AND8351

Multiple CAN Bus Network

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APPLICATION NOTE

This application note describes how to build a multiple CAN bus network by using AMIS-42700 or AMIS-42770. A real application is used as an example.

Application Description

Figure 1 gives a simplified representation of the initial application.

The application consists of 18 CAN nodes which are grouped by three nodes. CAN nodes in one group are located near each other and at a distance of 2 m from the Network Connection Board. The different CAN node groups are not necessarily close to each other.

Each CAN node consists of an input and output connection making it easy to connect a CAN node to the CAN bus. Inside the CAN node, the input is connected with the output making one big CAN bus[1].

Correct termination of the network is taken care of inside the Network Connection Board.

Because the CAN node groups are located at a distance of 2 m from the Network Connection Board, the minimum wire length a signal has to cross between two CAN node groups is 4 m. The maximum wire length is 20 m (for instance when there is communication between node 1 and node 18).

When a fault condition occurs on the bus, communication is not possible anymore between CAN nodes.

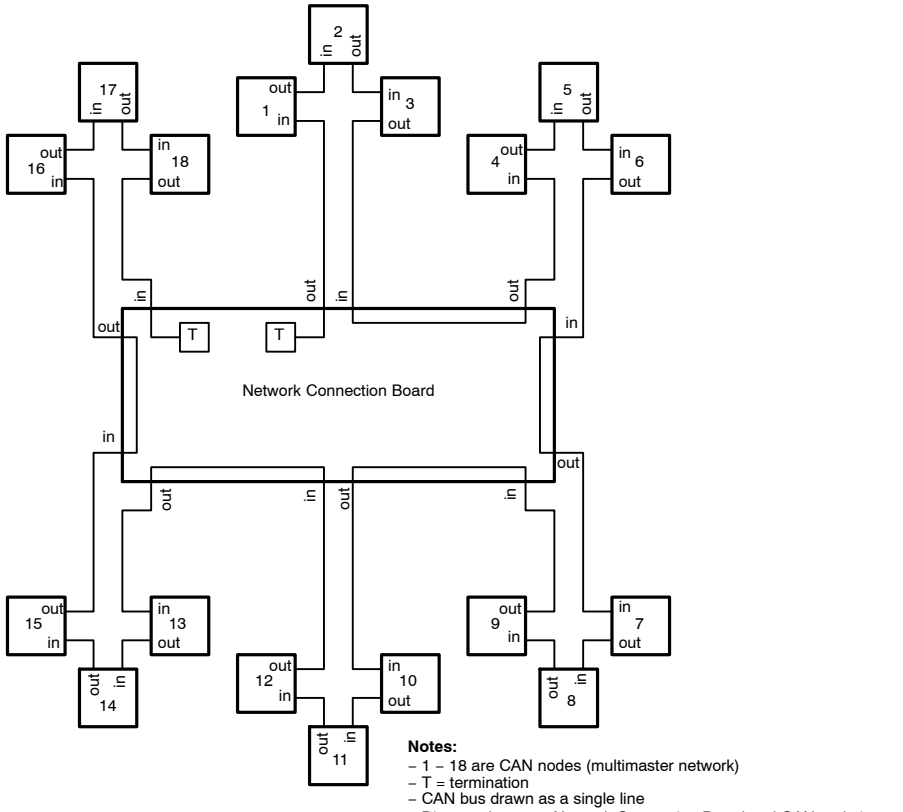

Figure 1. Initial Application

1. Because the input connection of the CAN node is connected with the output connection, input and output can be swapped.

CAN Bus Network

In the above bus topology a total wire length of 24 m is needed which is long considering that only six CAN groups are present, each at a distance of 2 m from the Network Connection Board.

Figure 2 gives a simplified view on how these problems can be solved by using AMIS-42700 or AMIS-42770.

To be consistent with the initial application, the same CAN nodes are used in Figure 2. The distance between the Network Connection Board and the CAN nodes in this example is also 2 m. Notice that now only 12 m of CAN bus cable is needed instead of 24 m.

As can be seen in Figure 2, all CAN node groups are located on a separate bus. Because of this, a CAN bus failure on one CAN bus will not affect the other CAN busses making communication on the other CAN busses still possible (even between CAN busses), unlike the example given in Figure 1.

Notice that only one termination is foreseen at the end of each CAN bus. To avoid reflections on the CAN bus, two terminations of 120 Ω must be foreseen at each end of the CAN bus. Depending on the application, one termination of 60 Ω can also be sufficient. In this application only one resistor is used (for each CAN bus) of 60 Ω in the Network Connection Board (see also Figure 3).

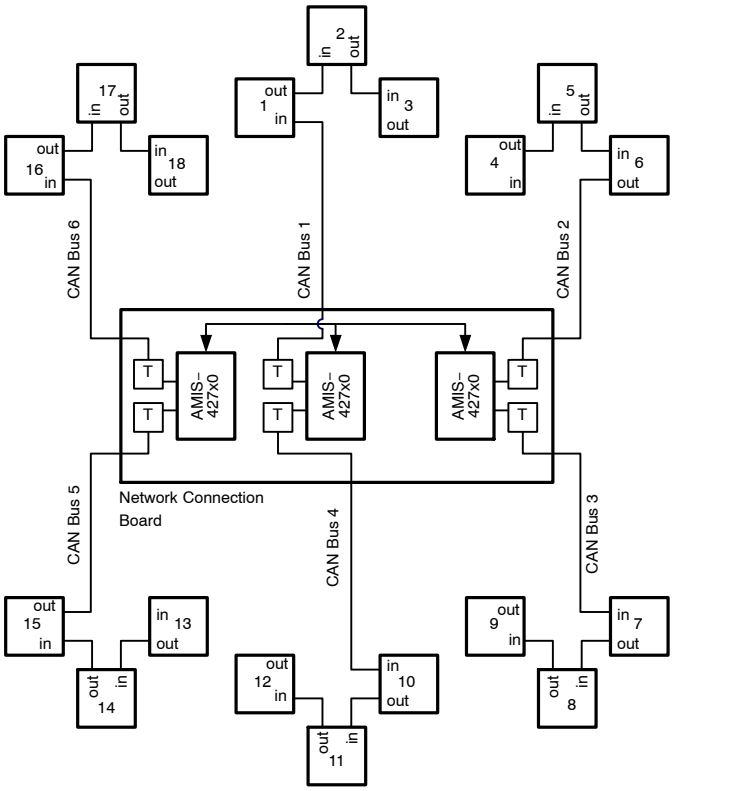

Figure 2. 6 CAN Bus Network

Test set up

A test set up was built similar to Figure 2 with the AMIS−3052x Evaluation Kit used as CAN nodes. This kit is the AMIS−3052x stepper motor driver kit which contains a microcontroller with on−chip CAN controller. The CAN transceiver used on this CAN node is either AMIS−42665 or AMIS−42675. A CAN bus cable of 2 m was used to connect the CAN nodes to the Network Connection Board (5.7 ns/m cable propagation delay at 1 MHz).

Figure 3 gives a more detailed view on the Network Connection Board.

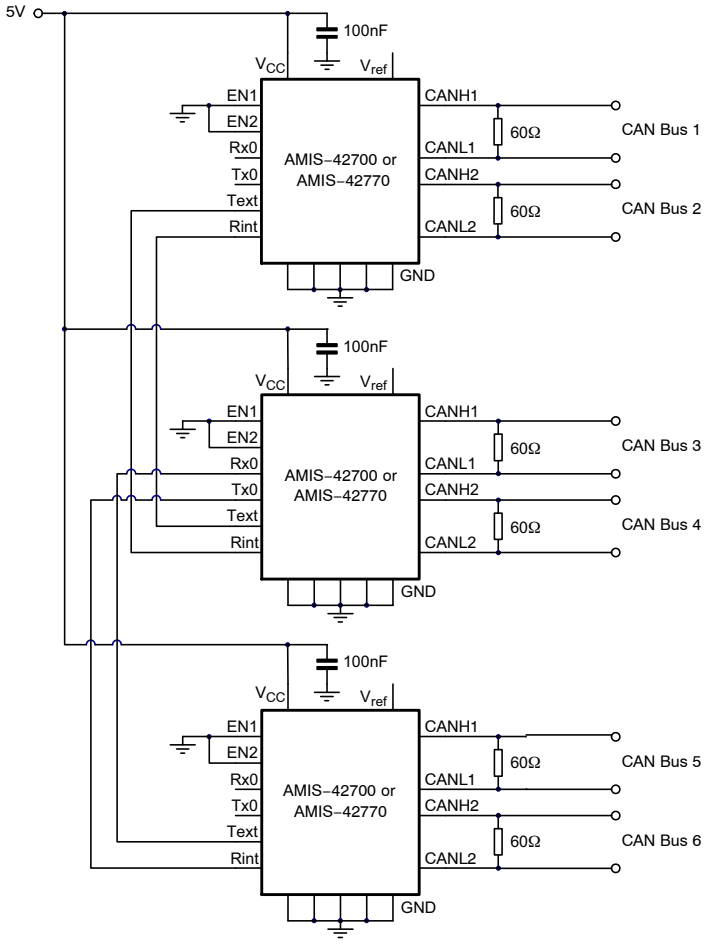

Figure 3. 6 CAN Bus Network Connection Board

As can be seen in Figure 3, only three AMIS−42700 or AMIS−42770 are needed to build a 6 CAN bus network (no additional logic needed). In the test set up, only a 60 Ω termination resistor is placed (see Figure 3). Because of this, no termination is needed on the other end of the CAN bus[2].

Knowing that AMIS-42700/AMIS-42770 introduces bus delay, tests were done to find the upper speed limit.

Limitations

Communication at 1 Mbps is not possible because AMIS−42700/AMIS−42770 adds delay to the signal. Taking Figure 3 as a reference, the added signal delay between CAN bus 1 and CAN bus 2 caused by AMIS−42700/AMIS−42770 will be 245 ns (worst case). Knowing that the cable used in the set up (see Figure 2) has a propagation delay of 5.7 ns/m, one can say that AMIS−42700/AMIS−42770 adds a delay equal to about 43 m of cable. For the CAN nodes it will look like the CAN cable is 47 m long.

The added delay between CAN bus 1 (or 2) and CAN bus 3 (or 4) will be a few nanoseconds more (about 260 ns in total) which is equal to about 45 m of cable. For the CAN nodes it will look like the CAN cable is 49 m long.

In general, the maximum signal delay added by AMIS-42700/AMIS-42770 will be about 260 ns worst case (in this bus topology). Although the signal only has to propagate over 4 m of cable, the added delay by AMIS-42700/AMIS-42770 will make it look like it is actually about 47 m or higher. Knowing that 1 Mbps CAN communication is limited to 40 m bus length, AMIS-42700/AMIS-42770 will introduce too much delay to be able to work at a CAN speed of 1 Mbps (in this bus topology).

During the test, communication up to 500 kbps was possible[3]. A fault condition on one of the CAN busses had no effect on the communication of the other busses.

2. To avoid reflections, two terminations of 120 Ω have to be placed at both ends of the CAN bus. Depending on the application, one termination of 60 Ω at one end can be sufficient.
3. CAN Bit Length = 8TQ, SJW = 1TQ, TSEG1 = 5TQ, TSEG2 = 2TQ

Multiple CAN Bus Network

AMIS−42700/AMIS−42770 makes it possible to build a multiple CAN bus network. Where Figure 3 demonstrates how to build a 6 CAN−bus network, an 8 CAN−bus network can easily be built by adding one additional AMIS−42700/AMIS42770 (see Figure 4). Building a 10 CAN bus network or a 12 CAN bus network is also possible by adding additional AMIS−42700/AMIS−42770. Connect the Tx0 signal with the Rint signal of the next AMIS−42700/AMIS−42770 and also the Rx0 signal with the Text signal.

Whether 500 kbps will still be obtainable depends on the network; the more AMIS-42700/AMIS-42770 are added, the more signal delay will be introduced between a CAN bus of the first AMIS-42700/AMIS-42770 and a CAN bus of the last AMIS-42700/AMIS-42770. This has to be kept in mind.

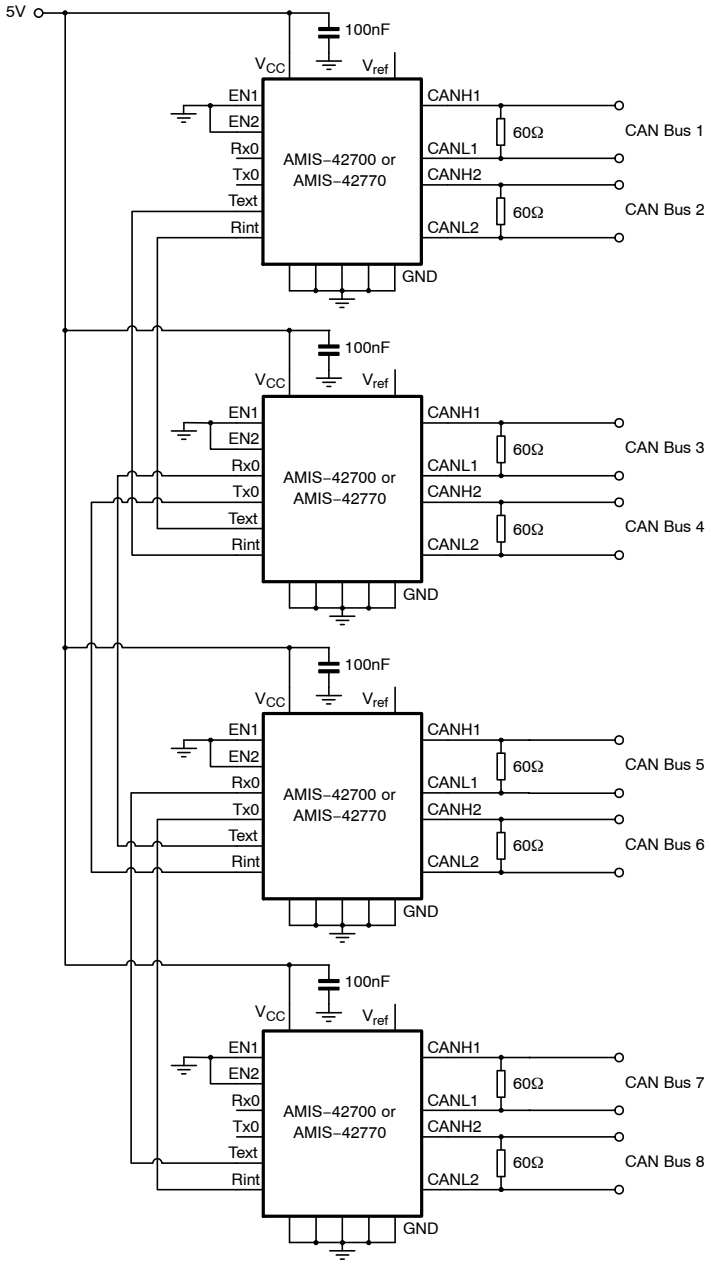

Figure 4. 8 CAN Bus Network

Higher Speed

As mentioned previously, 1 Mbps cannot be obtained (in this bus topology). Taking the original application (Figure 1), the maximum bus length is 20 m. Although never tested, 1 Mbps should be possible in this application.

The fact that 1 Mbps can not be obtained does not mean that the CAN baud rate of the multiple CAN bus system (e.g. Figure 2) will always be lower than the original application. Assuming that, in the original application, the CAN node

groups are located at a distance of 20 m (instead of 2 m), the worst case bus length will be 200 m.

Although never actually tested, the assumed maximum CAN baud rate will be 250 kbps. Taking the 6 CAN bus network (Figure 2), the maximum bus length will be 40 m. Knowing that the Network Connection Board will add signal delay similar to about 50 m of cable (worst case), the total signal delay (in one direction) will be less than 100 m of cable. At this cable length, 500 kbps CAN baud rate should be possible.

Central CAN Nodes

In Figure 4, no CAN node is included in the Network Connection Board. Adding a CAN node can be done by connecting it to one of the CAN busses. An easier and less expensive way is displayed in next figure.

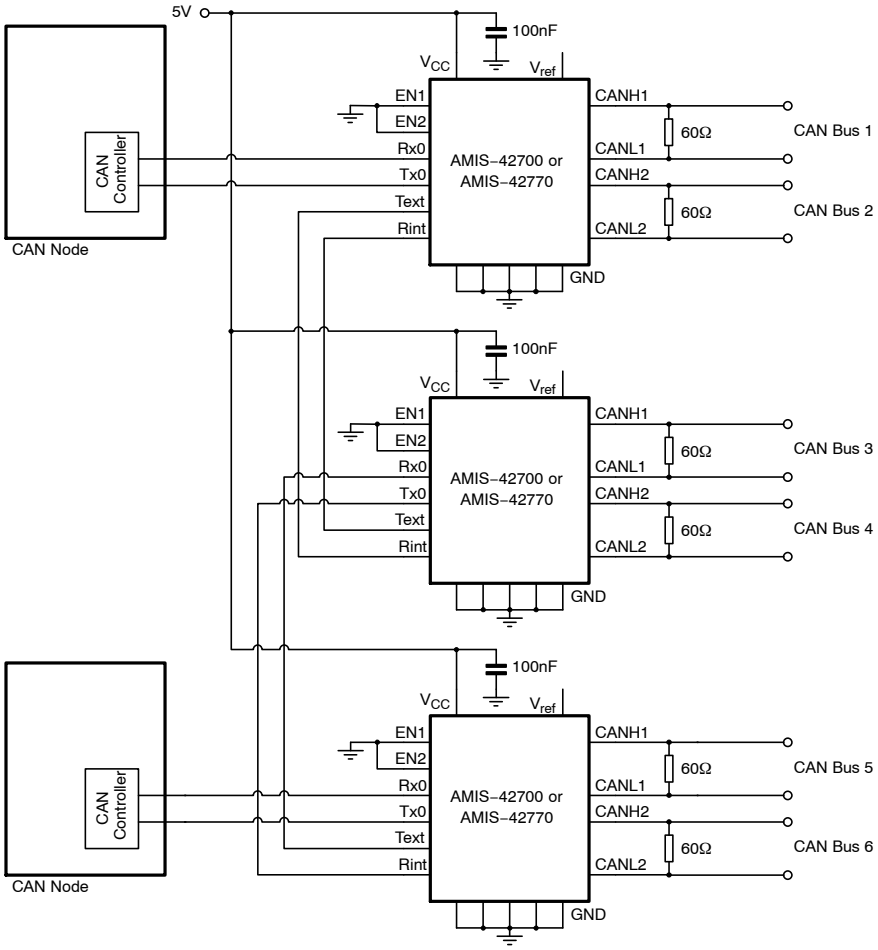

Figure 5. Adding CAN Nodes in Network Connection Board

By connecting the two CAN nodes as in Figure 5, two CAN transceivers can be saved, making the application less expensive.

Conclusion

By using AMIS-42700/AMIS-42770, a multiple CAN bus network can be built in a very easy and inexpensive way. Additionally, the multiple CAN bus network will make the complete network more fault tolerant (safe) and also could save several meters of wire. Whether the same CAN baud rate can be obtained as in the original application depends on the bus topology.

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