

1.1.5 Error Detection Techniques

-  **Parity (VRC - vertical redundancy check)**
 One bit per character, even or odd; only suitable for character-by-character data transmission as used, for example, in KNX; usually applied to all start-stop transmission methods; often referred to as vertical parity. Parity checks only detect odd bit errors and not the even ones.
-  **Horizontal/longitudinal parity (LRC - longitudinal redundancy check)**
 A check digit is used which contains exactly as many bits as the characters of the transmitted information. The bits of the check digit are derived from the associated bit positions of all characters of the information already transmitted and appended to the actual information in the form of (even or odd) parity bits.
-  **Cross check**
 Combination of vertical and horizontal parity checking. This type of transfer check is capable of correcting single-bit errors and detecting double-bit errors. Example: KNX with even vertical and odd horizontal parity.

Example 1

Running number	Character								Even vertical parity
1	1	0	1	1	1	1	0	0	1
2	0	1	0	1	0	0	0	1	1
3	0	0	0	0	1	0	1	0	0
4	0	(1)	0	0	1	0	0	0	[1]
5	0	0	0	0	0	0	0	1	1
6	1	1	1	0	0	0	0	1	0
7	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	1
Odd horizontal parity	0	[1]	1	1	0	0	0	0	

There is a single-bit error in the 4th character. This error is detected by the vertical parity check, whereas the position of the incorrect bit is recognised by the horizontal parity check. This makes it possible to correct errors.

Example 2

Running number	Character								Even vertical parity
1	1	0	1	1	1	1	0	0	1
2	0	1	0	1	0	0	0	1	1
3	0	0	0	0	1	0	1	0	0
4	0	1 ^{*)}	0	0	0 ^{*)}	0	0	0	1
5	0	0	0	0	0	0	0	1	1
6	1	1	1	0	0	0	0	1	0
7	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	1
Odd horizontal parity	0	1 ^{**))}	1	1	0 ^{**))}	0	0	0	

*) Bit error

**) Bad parity

The 4th character contains a 2-bit error which remains undetected by the vertical parity check but is recognised by the horizontal parity check.

 Cyclical check (CRC - cyclical redundancy check)

With this error detection method, a check digit is generated as a result of an extensive polynomial calculation. The CRC procedure detects even complex errors.

Comparison of the Different Error Detection Techniques

Method	Reduction of undetected bit errors by factor (approx.):
Vertical parity	10^2
Horizontal parity	10^2
Cross check	10^4
Cyclical check	10^5