

10 March 2009

## CONSTRUCTION

Subject	<b>GCS900 Grade Control System: CAN (Controller Area Network) Troubleshooting</b>
Product(s)	GCS900 Grade Control System, versions 6.xx, 10.xx, and 11.xx, MS980 GPS receivers, MS990 smart antennas

Question	<b>How do I troubleshoot the GCS CAN network?</b>
Answer	<p><b>Introduction</b></p> <p>The GCS900 system uses an information communication network called the Controller Area Network (CAN). This is a very robust serial communication system that operates at 250 Kbaud and is currently used in construction equipment, agriculture equipment, heavy-duty trucks, buses, automobiles, and factory automation.</p> <p>The network consists of two wires, that run through the entire system from end to end and which are compared with each other to determine the message, and which runs. It can be described as a super-highway in which traffic enters and exits the highway at every device.</p> <p>The CAN network can be used for troubleshooting. Due to the nature of the messages on the network, it is virtually impossible for a message to be “sort of right”. It is either all there or is not present at all. This provides you with a robust, low cost, high performance, low latency network.</p> <p>The CAN network uses the SAE J1939 Communication protocol.</p> <p>The CAN bus must run on a twisted pair of wires of the correct impedance. You must be aware of the limits and rules that govern the system: ensure that the main harness is not too long, and that the individual drops are not too long. Do not cut and splice the harness unless you are aware of these limits and rules.</p> <p><b>The CAN Bus</b></p> <p>The GCS900 system uses the CAN to communicate with all devices in the system, with the exception of lightbars and third party radios.</p> <p>The traffic is message-based not address-based, so all devices hear and verify all transmissions from all other devices. The CAN hardware filters the information so that each device reacts only to the message it is interested in.</p> <p>You can add or remove devices from the CAN bus without affecting any other devices.</p> <p>The harness consists of two wires—CAN High and CAN Low.</p> <ul style="list-style-type: none"> <li>• The wires must be terminated to minimize the reflected waves, which can corrupt the main signal. To do this, a resistor (the CAN terminator) is connected at both ends.</li> <li>• The CAN Bus can be up to 40 m long, with drop-off (spurs) that allow devices connected to the Bus to be 3 m long.</li> </ul>

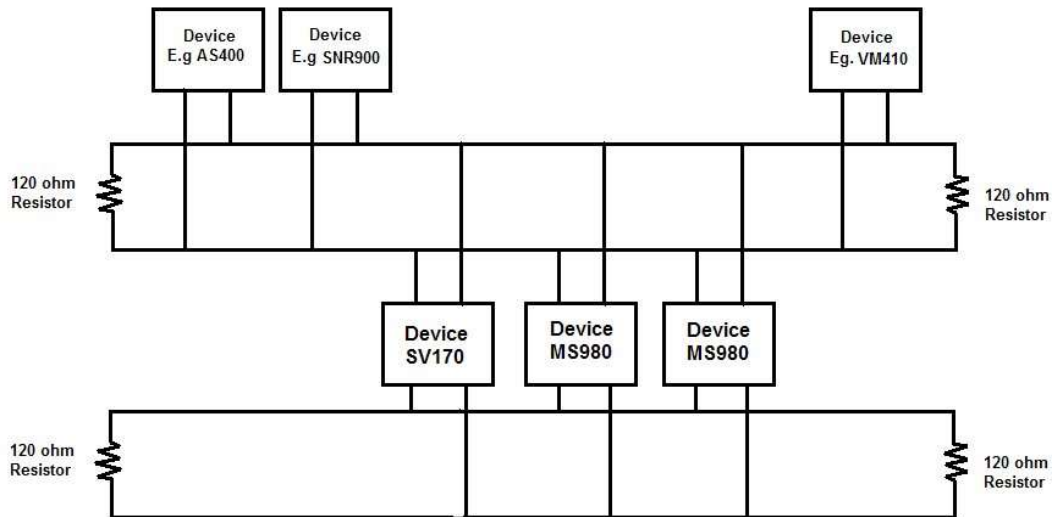
## GCS harness

### Version 6.xx

This harness consists of two separate CAN buses:

- CAN 0: Allows all CAN devices to talk to each other.
- CAN 1: Allows the two GPS receivers to communicate with each other by transmitting CMR signals.

If there are unexpected problems with sensors not being seen, or with intermittent loss of sensors or data, this could be a harness/CAN problem.



### CAN BUS FEATURES

#### Rules

1. Must be CAN terminators at each end of the CAN bus
2. Resistance between CAN High (+) and CAN Low (-) = 60 ohms.
3. CAN Bus length < 40m
4. CAN drop length < 3m.
5. Maximum number of nodes (devices)
6. Can lines usually shielded twisted cable

### Version 10.xx

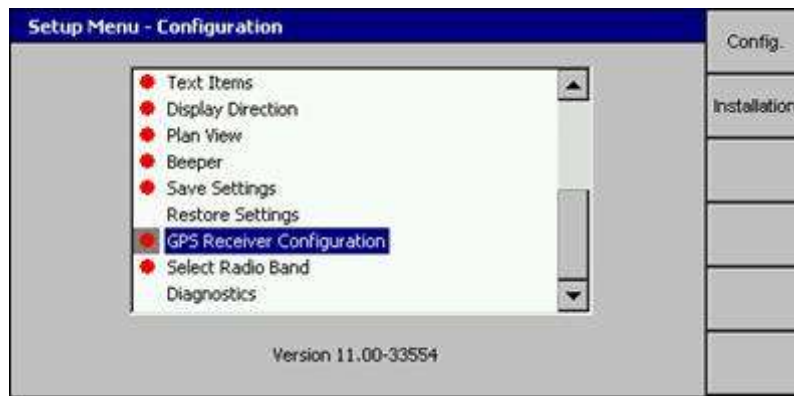
Consists of one CAN bus that is used for all CAN devices and GPS CMR information.

### Version 11.xx

- The CAN0 bus is used for all sensor device communication.
- The CAN1 bus is used for CMR messages transferred from left to right of the MS980 GPS receivers and MS990 smart antennas.
- It is not used for:
  - The John Deere military dozer, JD850JR
  - Caterpillar systems.
- It is re-used in version 11 to make CMR transmission from left to right more efficient.

### CAN version 11.00 - Default override

You can manually set the CAN bus used for the CMR formats in the *GPS Receiver Configuration* dialog.



If you switch CAN1 off, you can transfer all CAN traffic to CAN0.



This option is available on both the AccuGrade and GCS900 grade control systems.

GCS HEX and some Caterpillar ARO machines **do not** have CAN1 wires in the harness.

### Troubleshooting procedure for CAN problems

#### *Diagnostics reports that a sensor is missing*

Diagnostics			
Device	Status	App.	Loader
SV170	Connected	6.00-15	
M5980 - Left	Connected	1.31	1.04
M5980 - Right	Not Found		
VM410 - Lift/Tilt	Connected	1.70	1.70
A5400 - Blade Pit	App. 1.89 required	1.84	1.04
SNR900	Connected	3.12	0.00

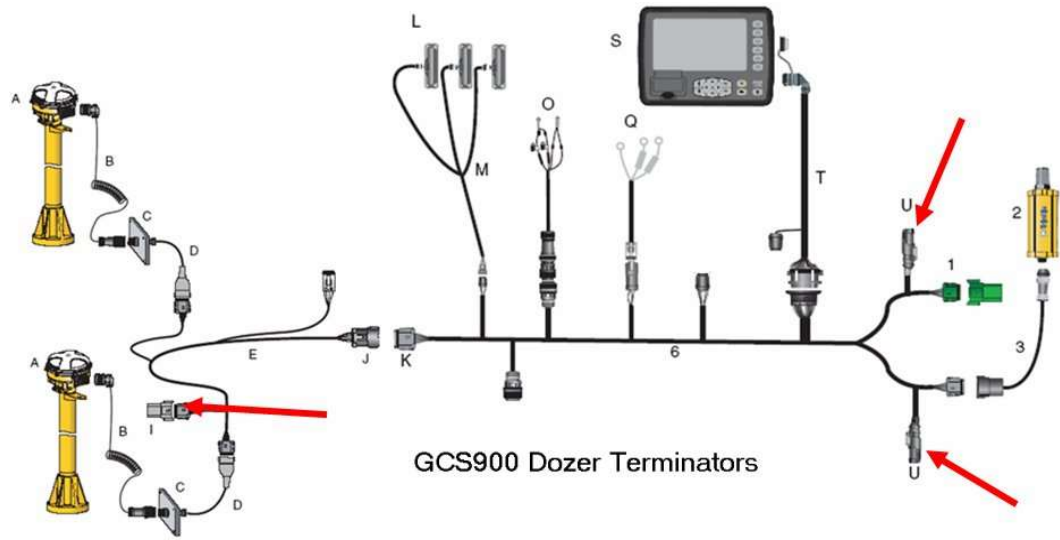
GPS Valves Sensors Recheck

This could be a CAN problem.

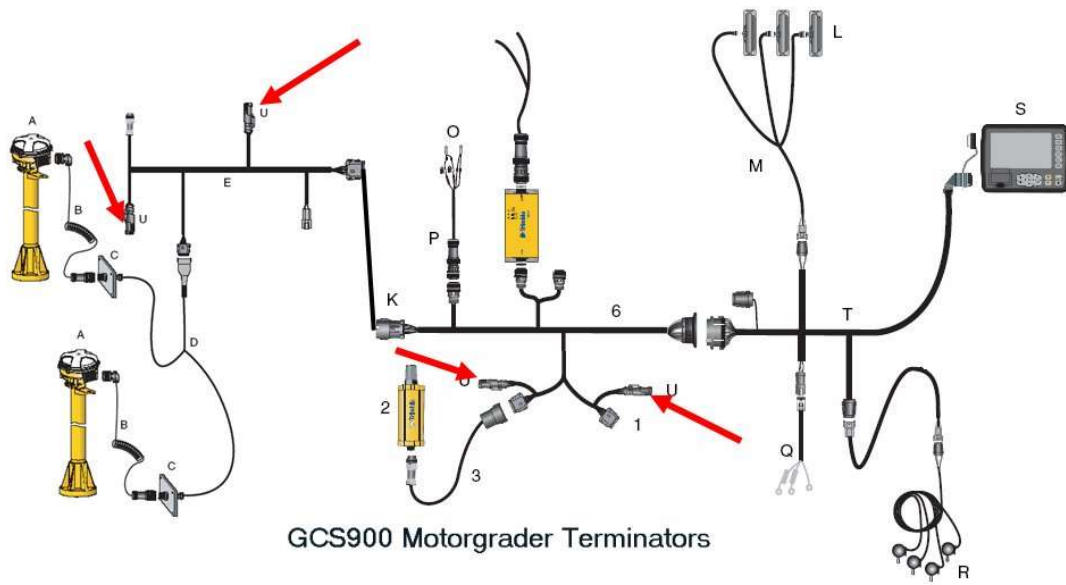
**Equipment required:** Multimeter

Carry out the following tests:

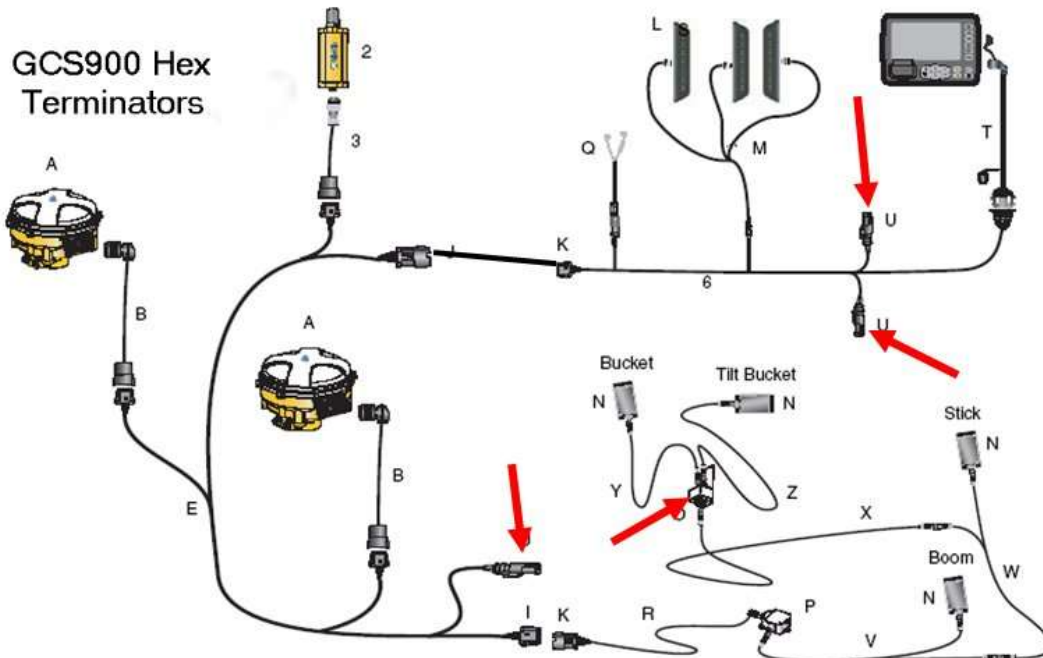
- Check that terminators are present and connected correctly to the harness:



GCS900 Dozer Terminators

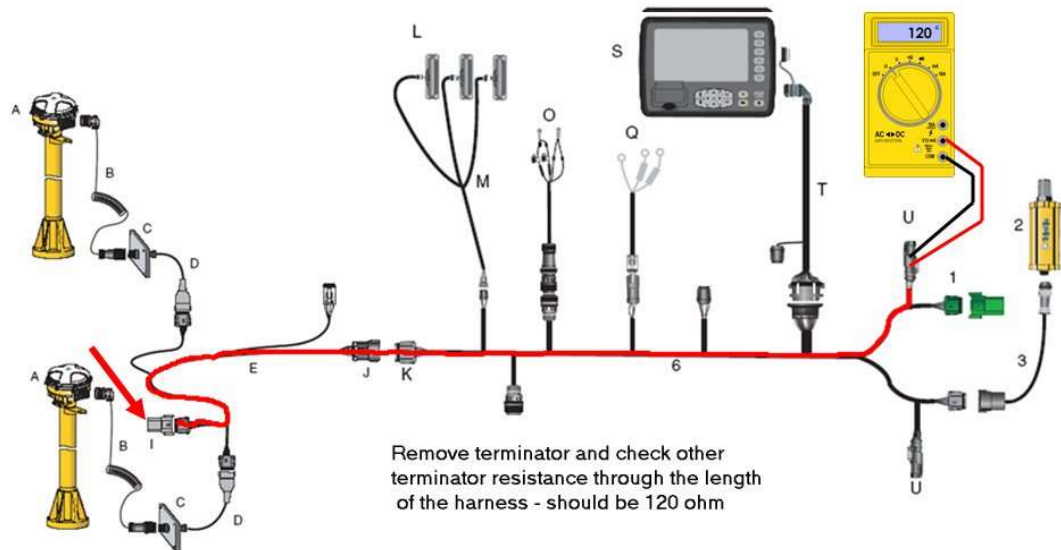


GCS900 Motorgrader Terminators



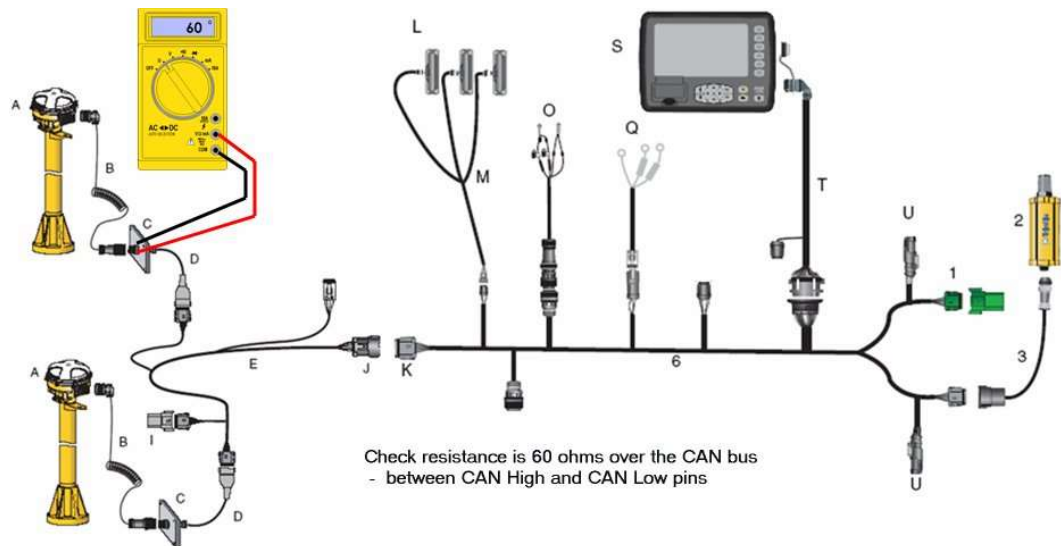
GCS900 Hex Terminators

- Check that the termination resistance is 120 Ohm:

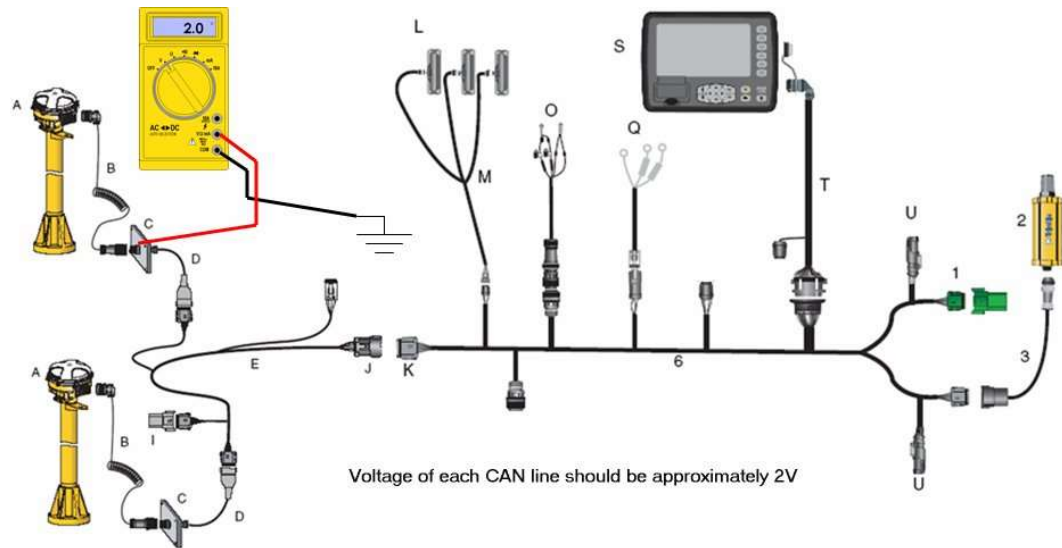


- Check that the resistance is 60 Ohms over the CAN bus, between the CAN High and CAN Low pins.

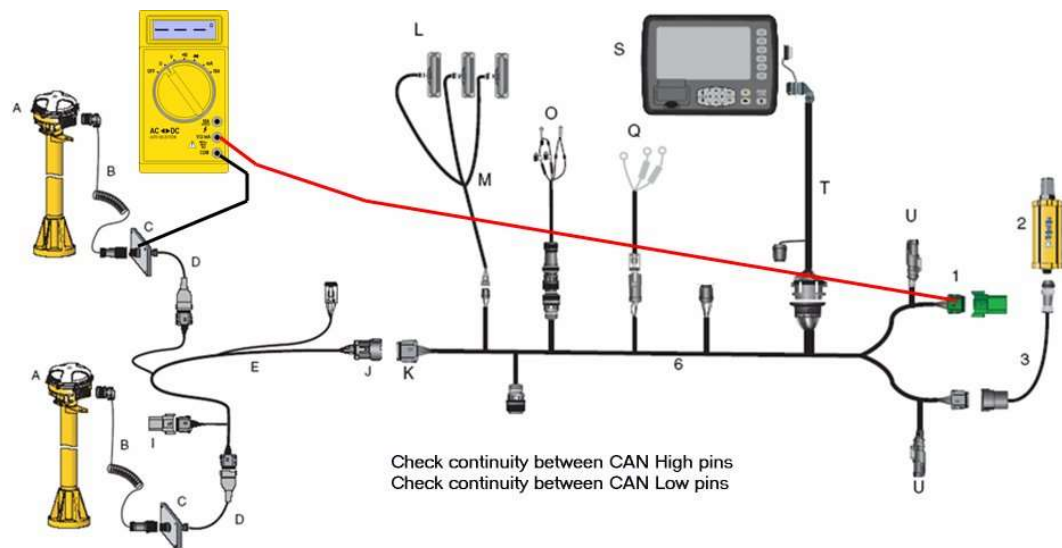
**Note:** Disconnect power before you check resistance.



- Check that the voltage between CAN High and ground is between 2.5 V and 3.5 V.
- Check that the voltage between CAN Low and ground is between 1.5 V and 2.5 V.



- Check continuity between CAN High pins.
- Check continuity between CAN Low pins.



## CAN problems

You may see the following CAN problems:

- CAN lines short to ground:
  - Voltage is around 0 V instead of approximately 2 V.
- CAN lines are shorted together:
  - Resistance at about 0 Ohm.
  - The whole CAN bus can be lost.
- CAN lines are disconnected from a device:
  - The device is not seen in the *Diagnostics* screen.
- CAN lines are shorted to power:
  - CAN terminators became hot.
  - Voltage is around 24 V instead of approximately 2 V.
  - Resistance looks correct (because power is off).
  - Sensors (MS980 on right side) missing from diagnostics.
- CAN lines swapped:
  - Resistance fluctuates, not steady.

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