Controller Area Network (CAN) and QFSAE

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1 CAN Bus Protocol

1.1 Background

Controller Area Network (CAN) is a communications protocol that is standard for electronics in the automotive industry. The protocol was introduced by the Society of Automotive engineers (SAE) in 1986. CAN is primarily used for communication between different electronics systems in different locations on the car. For instance, sensor systems on the back of vehicle would be able to read data from the Engine Control Unit (ECU). In the case of the team's car, the ECU is the primary CAN device that other systems communicate with. The ECU provides a variety of metrics about the engine such as RPM, throttle position, ignition angle and many more. These metrics are read from the ECU over CAN by using their CAN ID. Each message must have a unique ID from the IDs in use by other devices on the car. It is also important to note that only one message can be on a CAN bus at a time. Messages with more "dominant" IDs will take precedence on the bus. As a result, there must be careful consideration when selecting an ID for a certain message depending on its priority overall.

1.2 Data Transmission and Addressing

CAN is two wire half-duplex serial based communication protocol. Half duplex means that the CAN bus can only be used to send or receive messages in an alternating fashion and not at the same time as with full-duplex protocols. CAN messages consist of an identifier (CAN ID) and a data frame. There are several standards for the size of the message frames. The ECU on the QFSAE car implements the Society of Automotive Engineers (SAE) J1939 standard. This standard uses 29 bit message identifiers and 64 bit data frames. Since CAN is half-duplex, only one message can be on the bus at a time. However, CAN can still be used to create large networks of CAN devices despite this through its implementation of a priority bus. CAN defines "dominant" and "recessive" bits where logical 0 is dominant. This allows to CAN to resolve conflicts on the bus. The table below summarizes this process.

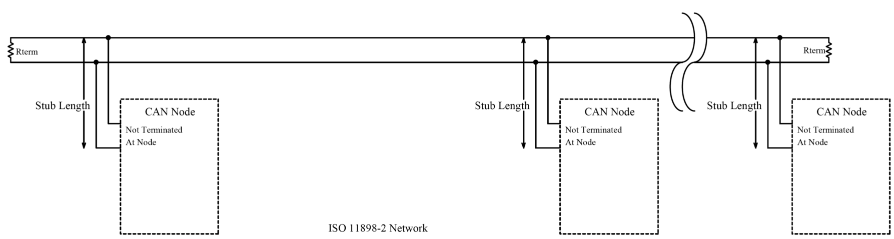
	CAN ID Bits				
	Start Bit	3	2	1	0
Node 3	0	0	0	0	1
Node 4	0	0	1	Stopped Transmitting	N/A
CAN Bus Data	0	0	0	0	1

Table 1: Demonstrating how CAN chooses the most "dominant" ID on the bus in the case of a conflict between messages.

As a result of 0 being the dominant bit on the bus it is the smallest CAN IDs that have the highest priority on the bus. This property of the bus must be considered when selecting CAN IDs for custom messages outside of those broadcast by the ECU. For example, a message indicating to the dash that a gear shift happened is likely of a higher priority than updating the RPM.

1.3 Wiring

CAN consists of a two wire interface where the first two nodes connected to one another should have two 120Ω terminating resistors connected on either end of the bus as shown in the figure below.



In the case of the Formula car, The ECU has a terminating resistor and so does the Dash (CONFIRM W LOGAN). Thus, additional CAN peripherals should omit the terminating resistor to keep the bus functioning properly.