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CAN FD circuit board reference design

Analog Devices (AD) provides printed circuit boards (PCB) and components for development of CAN FD based applications. This article shows details and evaluation of a CAN FD circuit board.

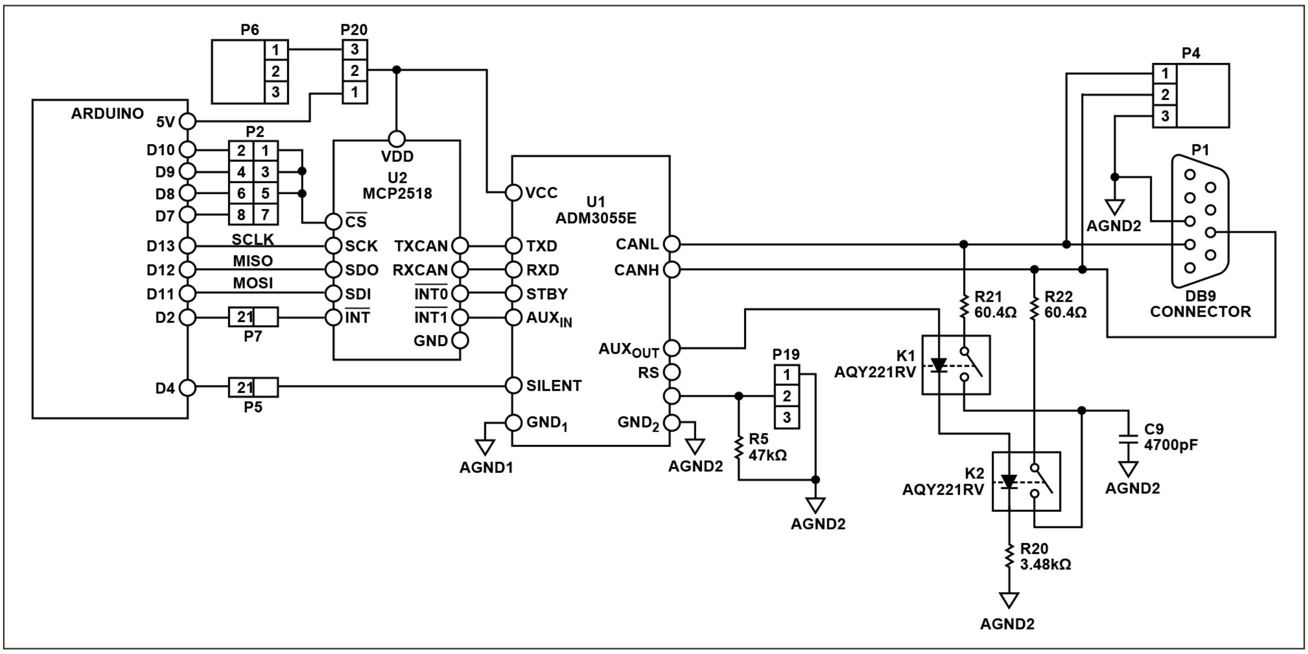

Figure 1: Simplified schematic of EVAL-ADM3055E-ARDZ (Source: AD)

The complete article is published in the September issue of the CAN Newsletter magazine 2021. This is just an excerpt.

CN-0401 circuit evaluation board (EVAL-ADM3055E- ARDZ) is an Arduino Uno compatible isolated CAN FD communications port. It offers a possibility to add CAN FD communication to new and existing designs. The described evaluation procedure of the CN-0401 is performed using the Arduino-based development board (EVAL-ADICUP3029).

Circuit function

The circuit (Figure 1) shows the CN-0401 Arduino Uno form-factor platform connected via an existing serial peripheral interface (SPI) to the standalone MCP2518FD controller from Microchip and the ADM3055E CAN FD transceiver from Analog Devices. According to the manufacturers, this circuit enables CAN FD bit-rates of up to 8 Mbit/s. The CAN FD controller can operate in the Classical CAN or CAN FD mode. It is tolerant to CAN FD frames when operating in the Classical CAN mode.

The transceiver provides integrated signal and power reinforced isolation. The integrated DC-to-DC converter draws power from the logic side to power the CAN channels and the transceiver. Thus, no external power on the CAN lines is required. The EMC-robust (electromagnetic compatibility) transceiver has a common-mode range of ±25 V_{DC}, which exceeds the corresponding requirement given in ISO 11898-2:2016. It also offers a high tolerance to localized ground potential differences when receiving CAN frames. Integrated ESD (electrostatic discharge) protection on CAN-High and CAN-Low pins complies with IEC 61000-4-2. Providing a ±40â€'V_{DC} fault protection, the pins can withstand erroneous wiring and short circuits to 24â€'V $_{DC}$ systems.

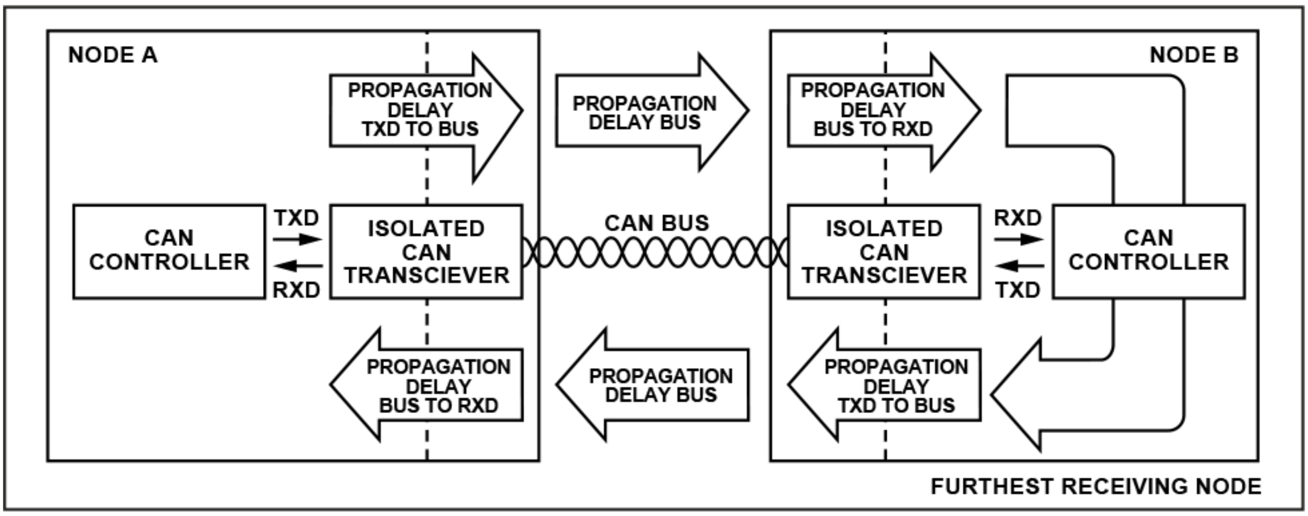

Figure 2: Total signal propagation delay (Source: AD)

Depending on application requirements, CAN connections may be made with different cable types e.g. unshielded twisted-pair or shielded cables. An ideal CAN network daisy chains one node to the next and has terminations at both ends. The CiA 303-1 document gives recommendations for CAN(open) cabling and connector pin assignment e.g. for the 9-pin D-Sub connector, as used in the shown circuit. The switchable termination circuitry connects a 120â€‘Ohm split-termination with a common-mode filtering capacitor between the CAN lines. Switchable termination allows to configure (via software) the termination location when the conditions on the CAN network have changed. Additionally, the circuit can be configured at the runtime to enter a reduced power stand-by mode. In this state, the transceiver responds only on a defined wake-up sequence from a remote node according to ISO 11898-2:2016.

Circuit description

Fast loop delay and bit-rate: During the arbitration phase of a CAN FD frame, the maximum bit-rate is limited by the longest total signal propagation time between two furthest nodes on the network. As illustrated in Figure 2, the signal path starts when the Node A CAN controller begins with the transmission. This signal first passes through the Node A transmitter, then propagates over the cables, then through the receiver of the furthest node B, and finally reaches the furthest CAN controller. As the receiving node B may also transmit during the same bit, the signal propagation delay from Node B to Node A has to be considered as well. The highest propagation delay determines the possible maxi- mum bit-rate of the arbitration phase.

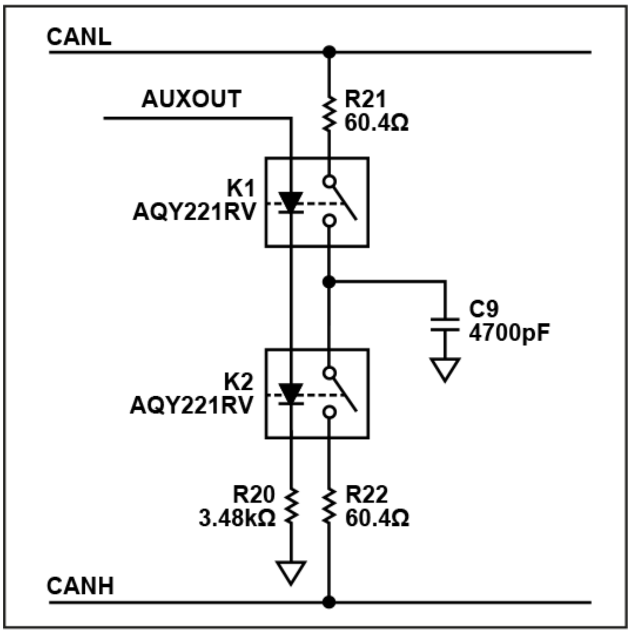

Figure 3: Switchable 120â€‘Ohm termination resistance using Photomos relays controlled via an auxiliary channel (Source: AD)

Propagation delay along the bus lines increases with the cable length and enlarged construction. Cable lengths are typically determined by the nodes' mounting locations. Therefore, this portion of signal propagation delay becomes basically fixed. The propagation delay through the transceiver's receive and transmit circuitry is called loop delay. The ADM3055E transceiver has a maximum loop delay of 150 ns, which is an industry-leading small value, claims AD. This allows the network designer to dedicate less of the bit time to the transceiver. These time savings can contribute to higher arbitration bit-rates, longer bus cables, or longer bus signal settling time for added communication robustness at any arbitration bit-rate.

The maximum bit-rate in the data phase of a CAN FD frame, by contrast, is not determined by the propagation delay, but rather by the network signal quality. Reflections, due to impedance mismatches and cable stubs, are among the factors limiting the data-phase bit-rate in multiple-node networks. Data-phase bit-rates of 2 Mbit/s are a popular conservative choice for multiple-node CAN FD networks. The ADM3055E transceiver can operate at up to 12 Mbit/s in the data phase. This enables fast data transfers for point-to-point connections, and is suited for future bit-rate requirements.

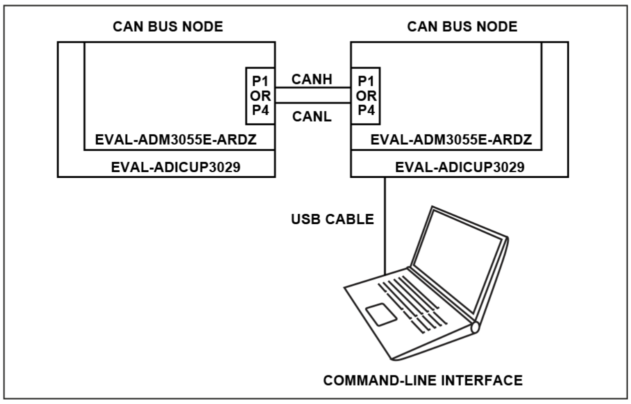

Figure 4: EVAL- ADM3055E-ARDZ functional test block diagram (Source: AD)

Standby mode and remote wake-up: The CAN FD controller and the CAN FD transceiver can be set to the standby mode with commands issued by the development platform over the SPI bus. On receipt of the standby command, CAN FD controller sets itself and the transceiver to the standby mode. Here, the transmit functionality of the transceiver is disabled and its output is set to a high-impedance state. The transceiver can only be taken out of the standby mode by the local CAN FD controller. However, the transceiver responds to the remote wake-up calls made by other nodes. The remote wake-up pattern is defined in ISO11898-2:2016. It can be sent in the arbitration field or in the data field of a CAN FD frame and has to meet the timing requirements of the transceiver. When the remote wake-up pattern is received, the RxD pin of the transceiver toggles in response to the data on the CAN FD network.

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