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Commercial vehicle controller area network (CAN) communication protocol

商用车控制器局域网（CAN）通信协议

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5 Physical Layer Technical Requirements

5.1 General requirements for the physical layer The physical layer should implement the electrical connections between the various ECUs in the network. Typically, a CAN network consists of several networks, including subnets. The network is composed of segments, each segment consisting of several ECUs, but the number of ECUs connected to each segment is limited by the load capacity of the bus lines. Based on the CAN bus electrical parameter definitions, and taking into account the physical medium type of signal transmission, bus capacitance, propagation delay, and CAN transceiver. Due to factors such as the chip's driving capability, the maximum number of ECUs connected to each network segment should not exceed 30.

5.2 Physical Medium Parameter Requirements

5.2.1 Physical Medium In this document, the physical medium used for signal transmission between ECUs should be a shielded twisted pair (STP) or unshielded twisted pair cable. (UTP), where the cables are named CAN_H and CAN_L respectively, usually distinguished by yellow (CAN_H) and green (CAN_L). In a shielded twisted-pair cable, the third wire connecting to the shield terminal is represented by CAN_SHLD. The corresponding pins of the ECU's CAN transceiver should be... Use CAN_H and CAN_L to represent the cable. The cross-sectional area of the cable core should preferably be

0.5 mm^2 or

0.75 mm^2, and the cable parameters should meet the requirements of Table 1. Require.

5.2.2 Network Layout Figures 1-3 illustrate various network cabling topologies with different network termination combinations. (Excluding internal terminating resistors (RL)). An ECU is defined as a Class I ECU, and an ECU containing an internal terminating resistor (RL) is defined as a Class II ECU. (See Figures 1-3 for ECU1, ECU2, and ECU3.) ECU2, ECUn-1, and ECUn are Class I ECUs, while ECUA and ECUB are Class II ECUs. The cabling topology of the network segment should be close to a linear structure to avoid cable signal reflection. In practical use, short branch lines should be used to... The ECU is connected to the main cable. To reduce standing wave effects, the length S of each ECU branch line should not be equal, and ECUs should not be evenly spaced on the main bus. The network layout parameters are shown in Tables 2 and 3. Control the wiring layout to prevent unwanted signals from coupling into the CAN_H and CAN_L wires via mutual inductance and/or capacitance. Combined signals can interfere with communication, reducing or disrupting CAN transmission line transmit and receive speeds during extended cycles. This can be addressed by adjusting the cables in this document, including those for the ECU. Keeping ground and power lines away from high-current devices, high-speed switching loads, and the wires connected to these devices can reduce the risk of coupling. Devices and related wiring that should be avoided include. starter motors, wiper relays, switch signal relays (flashers), high-voltage equipment and their cables, etc. In addition, network and branch cabling should not be too close to sensitive devices (e.g., radios, circuit boards, or other telecommunications equipment), and communication cables should not be placed in close proximity. If cables are bundled or in contact with high-voltage cables or low-voltage signal lines such as high-current switches, a safe distance or cross arrangement should be ensured if this cannot be avoided.

5.2.3 Terminating Resistor A matching terminating resistor RL should be connected to each end of the CAN bus backbone network. The parameters of the terminating resistors should meet the requirements of Tables 2 and 3. If a Class I ECU is used, the terminating resistor should be connected between CAN_H and CAN_L at both ends of the main network, as shown in Figures 4 and 5. Class II ECUs should include either a bus terminating resistor or a separate terminating resistor. If a Class II ECU is used, it should be connected to the backbone network. One or both ends, see Figures 6-

9.Except for nodes acting as bus terminals, other nodes should not be configured with terminating resistors. The separate terminating resistor RL is divided into two well-matched resistors, as shown in Figures 8 and

9.This is to achieve good electromagnetic compatibility (EMC). For performance, the tolerance between the two resistors should not exceed ±1%. The connection between the two resistors should be grounded through a 4.7nF capacitor (CL).

5.3 Electrical Parameter Requirements

5.3.1 Bus Voltage The bus is always in one of two logical states. dominant or recessive. A schematic diagram of its logical states is shown in Figure

10.When the bus is in a recessive state... At that time, the voltage VCAN_H of ECU CAN_H relative to ECU ground and the voltage VCAN_L of CAN_L relative to ECU ground are fixed at a certain value. The difference between the median voltages VCAN_H and VCAN_L is the bus differential voltage Vdiff. On a bus with a matched terminating resistor, the bus differential voltage... The voltage is close to 0V. When the differential voltage exceeds the minimum threshold for the dominant state, the bus is in the dominant state. During arbitration, the dominant state overrides... The recessive state is transmitted as a dominant bit, and the differential voltage value of the dominant state depends on the number of ECUs that are simultaneously in the dominant state.

5.4.3 Fault Tolerance Performance of CAN Bus When all CAN nodes are connected to the CAN bus with matched terminating resistors, ensure that there is no interference in the event of a fault. Normal communication with other nodes on the CAN bus network. The fault tolerance requirements of the CAN bus should meet the requirements in Table 13.

5.4.4 Handling Bus-off Faults at CAN Nodes When a CAN node enters the bus shutdown state, in order to ensure that the CAN node can automatically resume participating in bus communication, but not too quickly... Rapid recovery can affect other nodes on the bus. Therefore, the recovery process for a CAN node bus-off fault should be programmed to control the node. The waiting time for the point to recover from the bus-off state to the active error state. The recovery behavior and recovery time for CAN node bus-off faults should meet user definitions.

6.1 General Requirements for the Data Link Layer

6.1.1 Frame Format This document requires the use of node addresses in the network definition to prevent multiple nodes from using the same CANID field. This document only supports CAN data frame formats CBFF and CEFF. This document further defines the labeling process using the CEFF format. The complete strategy for standardized communication, using the CBFF format, is user-defined. CAN data frames are parsed into different bit fields. The number of bits and parsing are determined in the arbitration and control fields, as well as in the CBFF and CEFF messages. There are some differences. CBFF messages contain 11 identifier bits in the arbitration field, while CEFF messages contain 29 identifier bits in the arbitration field. Sign bit. Table 14 defines the sign bit in the arbitration and control domains of the CAN data frame format.

6.1.2 CEFF Message Format CEFF-based messages contain a single PDU. A PDU consists of seven predefined fields. These fields are determined by information provided by the application layer. These fields include. Priority (P), Extended Data Page (EDP), Data Page (DP), PDU Format (PF), and PDU Details (PS). The target address (or group extension), source address (SA), and data field (Data). These fields will be packaged into one or more CAN data frames and transmitted to other network nodes via the physical medium. Certain parameters Group number definition requires multiple CAN data frames to be sent.

6.1.3 Parameter Group Number (PGN) The Parameter Group Number (PGN) is used to identify which parameter group the data field of a CAN data frame belongs to, and its length is 3 bytes (24 bits). First, the LSB is sent, then the intermediate byte, and finally the MSB. The PGN consists of the following parts.

--- The bit set to 0 (6 bits);

---PS (8-bit). The process of converting the identifier field to PGN is as follows: set the 6 most significant bits of PGN to 0, and copy EDP, DP, and PF. Move to the next 10 digits. If the PF value is less than 240 (F016), set the LSB of the PGN to 0; otherwise, set it to the value of the PS field. Table 15 provides examples of PGNs and their components. This document specifies 8672 PGN calculation formulas that are preferred for use in this document. See formula (1).

6.2 Protocol Data Unit (PDU)

6.2.1 PDU format requirements The application layer and/or network layer provide a series of messages in the form of PDUs. A PDU provides a framework for organizing these messages. The message is crucial for every CAN data frame to be sent. The PDU consists of 7 fields, and its format is shown in Figure

15.The PDU is encapsulated in... One or more CAN data frames are transmitted to other network devices via a physical medium. Each CAN data frame should have one PDU. Some parameter group (PG) definitions require more than 8 data bytes, therefore multiple CAN data frames are needed to send the corresponding data. Transport Protocol (TP) messages are PG messages used to transmit more than 8 data bytes. Some fields in CAN data frames are not defined in the PDU, including SOF, SRR, IDE, RTR, r1, r0, CRC, ACK, and EOF domain. Figure

15 Protocol Data Unit This document defines two PDU formats. PDU1 format (PS=DA) and PDU2 format (PS=GE). Two separate... The PDU format is designed to provide more possible PGN combinations while still enabling communication for specific targets. The PDU1 format allows CAN data frames to be directed to a specific or global target address (DA), with the PS field containing the DA. PDU

1 The format message can be sent as a request or as an unrequested message. The format message of PDU1 is determined by the PF field; when the PF field value is 0~239, the message... The message is in PDU1 format. The PDU1 format should conform to Figure

16.The format of the PDU1 message should conform to Figure 17.

6.2.2 Priority (P) These three bits are used only to optimize message latency during bus transmission. The receiving node should globally mask (ignore) them. Priority of any message. The priority level can be set from a high of 0 (0002) to a low of 7 (1112). The default priority for all control messages is 3 (0112), and other information, dedicated, and