White Paper

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USB 1.0 Spec Position on Extension Cables and Pass-Through Monitors

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Why No Extension Cables and Pass-Through Monitors for USB

The USB 1.0 spec does not allow for an extension cable for USB devices. Extension cables refer to any cable built with a series A socket or a series B socket at one end.[1] Another form of extension cable that is also not allowed is pass-through monitors. Pass-through monitors typically have a single series A socket on the monitor, and provide connectivity to the connector using a standard cable plugged into the PC. This usage **is** an extension cable where the monitor is part of the cable, and it is **not** allowed.

While there is no sentence that explicitly states that cables cannot be extended, the facts that make clear that it is not permissible are explicit. The spec was written to maximize the performance and capability of the USB bus while minimizing the cost. Because of this design philosophy there is not a lot of waste in either the timing or power specifications. This does not allow for ad hoc extensions to the bus in the form of add-on extension cables.

There are 2 basic reasons why an extension cable is not possible, the cable power budget and the cable timing budget. Both of these problems can occur in any legal configuration with an exceptional, but spec compliant, device. In addition there are many not exceptional but common devices to which an end user could mistakenly add too much extension cable. End users are not supposed to need to understand the cable length limit so a spec violation and device or system failure is easily the result. While it could be argued that user education might minimize the second issue, it is counter to the general “ease of use” message to require a user to understand increasingly technical details about his machine just to get a “plug and play” peripheral to work.

Power Limitations

The cable length limit is critical in maintaining the power supply budget for devices that connect to USB and derive power from the bus. There is a great deal of design flexibility for designers of devices in how they use the bus power if they choose to use a captive cable in their device. It is completely within spec to depend upon the guaranteed minimum voltage being available from any USB socket that they are plugged into. It is possible to save design effort and cost within the device by meeting that spec, but not providing excess margin beyond that spec. This might be considered an exceptionally aggressive device design, but it remains spec compliant. The designer of a host system or hub will do the same. The specification does not allow for any additional voltage drop between the socket and the plug therefore the minimum output voltage for a USB socket and the minimum voltage guarantee to a plug are the same. No cable of any length, not even a plug and socket combination with a theoretical zero length cable between the two can be interjected without effecting the voltage guarantee to a device.

Timing Limitations

Cable length is also critical in maintaining the signal timing that the protocol is based upon. It is not an approximate distance over which the signal quality will remain good, instead it is the maximum distance that the signal can propagate in the time allowed in the USB protocol for device responses. The bus is a master slave bus not a peer to peer bus and that means that the

[1] Note that a cable with a series A plug at one end and a series B plug at the other is not an extension cable, but simply a removable USB cable.

direction of the buffers driving signal wires is controlled by the master and the timing for changing directions is set in the architecture of the wire protocol. A cable that is longer than the maximum spec limit will cause devices to be driving the wrong direction on the bus. These buffer conflicts will lead to devices being ignored and/or devices and hubs being shut down. As with the power considerations there are specifications that a designer must meet for his device to operate correctly, but there is the freedom to save effort or cost by not building in expensive overkill. As long as device cables are captive to the device excess timing budget can be converted to cost savings for a completely spec compliant device.

Obviously end user ignorance of the cable length limit can exaggerate both of these conditions even in common, non exceptional devices.

FACTS FROM THE SPEC

- The USB 1.0 Spec contains a cable length limit of 5 meters, a cable delay spec of 30ns and a supply voltage minimum at any USB socket of 4.4 volts.
  Chapter 7 of the spec covers the electrical specifications of the USB signals and limits all cables of any length to 30ns prop delay. Since cable varies from 3 to 6 ns per meter prop delay the maximum cable length can be calculated to be 5 meters. If exceptionally bad cable were used the prop delay could be greater than 6 ns per meter and a designer could build a device with a 1 meter cable and possibly save a few pennies by using slow cable with a max prop delay over only 1 meter in length. Power delivery is not speced in terms of drop per cable length, but in terms of minimum voltage at any USB socket and minimum voltage guaranteed to any device at its USB plug. The number is the same for the minimum allowed at a socket and the required minimum at which a device must operate. The voltage limit is specified at both 4.4 volts and 4.75 volts, but the choice of input operating voltage is related to whether the device is a high power or low power device, not allowing a voltage drop budget for miscellaneous uses.
- Wire size for USB cables is allowed by the spec to vary if the cable is captive to the device.
  Chapter 6 describes the requirements for cable material for USB cables. Many characteristics are specified and there is some flexibility in choosing cable as long as it meets the requirements of Chapter 6. The maximum prop delay and power wire resistance is specified for more than one type of cable which allows a cheaper or more flexible cable if proper tradeoffs in the total cable length are made. Specifically section 6.5 provides detail for cables that are exceptional in prop delay characteristics so that this kind of tradeoff with length can be made.
- The configuration and specifications of the plugs and sockets for USB cables are covered in detail, but no specification for a cable mounted socket exists.
- Chapter 6 details the dimensions and configuration of all of the USB sockets and plugs that are compliant with the spec. The mounting is specified for both plugs and sockets and for both series A and series B types of connectors. There is no description of a cable mounted socket for either the series A or series B connector type. This is because the intent of the spec and in fact the technical limitations on cable length mentioned above do not include any cable configurations that would require a cable mounted socket.