Bosch's CAN Bus
Investigation of the Standard

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CONTENT

INTRODUCTION AND BASIC CONCEPTS

- Controller Area Network [1]
- Serial communications protocol/bus system
- Supports distributed realtime control with a very high level of security

PURPOSE AND CONTEXT

- ▶ Created by BOSCH
- ▶ Used in the automotive industry, automation engineering, medical technology, aerospace engineering
- ▶ Connecting automotive electronics, engine control units, sensors, anti-skid-systems
- ▶ High speed networks to low cost multiplex wiring

RELATED STANDARDS

- standardized after ISO 11898
- ISO 11898-2 (Highspeed-CAN) - related
- ISISO 11898-3 (Lowspeed-CAN)- related
- Not compatible with each other

MESSAGE TRANSFER AND VALIDATION – 1

Overview:

- ▶ Information is sent in fixed format messages of different but limited lengths
- ▶ When free, any connected unit may send messages over the bus
- ▶ The content of the message is named by an identifier

MESSAGE TRANSFER AND VALIDATION – 2
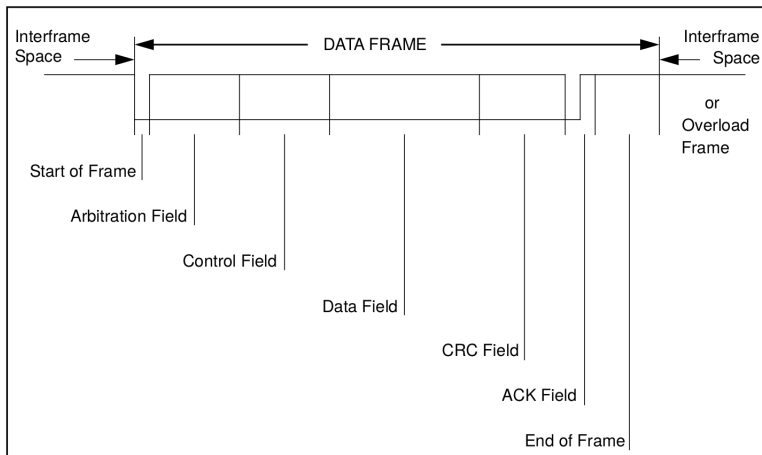
MESSAGE TRANSFER AND VALIDATION – 3

- Multi-master serial bus standard
- All nodes in the network need to be synchronized
- "Dominant" and "recessive" bits

CODING AND ERROR HANDLING – 1

Overview:

- Bit stuffing $\rightarrow$ control mechanism
- Distortions etc. $\rightarrow$ error handling to achieve error tolerance
- 5 different error types (Bit, Stuff, CRC, Form, ACK)

CODING AND ERROR HANDLING – 2

- ▶ Message passing mechanism, no additional structure needed
- ▶ Errors broadcasted when detected
- ▶ Semantics important for correct transmission
- ▶ Drivers: reliability, error limitation
- ▶ Problem: new error types?

FAULT CONFINEMENT

- ▶ Unit can have 3 states and 2 counters
- ▶ Strength: Enables extensibility
- ▶ Drivers: Seperation of concern, reliability, error limitation
- ▶ Problem: More Unit means more errors?

BIT TIMING REQUIREMENTS

- List of definitions and rules
- Strength: short, but includes everything important
- Weaknesses: almost text only, hard to read (structure), like a glossary
- Improvable by usage of more pictures and examples

CAN ENHANCEMENT – 1

Aim: Increase Oscillator Tolerance

Modifications:

- Delay START OF FRAME (SOF) by fully sample INTERMISSION
- Insert (not necessary) OVERLOAD FRAME
- Synchronise on recessive to dominant edges

CAN ENHANCEMENT – 2

Still valid:

- ▶ Hard Sync on SOF
- ▶ No SOF until three recessive Bits on INTERMISSION have been read

What was achieved?

- ▶ Use of ceramic oscillators instead of quartz oscillators
  $\rightarrow$ PRICE!
- ▶ But... all nodes need to work with the enhanced protocol AND only if the most demanding node works with high tolerance

CONCLUSION – STANDARD

- CAN: serial bus system with security features by Bosch
- Developed for automotive industry
- Standalone standard ISO 11898

CONCLUSION – DOCUMENTATION

- Describes CANs technical details
- Strengths: compact, covers standard as a whole
- Weaknesses: very general, very dry
- Improvements: extend by examples, pictures, applications

CONCLUSION – STRUCTURE

- Message-passing pattern with multi-master
- Strict message semantics to avoid errors

CONCLUSION – PROPERTIES AND TRADEOFFS

- Drivers: real time, error handling and limitation, controlled messaging
- Tradeoffs: new error types?, error scaling?

REFERENCES

Robert Bosch GmbH.
CAN Specification.
http://www.bosch-semiconductors.de/media/ubk_
semiconductors/pdf_1/canliteratur/can2spec.pdf.
Last accessed: July 16, 2016.