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# Concept of asynchronous ZanderLink for quick coupling of ZX series controllers V0.1 (October 5, 2023)

## introduction

The speed of the ZX series controllers - all work can be carried out within a microsecond - has been mapped to the coupling using the (synchronous) ZanderLink network, which enables data exchange up to a cycle time of 800 ns (use ZX08DIO or ZX06AIO, 8 each data bits per direction, 50 Mbit/s transmission rate). In addition, this document introduces an asynchronous variant for data transmission via ZanderLink, which has the following properties compared to the synchronous variant:

- + The transmission only requires one data line (with 2 wires, differential signals)
- + The transmission shows no clock skew because the clock is not transmitted, but rather on receiver is permanently set. This allows "any" distances until transmission is no longer guaranteed due to electrical conditions.
- Only significantly lower data transfer rates are possible because the receiver is limited to the The arrival of the start bit must be synchronized

## Integration into the development systems

### Integration into the EX\_PRESS 5 development system

Integration into an application takes place via function blocks. This means that the compiler itself does not need to be changed, only appropriate function blocks need to be developed and tested. A first parameter list for a universal function block:

- Master/Slave (configuration): One of the communication partners must be a master and the other a slave. The difference is relatively small, the master is allowed to communicate (see below) start, the slave only responds.
- Speed (configuration): The following are 20 (20 kBit/s), 50 (50 kbit/s), 100 (100 kbit/s), 200 (200 kbit/s), 500 (500 jbit/s) and 1000 (1 Mbit/s).
- RS-485 port used (configuration): On the ZX09A there are 11 and 12 for the RS-485 port (configuration): 485 interface as well as 21 and 22 for the SSI
- Number of input variables (configuration), currently 1
- List of input variables (as target) with bit width (default: 16)
- Number of output variables (configuration), currently 1
- Listing of the output variables (as source) with bit width (default: 16)
- Signal (impulse) for errors detected in the package (output)
- Signal (impulse) necessary for resynchronization (output)
- Signal (level) for communication missing (output)

The transmission via asZanderLink then takes place in the order LSB first (for variables > 8 bit) specified output variables (when sending), as does the sorting when receiving. When it comes to the bit width of the output variable, it should be noted that this can be limited compared to the source in order to save transmission capacity.

## Transmission via RS-485 (or M-LVDS)

ZanderLink\_as uses RS-485 as the electrical standard for transmission, but with an optimized frame format for the data. The following framework is provided for ZanderLink\_as:

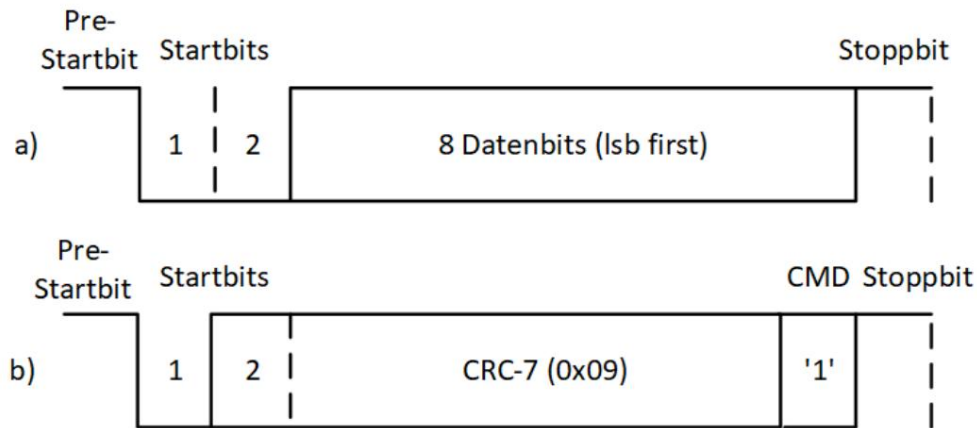


Figure 1 data frame ZanderLink\_as (V1)  
 a) First and following bytes b) Last byte

In contrast to the usual frames, which use a start and 1-2 stop bits, here 2 start bits are defined, which define the start of transmission with the first bit (always '0') and with the second ('0' or '1'), whether the first or subsequent frame (0) or the last frame (1) is initiated. Furthermore, each frame is ended with a stop bit ('1') and - to support synchronization - a pre-start bit ('1') is inserted before each byte.

For your understanding, the transmission via ZanderLink\_as is described. ZanderLink\_as version 1 is defined for a point-to-point connection in which one of the participants is defined as master and the other as slave. The only difference between master and slave in the asynchronous variant is the initiation of communication, which originates from the master. The master sends its packet, the slave responds with minimal delay, then the master again etc. To ensure this, the recipient must be able to detect the end of the packet (or wait for a timeout).

The frames are transmitted in a fixed time sequence, i.e. after the end of the first frame, the second frame (i.e. the other participant's transmission) begins immediately, etc. The retransmission of the start bits is in principle obsolete, but can be used for re-synchronization.

The last frame must be recognizable to avoid the timeout, hence the varied 2nd start bit.

The last frame then contains a slot for a CRC-7 to control the transmission and another bit, the command bit (CMD). is being used. The CRC-7 is given by the polynomial  $(x^{73+x} + 1)$  which corresponds to the standard for SD/MMC cards and is identical to the Hamming code (127,120) is (MHD from 3 to 120 bits). Each byte is therefore transmitted in the form of 12 bits.

If no packet is to be sent, for example because a participant only receives data, this participant must send a packet with the last byte (i.e. CRC-7 of the empty field and CMD). If there is no response from the receiver, the "Communication missing" signal is activated after 8 cycles.

### Performance considerations

Assuming a bit rate of 125 kbit/s, which can be easily achieved by dividing the 24 MHz (or even 100 MHz), 8  $\mu$ s are required per bit to be transmitted. There are 12 bits per byte

sent, this results in 24 bits for the frame (two communications without net data) with a duration of 192  $\mu$ s.

Formula for calculating the cycle time (in  $\mu$ s if bit rate in Mbit/s):  $\frac{192}{\text{bit rate}} + 24$

#### Space requirements

The space requirement for a ZanderLink\_as connection (master-slave) was determined to be 25% for the ZX08DO and ZX06AIO (ZX09A/D/E: 15%). The information refers to the LUTs; the usage of registers is significantly lower.