USB Version 3.1 – a crucial turning point for industrial applications?

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Universal Serial Bus (USB) has a strong foothold in consumer electronics, but has yet to prove itself in industrial applications. Electronic component manufacturers predict a significant increase in the future and see the introduction of the USB 3.1 standard as a turning point, if certain quality standards of the components are met.

Figure 1. USB-3.1 connector, C-type: the end of trial and error on insertion

■ IEEE 1284 and PS/2 ports on PCs are just two of many interfaces that USB has completely replaced as the standard in the consumer field. In industrial applications, USB has also increasingly been applied in the past, for example to connect mobile devices, to read out measurement data, or to import and install software updates onto machines. But why is USB not widely used in industrial applications even more? Depending on the application, restrictions in the specification could be one reason. But one thing not to be underestimated is that USB has an image problem.

USB connectors are considered to be cheap accessories for undemanding applications, but not a robust industrial connector. And that is not entirely unjustified. Many products simply had quality deficits; the price pressure on universal connectors was extremely high. For this reason, the raw materials used were often not matched to the demands of the application, which led to problems with solderability and consequently to weaknesses in the locking mechanism and durability. Not only the materials played an important role, but rather the mechanical design of the connector: insertion and withdrawal forces could have a negative impact. In the worst case, the connector destroyed the socket on insertion or pulling out.

Another latent issue: on account of the symmetrical data transmission, USB should actually be very interference-resistant. In the case of the inductive interference effect (magnetic field), the twisting of the wires achieves compensation of the interference effect. Theoretically, as a result of symmetrization of the partial inductances, the interference influences compensate each other. Practically, this interference immunity can be compromised, which led to use for some applications being considered unsuitable. The reason often lies in the lack of symmetry of the inputs/outputs of the USB controller or simply in the poor quality of the modules. The interface design (receptacle, housing) is inadequate. Poor ground reduces the shield attenuation of the cable. Filters have poor ground reference. The USB cable is asymmetrical, poorly shielded and has inadequate ground connection. The cable deteriorates the signal quality, radiates signal harmonics and has insufficient shield attenuation towards external interference sources. Only those developers in industry who anticipated that the controller bought-in or the cable used by the end user may not be sufficiently immune to interference and looked into additional EMC protection circumvented this problem. Manufacturers and developers that ignored the EMC issue with a view to the theoretical properties of the USB connectors met with problems in practice.

Those who previously considered USB to be unsuitable for the mentioned reasons will rethink their decision in view of the additional advantages of USB 3.1. Doubling the data rate to 10Gbps alone is a powerful argument. The significantly increased supply power from 9W up to 100W is also extremely interesting for industrial applications. This enables additional applications. The power supply can now also be reversed – i.e. from the client to the host. Last but not least: USB 3.1 does away with the tedious poking to insert the USB connector the right way around: The C-type plug no longer has a direction in the USB 3.1 version. Not only the developers of consumer electronics will want to allow their users to benefit from this faster and simpler handling. 10 Gbps, 100W, simple handling – with these arguments a broad field of industrial applications opens up for USB 3.1. USB can now replace technologies complicated in their use - PCI Express or Thunderbolt, also with the cost argument of mass production, of course.

The conceivable deployment scenarios for USB really are universal. A single connector is the answer to many different requirements, such as data exchange, power supply, video content and networks, but also as a replacement for D-Sub and HDMI, as well as modular sockets. Examples for typical applications are external hard disks and servers, medical

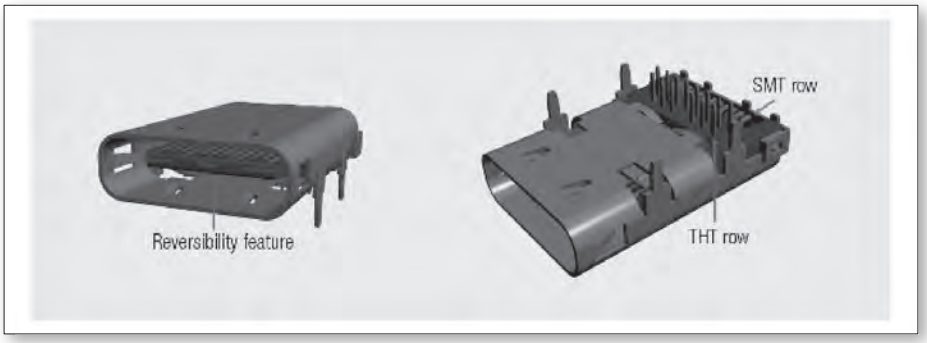

Figure 2. USB 3.1 C-type socket

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1–	Vbus	CC1	D+	D–	SBU1	Vbus	RX2–	RX2+	GND
GND	RX1+	RX1–	Vbus	SBU2	D–	D+	CC2	Vbus	TX2–	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Figure 3. Pin assignment USB 3.1 C-type socket

applications with integrated monitors, industry applications that require data backup, smart phones and all portable devices like sensors, power banks and small monitors. Nevertheless: even with the extended technical possibilities, the basic conditions for industrial use still need to be observed. For an industrial USB application, the issue of EMC protection outlined already is important and has to be credibly addressed in the applications. And those who do not want to risk the reliability of their application should not save too much on material and integrate high quality modules.

An example for one of the details that distinguishes the high-quality connector: the optimized connection angle. If the connection angle is greater than 40 degrees, the contacts could be damaged on inserting the connector. In theory, connectors have a chamfer of 30 degrees in order to limit the risk. In practice, this chamfer is not always integrated, however. So low cost connectors can damage the end application of the customer which leads to complaints, service costs, and the risk of suffering image damage - just because of an USB socket. The sockets on the market therefore have to be designed such that they are also suitable for non-compliant connectors. USB-3.1 modules with improved shielding and increased coating thickness of the contact surfaces to avoid high mechanical loads are the way forward - but are expensive, of course. But with a durability of 10,000 plug cycles, they are also suitable for devices that should last longer than short-lived consumer products.

What comes next with USB3.1? Firstly, there is a dynamic market development with consumer applications to be expected. Even today, many manufacturers of smartphones already use USB 3.1, C-type to supersede USB 2.0 or Micro USB 3.0, B-type. Connector producers expect industrial companies to follow suit within a year once development teams have evaluated their requirements and possible constraints on the use of the new technology. Especially when attention is paid to high-quality material and clean EMC solutions, USB 3.1 is true progress. ■

Figure 4. USB 3.1 C-type views