**Brief Report on CAN Bus’s Physical Layer**

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**Introduction**

CAN (Controller Area Network) bus was produced by BOSCH in 1980s which is used to simplify the communication in cars. There are too many ECU in cars, so a safe and high transmission way is needed to simplify wiring and reducing cost. This is a kind of Field Bus, which also means CAN is not point to point communication. Instead, it is two-wire bus. When a node (station) on the CAN bus sends data, it is broadcast to all nodes in the network in the form of a message. For each node, whether or not the data is sent to itself, it is received. There are so many advantages of CAN communication like high transmission speed (1Mbps) and long transmission distance. Therefore, it was gradually used widely in more fields, for instance, aviation industry, industrial control and safety protection.

**The CAN Standard**

There are three layers in CAN communication. They are physical layer, data link layer and application layer. And only application need to define by users. Physical layer and data link layer: ISO (International Standardization Organization) 11898. ISO 11898 defines high speed CAN communication standard with communication rate of 125kps~1Mbps, which belongs to closed-loop bus with length less than 40 meters.

***Physical layer***

**CAN topology**

Can bus includes CAN\_H and CAN\_L two wires. The node is connected to the CAN bus through the CAN controller and the CAN transceiver. The maximum signal transmission rate of high-speed can bus is shown above (ISO 11898-2), 1Mbps and supports the longest distance of 40m. It is a two-wire balanced signaling scheme. The maximum speed of low-speed CAN ((ISO 11898-3) is only 125Kbps, and there is no requirement for terminating resistance. It has fault tolerance, so even if a bus cable is disconnected or short circuited to ground or connected to a backup battery, the signal can continue to be sent.

**图片包含 图示

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Figure1. Topology of speed can bus (high--left, low—right)

As the transmission distance increases, the signal delay also increases. In order to ensure the correct information, the signal rate on the bus should also decrease accordingly. Figure 2 shows the relationship between the recommended distance and frequency.

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Figure2. Relationship between recommended signal rate and distance

**CAN transceivers**

There are CAN transceivers on CAN bus. The function of it is to convert logic signal into differential signal. CAN bus have high and low speed CAN. Also, there are high and low speed transceivers. High speed transceivers’ speed is 1Mbps. And low speed transceiver, also called Fault Tolerance CAN has a speed of 125kbps, which means even one line on the bus is failed, the bus can also communicate. When there has differential signal, the bus can transmit. From voltage difference between two differential signal lines, logic is obtained. And the logic figure is shown in Figure 3. Logic 0 is dominant level, otherwise logic 1 is invisible level.

图表, 折线图

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Figure3. Logic diagram (high--left, low—right)

Comparing and analyzing the logic of Figure 3, it can be found that the dominant bit can cover the recessive bit. The bus is in recessive state only if all nodes send recessive bits. This is the "wired-AND" mechanism of the CAN bus, meaning dominant first.

**References**

[1] HPL, Steve Corrigan. "Introduction to the controller area network (CAN)." *Application Report SLOA101* (2002): 1-17.