Lenz Elektronik, GmbH

X-Bus - Industrial Grade Electronics
for the Model Railroader

In the blink of an eye, your DIGITAL plus command station has communicated to each device on the X-Bus several times providing you lightning fast performance for such time critical applications as sound control.

What is the X-Bus?

The X-Bus is a high speed multi-point to muliti-point digital network based upon the industry standard RS-485 protocol. DIGITAL plus uses the X-Bus to communicate between its high speed components such as the command station, handhelds, tower cabs and its computer interface. The X-Bus communicates at 62.5 thousand bits per second (nearly 4 times faster than its closest competitor). It is the highest performance network in widespread DCC use and all its protocols are freely available to both the industry and the hobbyist. (see http://www.lenz.com for more information).

Why RS-485?

RS485 is a very popular worldwide industry standard protocol for communication between high speed real time devices. It is a multipoint to multipoint network commonly used in industrial real time control applications and networks. RS-485 chips are readily available from a wide variety of sources and like most industry standards, the price/performance of these products keeps getting better. RS-485 can communicate at speeds of up to 10 megabits per second over distances up to 4000 feet. This has been slowed down for model railroad applications to facilitate flexibility for X-Bus installations.

Northcoast Engineering, Ramfixx Technology, Wangrow Electronics, Lenz GmbH, Rivorossi, and ZTC have all independently chosen RS-485 because of its superior performance, commercial availability and reliability.

But isn't RS-485 a "linear terminated Bus"?

Yes and No. To communicate at the full speed and distance limits of the RS-485 network requires some discipline on the architecture and construction of the network. Electronic Industry Association's (EIA) RS-485 specification calls for a resistor to be placed at the last node of the network. This is what is meant by termination. RS-485 is also intended to be wired in a linear fashion which means you wire it in a point to point fashion rather than a tree with lots of branches. Because we use RS-485 at much slower speeds than the maximum allowed for, these restrictions are not necessary in Model Railroad applications. X-Bus installations can have 100 foot branches and do not absolutely require a terminating resistor However, if the need arises we have the capability to easily increase the speed of our network which is why we recommend following EIA's guidelines. Its just some extra insurance should we wish to do more in the future.

How fast is the X-Bus?

It takes less than a millisecond (1/1000 seconds) to complete a transaction to a handheld that has information to transmit and only 300 microseconds to communicate, should the handheld have no information that needs to be updated. In addition, only active devices that are currently plugged into the network are actually provided the token that allows communication. This means that you could have a network of 100 handhelds and each user could simultaneously press a speed change and all could be serviced in less than one tenth of a second, guaranteed! Since only a small fraction of users actually need to transmit information at the same time, the reserve capacity of the X-Bus is actually much much larger. No other DCC model railroad network has such performance and reserve capacity.

Wait a minute, I heard that the X-Bus was a slow polled bus, Why the confusion?

One of the problems present on any dynamic network is how to determine which devices are plugged in, since only active devices need to be provided time windows for communication. Every few seconds the command station goes out and looks for active devices. This is indeed done by polling all possible devices. This takes only a few milliseconds every few seconds and is totally transparent to the user. This polling greatly improves the overall performance of a token based network as devices that are not currently plugged in consume no resources.

But doesn't the existence of polling prevent true network style operations?

Absolutely not. Polling is simply one efficient technique to find out who is currently active on the network and who is not. Once the identity of the device is known multipoint to multipoint communications are not difficult to achieve. To date most devices on the X-Bus only have need to communicate directly with the command station. We have yet to identify a need

more

for our handhelds to be able to talk directly to other handhelds, but if the need arises, it is easy to provide this capability as well.

If RS-485 only requires 2 wires , why does the X-Bus need 4 wires?

Two wires are for RS-485 and 2 wires are for 12 volt power and ground. These additional wires provide power to the handhelds when they are plugged in. Providing power lines in our X-Bus eliminates the need for batteries in our handhelds.

If the X-Bus is so fast why only provide support for 30 handhelds?

Good question. The answer is simple. Up to now we have simply had few users who had a need for more than 30 X-Bus devices (most users currently have less than 10). The original EIA RS-485 specification only allows 32 RS-485 loads on a single network which is how we initially came up with that limit. But like CD ROM speeds, the RS-485 chips are constantly improving and 1/8 load chips are now commonplace. This means that RS-485 can currently support 256 devices which is more than we believe any model railroad will need and additional improvements in RS-485 chips are happening all the time. Should the need arise, we will provide support for more than 30 X-Bus devices. The growth potential is already built in.

Is all the intelligence in the Command Station?

No. DIGITAL plus distributes the intelligence between all the components on the X-Bus. Each handheld has a highly intelligent device and each handheld contains a built-in user replaceable microcontroller. This allows the user interface to be maintained in the handheld as well as providing a simple upgrade path towards the future. This style of architecture is called Client Server which simply means that the handheld (Client) needs to communicate with the command station (Server) in order to perform all of its tasks. To avoid the inherent problems of placing batteries in the handheld, the dynamic information the handheld needs to continue processing the user commands is provided to the handhelds by the command station each time the handheld is plugged into the X-Bus.

If the X-Bus has so much reserve capacity, why have a separate network for feedback devices?

Feedback devices do not have the same real time performance need as input devices used by model railroad operators. While we could have placed the feedback devices directly on the X-Bus network, we decided from the start to use a separate 2 wire bus for this purpose. This has the benefits of lower overall cost, and keeps the X-Bus free for more demanding applications such as the Tower Cab and Computer Interface. We see many future devices that can take advantage of the high speed performance that is inherent in the X-Bus. That is why we have avoided the temptation to overload the network now. Preserving your investment is one of our foremost concerns. It is part of the overall plus in DIGITAL plus.

I keep hearing about performance problems in the X-Bus. Why?

We are embarrassed to admit that in our first release of our command station in 1993 we had a minor software problem in our command stations that gave the appearance of slow performance under load. While never a problem with the X-Bus, and long since fixed, this software glitch caused significant performance problems in heavily loaded systems. A real advantage of our architecture is that by simply upgrading the software in our command stations whole new possibilities are opened up.   It allows us to constantly improve our product while not abandoning any of our customers. Several upgrades to the X-Bus protocol and command station software have occurred over the years and all older products continue to work. Customers of our original systems can easily upgrade to the latest software we have available, which provides them many more features than the system had when originally purchased. You can bet that more upgrades to our software are on in the works as the ability to upgrade is one of tenants on which DIGITAL plus has been built.

If all these companies are using RS-485 why can't I interchange handhelds today?

While all use a common hardware protocol, each currently use's different communication software. But this is changing. ZTC and Lenz GmbH systems can already interchange handhelds. This is because a common communications protocol has been adopted by both companies. North Coast Engineering and Lenz GmbH have recently announced that they are also working on the ability to support each others handhelds. Open protocols based upon industry standards facilities these agreements. Lenz GmbH will continue to support the evolution of these open protocol standards.

Wow, I never knew how much power the X-Bus had. What's in store for the future?

DIGITAL plus continues to evolve and the X-Bus will continue to evolve with it. We are very excited about the potential for handheld interchange that an RS-485 based network provides. We will continue to work with other DCC manufacturers to further enhance the powers of the X-Bus and we have several new products in the pipeline that even further exploit the power inherent in the existing X-Bus protocol. Simply put the X-Bus is fast, efficient and conceptually simple to understand and use. And as the needs arise, we will continue to evolve the protocol to meet those needs.