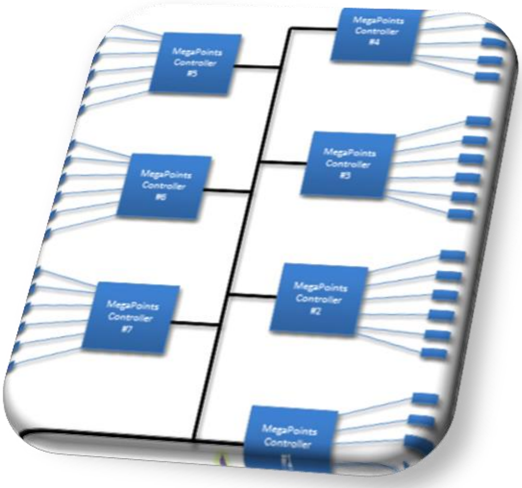
MegaPoints Network Guide

Supplemental connectivity guide and background for MegaPoints Controllers



Network guide

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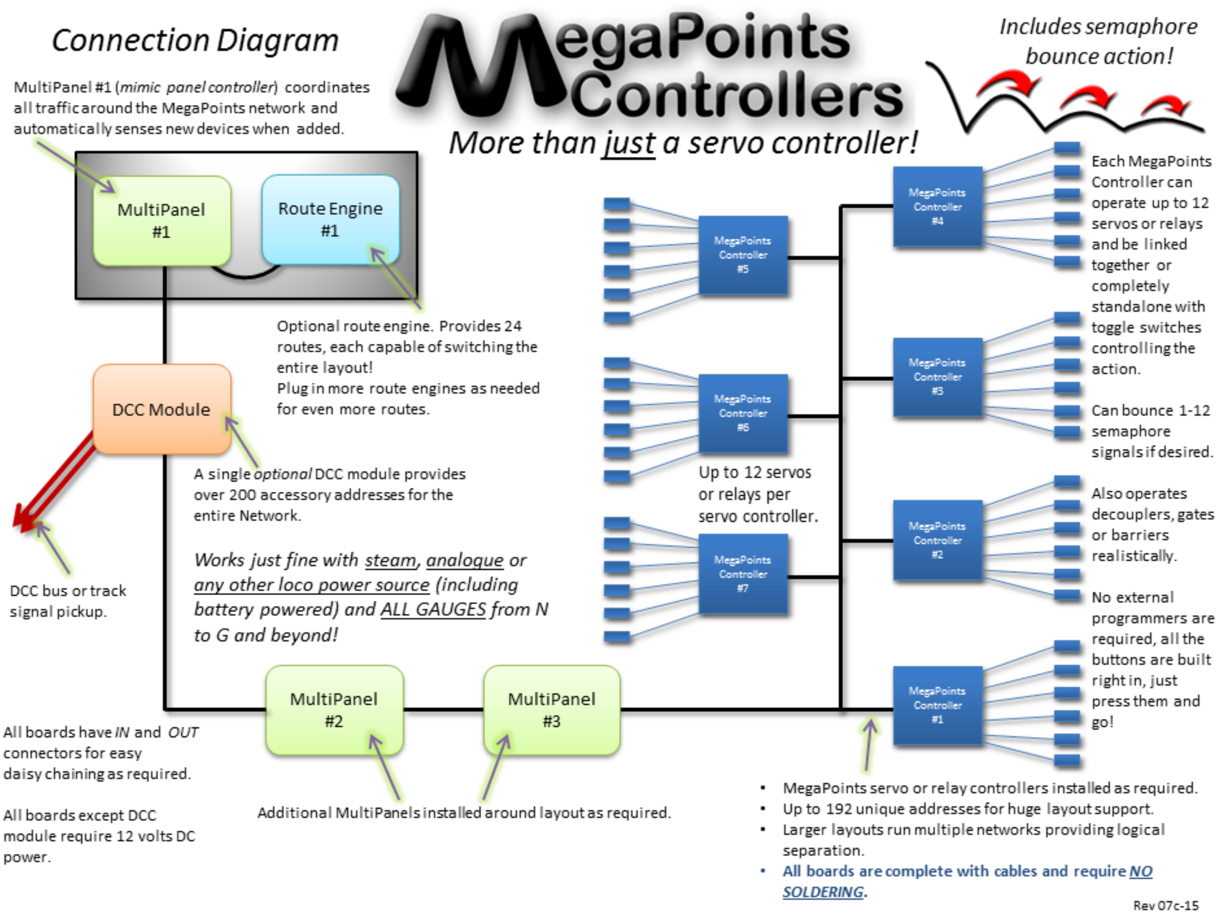
Audience

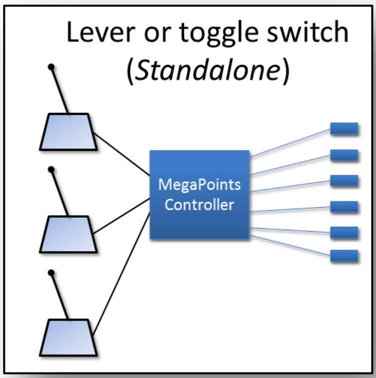
The following diagram shows various MegaPoints Controllers devices connected via a network. This document will guide the reader through the network connectivity options and offer practical advice where appropriate.



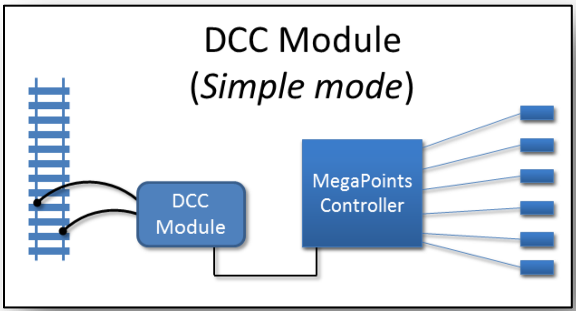
Control combinations

At the heart of the MegaPoints Controllers system is the Servo Controller. It is the workhorse that does the heavy lifting out on the layout. It can be controlled via any of the following methods:

Lever frame or toggle switch



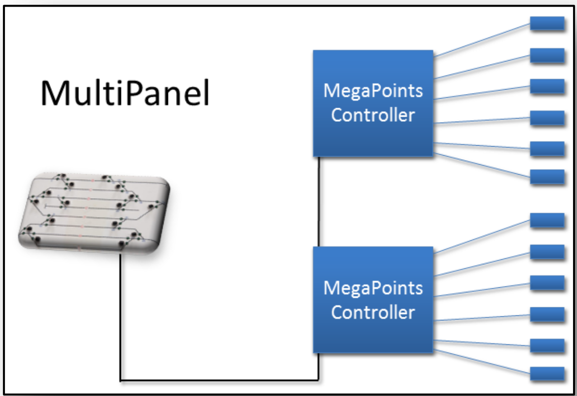
Use a lever frame or toggle switch directly connected to each MegaPoints Servo Controller. The Servo Controller will dutifully respond to the switch command. Uses make/break type switches (*not passing contact*). Switch input requires the Servo Controller to be in master mode. All other modes listed below require the unit to be in slave mode. Any connected switches or levers will be ignored when in slave mode.



DCC – simple mode

Connect a DCC module directly to a MegaPoints Servo Controller and the controller will instantly react to any valid input commands. This provides the simplest form of network control and each Servo Controller requires a dedicated DCC module. In this configuration the DCC module translates 12 DCC accessory addresses (*user definable*).

MultiPanel

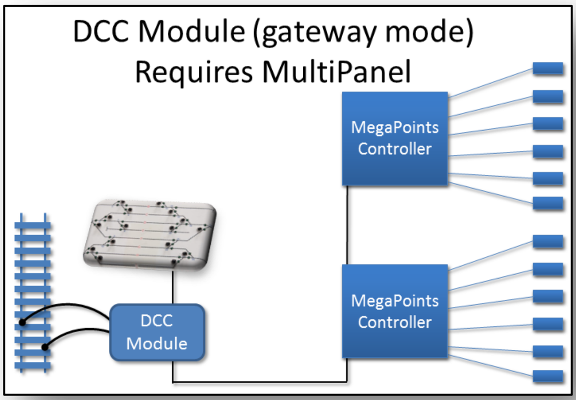


The MultiPanel can communicate with 16 separate Servo Controllers and up to 192 separate sets of points. This allows you to connect as many MultiPanels as are required around a layout and they can all operate cooperatively. MultiPanels use LEDs to indicate track settings and this is instantaneously broadcast to all connected MultiPanels ensuring all displays remain up to date.

MultiPanels use pushbutton switches for input (*push to make*) as the state of the points is held and maintained by the electronics. A second push releases this state returning the servo to its starting position.

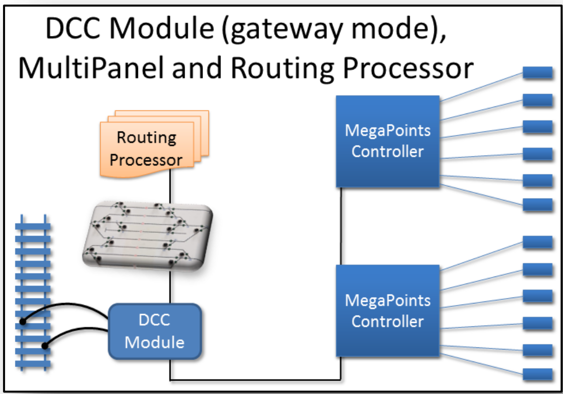
DCC – gateway mode

When MultiPanels are present on a layout the DCC module takes on a new personality and can decode DCC accessory packets for the entire system (*over 200 DCC accessory addresses*). You only need one DCC Module per layout as the MultiPanel will ensure all other network devices and panels are maintained up to date. Any time a DCC accessory packet is received all connected MultiPanels are updated with the change. With a DCC module operating in gateway mode you are free to operate your layout switching via DCC command and mimic panel pushbutton. This provides the highest degree of flexibility as you can use both DCC and mimic panel pushbuttons at the same time.



Routing processor

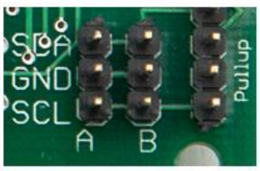
The routing processor communicates directly with an installed MultiPanel and allows a single button to configure the entire layout. If relay modules are installed a single button can configure points, set signals and enable or disable power to designated track sections. Every time a change is made the MultiPanel display will instantaneously update. DCC accessory addresses beyond the first 192 are used to enable or disable routes set with the routing processor.



Network connectors

All MegaPoints Controllers network devices feature two connectors. They can be used interchangeably unless specifically stated. Most commonly they can be used as an IN and an OUT connector enabling devices to be daisy chained around your layout. The connector is a typical R/C servo connector that is both inexpensive and readily available.

Examples of multiple network connectors.



We use a three wire network (*synchronous*) that is not fussy in use; however care should be taken to ensure that the same network pin is connected to the same pin on all other network devices. I personally use the convention of a WHITE wire (*or the lightest colour available*) connecting to the SDA connector. I then use the RED cable (*or grey*) to connect to the SCL connector and the BLACK (*or darkest*) wire to connect to the GND. By using a consistent colour approach you don't have to think back over how you wired the other end of the cable.

Cabling

You may be wondering why we chose a three wire cable over two wire cables so commonly used (*DCC for example*). The third wire is used as the clock reference for network traffic and allows us to vary that transmission speeds on the fly as electrical noise increases.

With a two wire (*asynchronous*) network the transmission speeds must be known by all network devices in advance and accurately controlled. With the three wire network (*synchronous*) the message sender sets the transmission speed by transmitting the timing information down the extra wire (*clock*). This makes it easy to adjust transmission speeds according to the environment without having to manually reconfigure each device.

The network management is built into the microprocessor and requires no additional hardware making for a very cost effective solution. The network we use is I^2C (*integrated circuit to integrated circuit*) or TWI (*Two Wire Interface*) and you can read much about its design and limitations on the Internet. Single chip network drivers are capable of driving a TWI signal a kilometre or more according to the NXP Design Note – see references on page 9. This makes for a very cost effective and flexible network that is fit for our purpose.

All devices connected to the TWI must be powered ON when connected. If you want to isolate a section of network, simply unplug it from the last device on the network chain.

Cable types

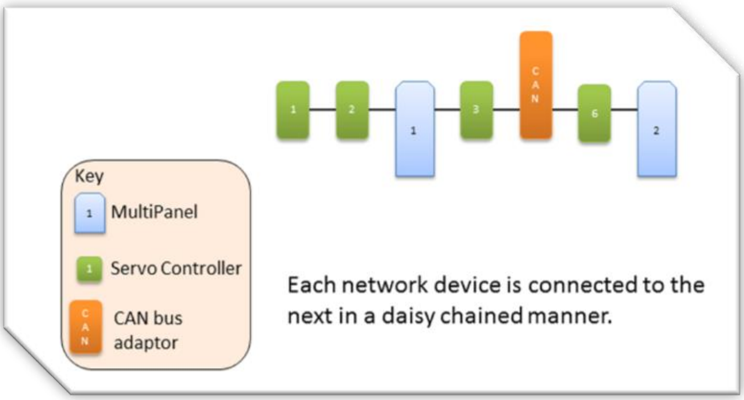
The cable type is less important when shorter overall network lengths are being used. I have used telephone wire, Ethernet cable (*CAT 5 & CAT 6*) and alarm cable with good results. As network bus length increases you should use a low capacitance cable. I personally prefer the flat four conductor alarm cables as these are inexpensive (*I paid £14 for a 150 meter roll*) and have low capacitance.

NOTE: CAT-5, CAT-6 and twisted pair cables have higher capacitance and are not recommended for network lengths over 100 feet.

Pull-up resistors

When you purchase a MultiPanel Controller you receive two 10k pull-up resistors in the box. These are designed to plug into a MegaPoints Servo Controller. When bench testing they won't be needed, however there's no down side to fitting them. Up to a maximum of four of these resistors can be fitted to MegaPoints Servo Controllers on the same network.

If you have a large layout with say 16 MegaPoints Servo Controllers a DCC Module, three MultiPanels and a Routing Processor installed we suggest fitting the pull-up resistors evenly around the layout. For example if you have 21 devices connected to your network fit a pull-up resistor close to each end and two somewhere towards the centre will yield best results. From the network perspective fitting one every 5th device along the network bus is ideal. Unless you are pushing the boundaries or have an electrically hostile environment this is not critical.

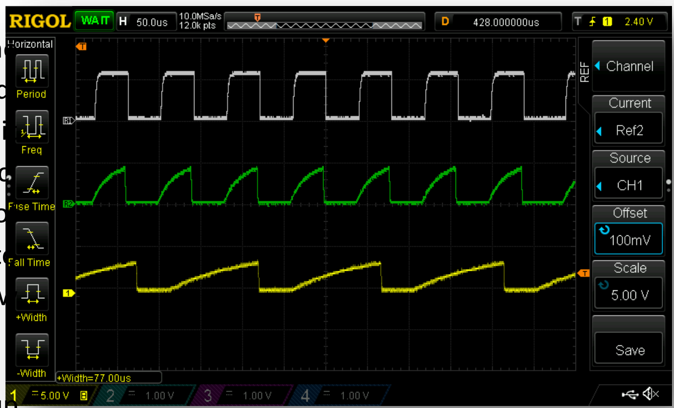


In the LAB we frequently use a single 4.5KΩ resistor irrespective of cable lengths and have achieved lengths greater than 250 meters or 820 feet. I have yet to personally discover the cable length limits.

Unlike termination resistors, pull-up resistors are designed to manage the bus capacitance. As cables grow in length the parallel wires act as a capacitor. Think of it as adding smoothing to your nicely constructed pulses that are used for the signalling. Capacitance is the enemy and pull-up resistors are used to increase the current flowing down the wire and thereby lower perceived capacitance and restore the rise times of the data. You can look up RC time constants in the referenced documents at the end of this guide for more details.

The oscilloscope traces show the effect of excessive capacitance and pull-up resistors on the network.

The top white trace shows a correctly loaded (*normal*) network signal. Observe the square wave output with only a slightly increased rise time of a couple of µsec.



The middle green trace shows the sam signal with the pull-up resistor removed You can see the rise time barely makes i from 0 volts to 5 volts within 40 µsec While this trace pushes the limits o acceptable, the network continued t function correctly showing just hov robust this design is.

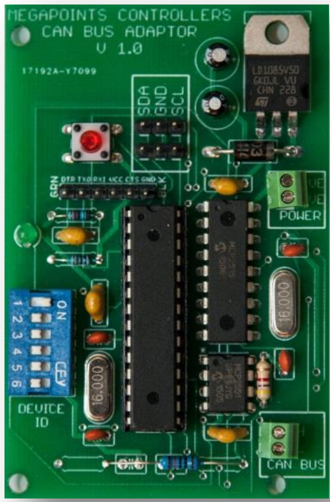
The lower trace (*yellow*) had the pull-up resistor removed and the cable length significantly extended. You can see how the signal does not rise within an acceptable time frame and stretching occurred resulting in network failure. Refitting the pull-up resistors solved this.

NOTE: You don't need an oscilloscope to diagnose network conditions – it's just for your information.

CAN bus adapter

For larger layouts, we recommend adding a pair of CAN (*Controller Area Network*) bus adapters.

This board is designed to sit between MegaPoints networks and provide a long distance option (up to 2.5 km) by routing traffic on to a CAN backbone. The CAN bus is well documented as used in modern vehicle and industrial systems to provide access to huge layout control possibilities while enabling the centralised configuration and operation that the MegaPoints system allows.



You can attach up to 32 CAN bus adapters to the MegaPoints network future proofing your investment. Each adapter connects all local MegaPoints devices through a local CAN bus adapter to the backbone thereby reducing the overall number required. See the CAN bus adapter guide for further details.

Due the to gateway design of the adaptor you do not need one per device. Local devices are connected in the usual manner to each other in daisy chained manner. The CAN adaptor bridges the local daisy chaining onto the CAN backbone.

See the CAN adaptor documentation on the web site for further information.

Troubleshooting

- Are all devices connected to the network powered up? If not either unplug their network connection or switch the power on.
- Do you have the network cables the right way around? Does the SDA connector go to the next devices SDA connector? Is the same true for SCL and the GND connectors?
- If you are exceeding 100 feet cable total network length use a low capacitance cable such as flat telephone cable (*not twisted pairs*).

References

Wikipedia – Your starting place for most things …
https://en.wikipedia.org/wiki/I%C2%B2C

NXP Design note – very useful and highly recommended background material
http://www.nxp.com/documents/application_note/AN10216.pdf

Official I2C bus specification
http://www.nxp.com/documents/user_manual/UM10204.pdf

All things I2C
http://www.i2c-bus.org/

Arduino - hacking the I2C bus
http://tronixstuff.com/2010/10/20/tutorial-arduino-and-the-i2c-bus/

CAN bus
https://en.wikipedia.org/wiki/CAN_bus

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If you have any product improvement suggestions we'd be very pleased to hear from you.

NOTE: We operate on a policy of continuous improvement. Colours, specifications and even the placement of components may vary from time to time. Documentation will continue to be updated to reflect changes or answer frequent customer questions as they arise.