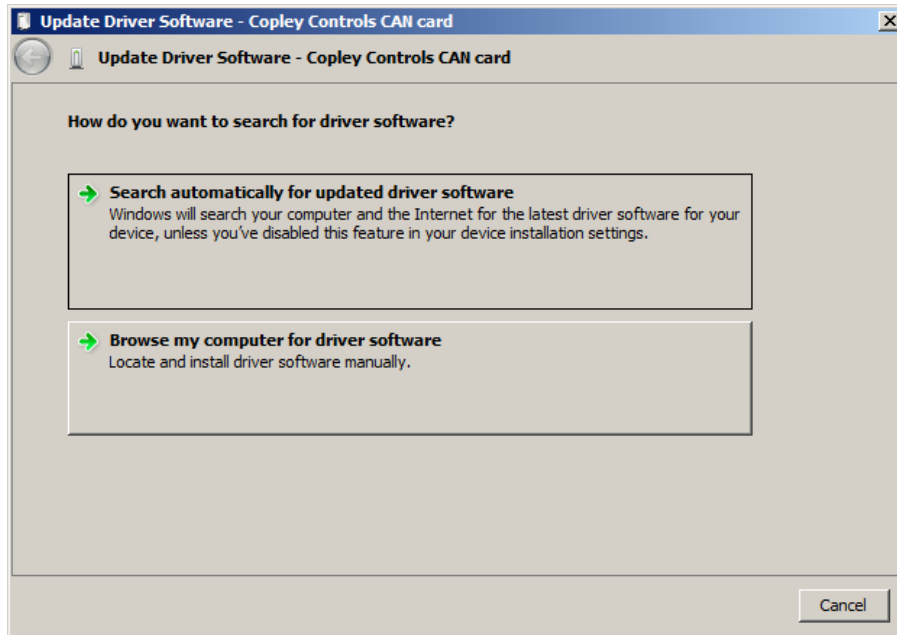
Alternately, the Device Manager can be found in the Control Panel in Windows 7. For Windows XP, open the Control Panel, select System, open the Hardware tab, and press the button for Device Manager.

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The Device Manager gives a list of all the hardware devices available in the system. The screen below shows card in the Windows 7 display. Right-clicking on the Copley Controls CAN card opens a pop-up to update the software. Select this option as shown.

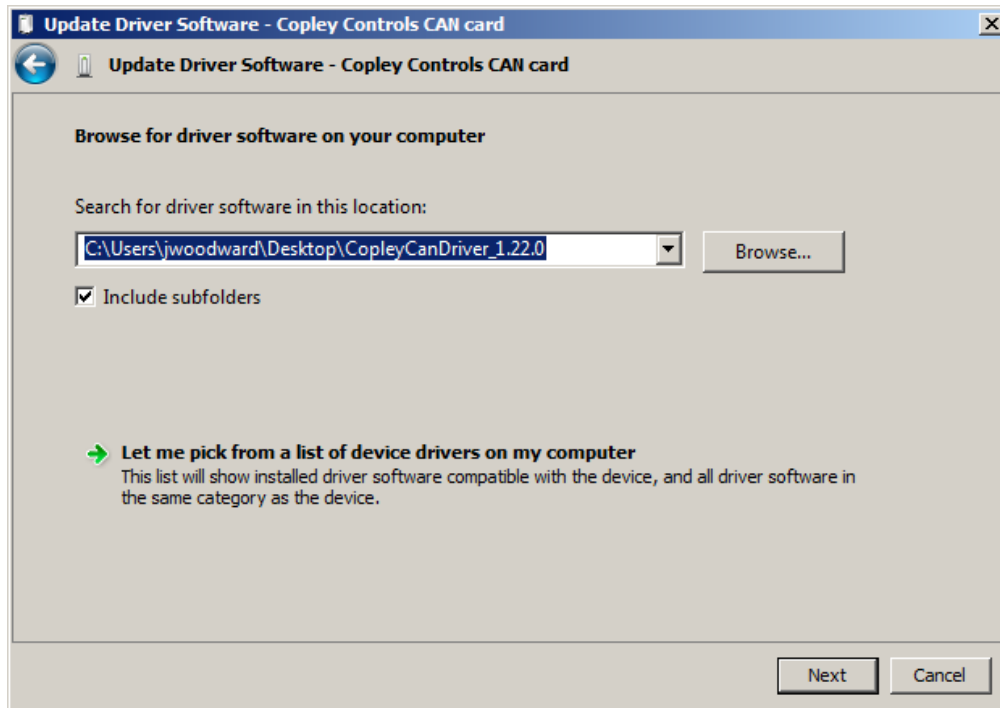


Choose “Browse my computer for driver software”. Locate the folder which contains the downloaded and extracted device driver.

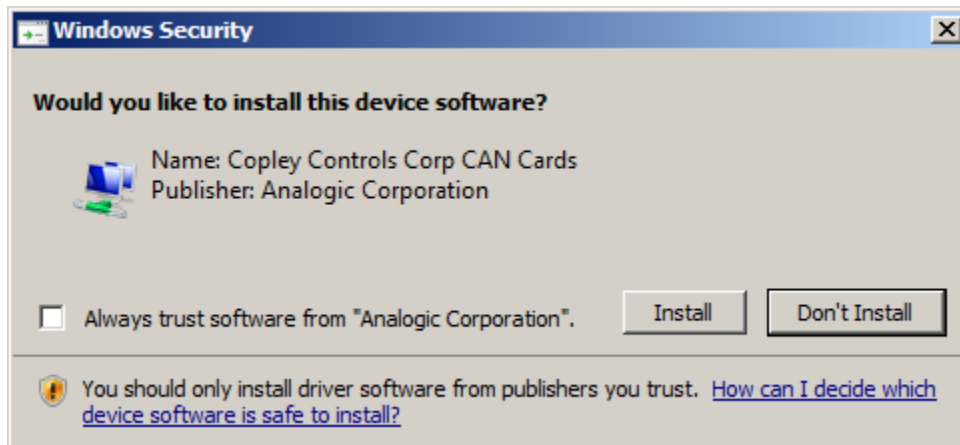


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The next screen opens to the folder containing the driver software.



Clicking “Next” will open a screen where Windows will confirm that you wish to install the driver. Click “Install” to proceed with the installation:



Linux

The Linux driver is distributed in source code format for easier installation on a variety of different Linux distributions and kernel versions. To install the driver, first download the driver files from the Downloads section of the Copley Controls web site: <http://www.copleycontrols.com/Motion/CanFiles/copleycan-1.00.0.tgz>

To decompress the archive file, use the following command (substituting the proper archive file name if necessary):

```
tar xzf copleycan-1.00.0.tgz
```

This will create a new directory containing the driver source files. Enter that directory and build the driver using the following command:

```
make
```

This should compile the driver. On success, the driver file (named **copleycan.ko**) will be created in the working directory.

To insert the driver into the running kernel, execute the following command (which requires super user privileges):

```
sudo insmod copleycan.ko
```

To install the driver in the appropriate kernel directory so it can be automatically loaded at startup, use the following command (which also requires super user privileges):

```
make install
```

When the driver is properly installed and detects a CAN card in the system, it will create device files named **/dev/copleycan00**, **/dev/copleycan01**, etc. There will be one such file created for each CAN port, so single channel cards will create one file, dual channel cards will create two files, etc.

Normally, the device files will be created with root ownership. On Linux distributions that support the **udev** device manager this can be changed by creating a **udev** rule file. The file should be named

```
10-cancard.rules
```

and placed in the **udev** rules directory in the system. For Debian based distributions this folder is

```
/etc/udev/rules.d/
```

The rules file should contain the following line:

```
SUBSYSTEM=="cancard", OWNER="someuser", GROUP="somegroup", MODE="0666"
```

Change the **someuser** and **somegroup** strings to valid user and group names in the system.

Please see the Linux **udev** documentation for more information on writing **udev** rules.

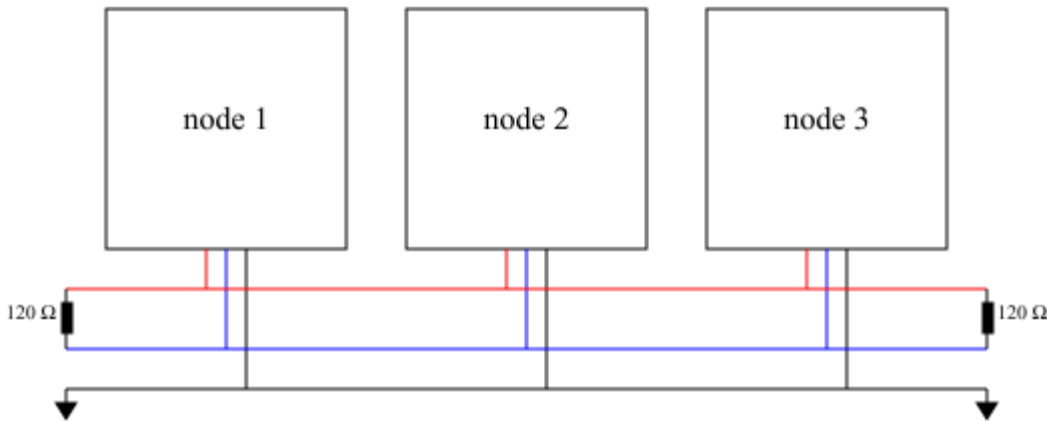
There are many different Linux distributions in the wild. Contact Copley Controls support if you encounter difficulties building or installing the Linux driver on your system.

CAN bus wiring

Laying out a system that uses the CAN bus requires a certain amount of care. When properly designed, a CAN network will provide a highly reliable communications link. If insufficient care is taken when designing the network layout, significant error rates can result.

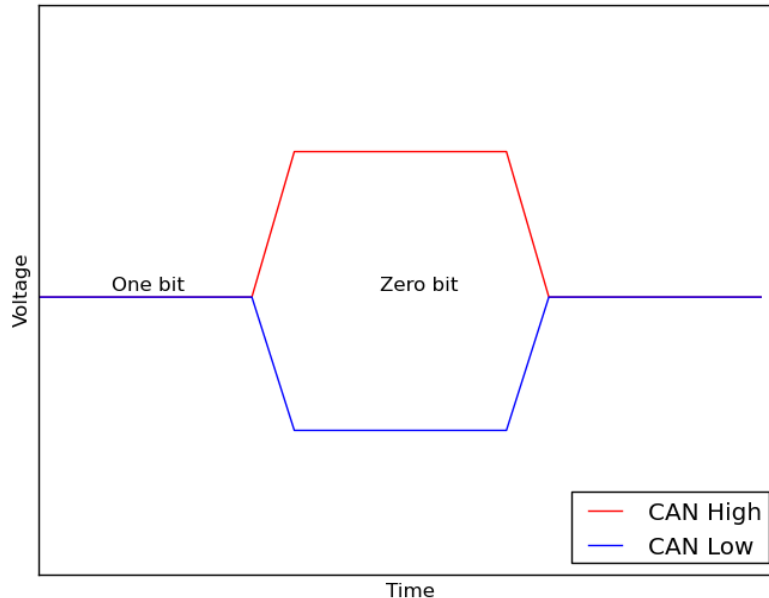
CAN is a shared bus style network. All nodes on the network are directly connected to the same set of bus wires. The CAN bus uses two signal wires named CAN_H and CAN_L. Networks will often function with only those two signal wires shared between the nodes on the network, but it's wise to also connect a common CAN_GND ground wire between all the nodes on the network. This avoids large ground shifts between nodes which could exceed the common mode voltage limitations of the CAN transceivers.

When a CAN network is designed, it should take the form of a single bus line with nodes hanging off of it. The length of the stub from the main bus to the CAN node should be as small as possible for best results. Termination resistors should be placed at both ends of the main CAN bus with values that match the impedance of the network cable, 120Ω is the value typically used. If the CAN-PCle card is being used at one end of the CAN network, then its internal termination resistor may be used by inserting the jumper next to the CAN connector. If the card is not at the end of the bus, then its internal termination resistor should be disabled by removing the jumper.



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Messages are transmitted on the CAN bus as a series of bits. 0 bits (called dominate bits in CAN terminology) are signaled by applying a differential voltage between the CAN_H and CAN_L bus lines. 1 bits (called recessive bits in CAN) are signaled by not driving the bus and allowing the terminating resistors to reduce the differential voltage to zero.



When a node on the CAN network needs to transmit a message, it first waits for the bus to be idle, then starts transmitting its message after a brief delay. It's often the case that multiple nodes will attempt to transmit a message at exactly the same time. As long as all nodes transmit the same bit value at the same time, there will be no conflict. As soon as one node transmits a zero (dominate) bit while another node transmit a one (recessive) bit, the dominate bit will be the value that is actually signaled on the bus. This is a natural result of the way bits are signaled on the CAN bus. Dominate bits are signaled by nodes actively driving the bus voltage, recessive bits are signaled by nodes releasing control the bus lines. Each transmitting node also monitors the actual state of the bus, and if it detects a dominate bit value at a time that it attempted to transmit a recessive bit value, then it immediately stops transmitting its message. This mechanism is called message arbitration, and is used to prioritize traffic on the CAN network.

In order for message arbitration to work, all transmitting nodes must also monitor the CAN bus lines to determine if the bits that they are sending are actually prevailing on the bus. This basic requirement of CAN is the reason that CAN networks are limited to a maximum data rate of 1 Megabit / second, and that the maximum length of the network is limited.

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When a CAN node transmits a bit, that bit value needs to propagate through that node's local CAN transceiver, along the entire length of the network through the transceiver of the farthest node on the network, and all the way back before the end of the bit time. In fact, the transmitting node typically samples the actual bus value at around 88% of the bit time, so this round trip delay needs to happen within 88% of the bit period. This restricts both the maximum bit frequency of the CAN network, and the maximum length of the bus.

The CAN in Automation group (<http://www.can-cia.org/>) recommends the following maximum network lengths and stub lengths for different CAN bit rates. Stub lengths are the distance from the main bus line to the individual CAN node.

Bit rate	Max bus length	Max stub length	Max accumulated stub length
1 Mbit/sec	25m	1.5m	7.5m
800 kbit/sec	50m	2.5m	12.5m
500 kbit/sec	100m	5.5m	27.5m
250 kbit/sec	250m	11m	55m
125 kbit/sec	500m	22m	110m
50 kbit/sec	1000m	55m	275m
20 kbit/sec	2500m	137.5m	687.5m

In addition to limiting bus length, bus termination is also very important. The bus termination resistors perform two important functions in the CAN network; they speed up the transition from dominant to recessive bit values, and they minimize reflected waves caused by impedance mismatches at the end of the bus. CAN transceivers are designed to be used with a 120Ω termination resistor on each end of the cable, and thus for best results the CAN network cable should have a characteristic impedance of 120Ω.

CAN is a very reliable network technology when properly implemented. For best results, the following guidelines are recommended when laying out a CAN bus:

- Use a single main bus line with nodes hanging off it via short stubs. Resist the temptation to lay out a CAN bus in a star or tree style configuration.
- Pick a network bit rate that's appropriate for the length of your CAN bus using the table above. In fact, use the next lower bit rate if possible. Lower bit rates provide a lot of extra tolerance to questionable termination or line layout.
- Don't forget to terminate both ends of the CAN network! This is probably the single most common cause of network errors in CAN.
- Use cable designed for CAN with 120Ω characteristic impedance. CAT-5 has a characteristic impedance of 100Ω which is not ideal for a CAN system.

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Revision 00
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