STW Technic, LP

Mobile Controllers and Measurement Technology

Application Note

AN2001: Troubleshooting CANbus

Topics

- Common Problems
- Solutions and Troubleshooting
- Errors in the CAN Bus

1 Introduction

This application note is designed to identify many of the common problems in CAN bus systems (section 2), offer remedies to these problems (section 3), and provide analysis of CAN bus errors (section 4).

2 Common Problems

Common problems in CAN bus systems include:

- Fewer than two devices on the CAN bus
- The CAN Bus is not connected
- Improper termination
- CAN+ and CAN- are swapped
- Mismatched bit rate settings
- Pin Outs for CAN are connected incorrectly
- Shorted CAN Bus

2.1 Fewer Than Two Devices on the Bus

Often times the CAN Bus is set up correctly and is running as it should, but there is nothing on the CAN bus. Because every CAN frame requires an acknowledgment from other nodes, this creates the appearance that the bus is not working correctly.

2.2 The CAN Bus is Not Connected

Sometimes the CAN bus is not connected at all, creating an open circuit. This is usually caused by either a disconnection at one end or a problem with the cable.

2.3 Improper Termination

The CAN bus must be properly terminated in order for the CAN bus to correctly work. In order to have a properly terminated CAN bus, there must be a 120Ω resistor at each end of the bus. If the CAN bus is not properly terminated the electrical signals can reflect off

Pioneering New Technologies

the end of the cable, essentially bouncing off the end of the cable. These reflections are can interfere with the CAN bus as the receiver circuits cannot differentiate between the original message and the echo. This can also lead to the CAN device missing new messages that sent during a reflection. Matching termination resistors completely eliminate the reflections.

2.4 CAN+ and CAN- are Connected Incorrectly

Many times a CAN bus error is due to the CAN+ and CAN- connections being backwards or disconnected. Be sure that the CAN+ and CAN- are connected appropriately. This is a common occurrence in many new installations.

2.5 Pin Outs for CAN are Connected Incorrectly

The pin outs for CAN may be connected incorrectly. Be sure to check that the wires from the pins designated for CAN are being connected to the correct locations. A table of the pin designations can be found in your controller's help file.

2.6 Incorrect Bit Rate Settings

Incorrect or inconsistent bit rate settings will cause problems in your CAN bus. The bit rate of all devices on the bus must match, or error frames will prevent any device from working. This behavior is by design, to ensure that no device can partially fail.

2.7 Shorted CAN Bus

Sometimes there is a short in the CAN bus. This generally occurs when there is a bad wire or connection in your CAN setup.

3 Solutions and Troubleshooting

3.1 Nothing on the CAN Bus

If your CAN bus seems that it is not working correctly, and all your connections are correct, then your CAN bus may very well be working correctly and there is just nothing being set over the CAN bus. To check this, you can open the CAN monitor and send messages over that and monitor your CAN bus, or you can set-up a program or device to send messages over your CAN bus.

3.2 The CAN Bus is Not Connected

Your CAN bus may not be connected properly, or at all. Be sure to check and make sure your cables are plugged in with solid connections. If you are still experiencing problems, then you may want to check the actual cables themselves. Be sure that the wires make a solid connection and and are routed to the correct locations. There are pin diagrams for each controller in their help files. You can use a multimeter to test for solid connections.

3.3 Improper Termination

Be sure to place proper resistance (a 120Ω resistor at each end of the CAN bus) on your bus. You can use a

multimeter to check that your CAN bus has been terminated correctly.

3.4 CAN+ and CAN- are Connected Incorrectly

The CAN+ and CAN- connections may be connected incorrectly, backwards, or not at all. Be sure that your CAN+ and CAN- are connected and that they are connected to their appropriate connections.

3.5 Pin Outs for CAN are Connected Incorrectly

Use the help file for your controller to find the pin designations. There will be pins that are marked for CAN. Be sure that those pins are being wired to the appropriate locations in your system. See sections 3.2 and 3.4 for additional information on CAN wiring solutions.

3.6 Incorrect Bit Rate Settings

If the bit rate settings do not match or are incorrect then your CAN bus will not function properly. Check to be sure that your CAN bus bit rate, and your controller bit rates match and that there is a connection between the two. If you are using the PCAN USB adapter, you can monitor this with PcanView and PcanStat.

3.7 Shorted CAN Bus

If there is a short in the CAN bus, then there is likely a bad wire or connection somewhere in your setup. Use a multimeter to test for bad wires and/or connections. If you find a bad connection or wire, repair it and test your CAN bus again.

3.8 Additional Troubleshooting

If you are still encountering problems with your CAN bus, check additional application notes and help files for information regarding setup and troubleshooting. Finally, if you still can not resolve your problems, please contact STW Technic, LP.

4 Errors in the CAN Bus

The following section addresses errors that happen within the CAN bus. There are two types of error counters that check for different types of errors. These counters are implemented at a hardware level, and are fully automatic from the perspective of the application software. Every time the CAN hardware sees an error, the counter is incremented. Once the error counter has reached a threshold, there will be an error frame transmitted on the bus. The error frame cannot be received by an application, but each CAN device can access a status flag set by the firmware. On a PC, the error message can be observed on the status bar in PcanView (Figure 1), and can assist in identifying problems within the CAN bus.

The two types of errors include:

- Overruns
    - Overruns occur when the hardware interrupts are no longer handled because the CAN controller is receiving too many messages.
    - A possible cause of an Overrun error is that the internal work rate of the application is not fast enough to handle all the messages.

- QXmtFulls
  - QXmtFulls occur when the driver is not able to send all of the messages to the CAN controller in time. The error appears at a delay because it can only happen when the sending buffer of the controller is completely full.
  - Some possible causes of a QXmtFull error can be a low Baud rate, high bus load, or an error on the bus. This error occurs with delay, since the sending buffer has to be filled totally.

When the error message count reaches certain levels an error will occur. These errors are:

- BUSLIGHT
- BUSHEAVY
- BUSOFF
- OVERRUN

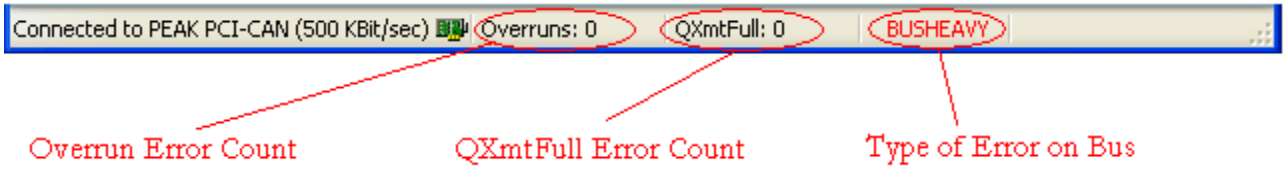

Figure 1

4.1 BUSLIGHT

The BUSLIGHT error occurs when there have been more than 96 errors according to the amount of messages that were sent or received. This can indicate a transient failure, or an impending BUSHEAVY error.

4.2 BUSHEAVY

The BUSHEAVY error occurs when more than 127 errors according to the amount of message that were sent or received. The most common causes are a connection problem or mismatched baud rates.

4.3 BUSOFF

The BUSOFF status indicates a heavy and continuous error is existing on the bus. This is when 255 errors have been reached. When this error occurs, the controller is reset by the driver and may be a result of a possible short on the bus. This error can also indicate a BUS with a single functioning device. If the device tries to transmit, it will not receive any acknowledgment, and therefore cannot send the message. Essentially, the bus appears to be off.

4.4 OVERRUN

The OVERRUN error occurs when the internal work rate of the application is not fast enough to handle all the messages that are being received and written into the buffer by the driver. This error is specific to the PCAN driver software, but a similar concept applies to the software of any CAN device.

5 Summary

Most of the problems that occur with the CAN bus occur when there is a bad or incorrect connection. To avoid CAN bus problems, be sure to check all connections and wires. Use a multimeter to test for these bad connections or wires. Use the help files for your designated controller to be sure that the controller pins are being routed correctly to the right location.

6 History

Revision	Date	Author	Comments
1	05/27/2008	J. Yore	Created.
2	8/21/2008	A. Jansen	Internal changes.

STW Technic, LP
3000 Northwoods Pkwy.
Suite 260
Norcross, GA 30071

Phone: (770) 242-1002
Fax: (770) 242-1006

About Us

STW Technic is the premier manufacturer of mobile electronics for on- and off-highway vehicles. A wholly owned subsidiary of STW GmbH, Germany, STW Technic is located in Atlanta, GA.

STW was founded in 1985, and has since provided electronic controls for world wide market leaders of agriculture, construction, municipal and military vehicles as well as many other kinds of mobile equipment. In 2007, STW will sell about 60,000 freely programmable controllers (more than any other manufacturer) in more than 200 different variations into these markets.

Due to highly demanding safety requirements for many applications in mobile equipment (i.e. cranes, fire equipment, etc.), many of STW's controllers are certified based on IEC 61508 (SIL2) and EN 954-1 (Cat. 3) standards. STW is also ISO 9001 certified, and further certification includes ISO/TS 16949:2002, the quality standard of the automotive industry.

In addition to the controller product range, STW offers displays, joysticks, sensors, and other electronic components to provide a complete electronic system for vehicles.

STW is also a supplier of robust pressure and force measurement sensors with thin-film, ceramic or silicon technology. STW specializes in applications in extreme conditions, which includes pressures up to 3,000 bar (44,000 psi) and media temperatures up to 300 °C (540 °F).

STW is a reliable partner, who not only supplies controllers, but can also train you to develop your own applications, write the applications for you, maintain inventory for you, and do everything a control engineering department would do.