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Multimedia systems and equipment — Multimedia signal transmission — Dependable line code with error correction

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Multimedia systems and equipment – Multimedia signal transmission – Dependable line code with error correction

Systèmes et équipements multimédias – Transmission de signaux multimédias – Code en ligne fiable avec capacité de correction d'erreurs

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CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviated terms 7
3.1 Terms and definitions 7
3.2 Abbreviated terms 8
4 4b/10b line code 8
4.1 Overview 8
4.2 Embedded clock 9
4.3 DC balance 9
4.4 Error detection and error correction 9
4.5 4b/10b data coding 10
4.6 4b/10b control code coding 10
4.7 4b/10b coding 11
4.8 Decoding and error handling 11
4.8.1 Decoding scheme 11
4.8.2 No error 11
4.8.3 1-bit error 11
4.8.4 2-bit error 11
4.8.5 Over 3-bit errors 11
4.8.6 Decoder 12
Annex A (informative) Characteristics of embedded clock 13
Annex B (informative) Characteristics of DC balance 14
Annex C (informative) An example implementation of a decoder 15
Annex D (informative) Examples of K codes usage 21
Bibliography 22

Figure 1 – Communications among sensor networks and wearable devices 6

Table 1 – The 4b/10b coding table 10
Table A.1 – An example of the length of consecutive 0s or 1s in case of a 1-bit error 13
Table B.1 – An example of the equality of the number of 0s and 1s in a consecutive 10-bit window 14
Table C.1 – An example of decoding in the case of no error 16
Table C.2 – An example of decoding in the case of a 1-bit error 17
Table C.3 – An example of decoding in the case of a 2-bit error 18
Table C.4 – An example of decoding in the case of a 3-bit error 19

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MULTIMEDIA SYSTEMS AND EQUIPMENT – MULTIMEDIA SIGNAL TRANSMISSION – DEPENDABLE LINE CODE WITH ERROR CORRECTION

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INTRODUCTION

This document defines a line code with error correction to ensure dependable communication. Several complex machines, such as IoT devices, wearable devices, sensor networks, robotics, and spacecraft, have a growing demand for distributed processing. In addition, modernizing facilities such as factories, offices, schools, and homes creates a ubiquitous and multimedia computing environment. Unlike conventional PC applications for documentation and Internet applications that exchange texts without time constraints, these types of cooperative computing require reliable real-time responses to physical events occurring in the real world that can be noisy. For distributed nodes to cooperate in real-time, an interconnecting network realizes dependable real-time communication without re-transmission in noisy environments. As a dependable line code with error correction for such reliable real-time communications, the 4b/10b provides an embedded clock, DC (direct current) balance, error detection, and error correction capabilities at a time.

"Real-time" means that the exactness of the system, including computation and communication, depends not only on the result but also on the time taken to achieve the result. In a narrow sense, "real-time" means that the time constraints, including deadlines or periods, are met. A line code is the lowest-level communication protocol on a communication line. Most current line codes have typical functions, including the embedded clock, DC balance, and basic error detection. The 8b/10b line code [1][1] is a major example, which is used for USB 3.0 [2], Serial ATA [3], and PCI Express 2.0 [4]. However, no conventional line code has an error correction capability. In the case of the 8b/10b line code, when one bit of an encoded code (a 10b code) is inverted during communication, the multi bits of the decoded code (the 8b code) are inverted. In other words, when a single-bit error occurs in an encoded 10-bit code, the decoded 8-bit code (a byte) is completely corrupted.

When the decoder detects an error, the corrupted data is generally re-transmitted under an upper-level communication protocol. However, the re-transmission scheme is unsuitable for real-time communication because the WCRT cannot be obtained. Therefore, the forward error correction scheme against the bit error is required for real-time communication. However, even if a one-bit error occurs in the encoded line code, multiple bits of the decoded code are inverted at the receiver, so it is difficult to use a bit-error correction code, such as Hamming code or BCH code, as an error correction code.

To correct an error at the receiver side, it has been necessary to use a block-level error correction code such as RS (Reed Solomon) code in a large block unit at the subsequent stage. In this scheme, error correction can only be performed if all packets are received, and latency becomes long. Therefore, this scheme is also unsuitable for real-time communication. The line code with error correction is desirable for reliable and low-latency real-time communication.

The 4b/10b line code is designed so that the following functions necessary for dependable real-time communication, which could not be performed at a time by conventional line codes, can be achieved by a single line code:

a) embedded clock,

b) DC balance,

c) error detection, and

d) error correction

[1] Numbers in square brackets refer to the Bibliography.

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