Bus configuration and bus load in a tractor fertilizer spreader system (LBS by DIN 9684)

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Introduction

Electronics become more and more part of modern agricultural tractors and their equipment. The aim is getting the work faster and exacter done, improving the control, fullfilling higher environmental standards and collecting data and information automaticly. But the full potential of the installed electronic components can only be used if there is a standardized communication. Therefore the standardization of a fieldbus system for mobile use in agriculture was initiated in Germany in 1986 [1]. First prototypes were developed starting in 1991 [2]. In the moment the different manufacturers are testing their parts of the system to introduce them on the market in 1996.
With this new technology a system for spatial variable fertilizer application had to be realized. The functionality, the bus load and the influence of GPS positioning data with different update intervalls to get higher positioning acuracy was investigated.

System and Method

The used system consisted of a tractor (FENDT Favorit 511C with 85 kW) and internal bus system (CAN controller area network), a tractor mounted pneumatic fertilizer spreader (RAUCH AERO 2115) with 15 m working width and a LBS electronic application rate controller, a bus terminal (LH Agro AGRO CONTROL TERMINAL ACT) and the "Landwirtschaftliches BUS-System (LBS)" by DIN 9684, part 2-5, agricultural field bus.
For the investigations an industrial PC (KONTRON IP-Lite PC486) with an CAN-bus analysing and simulation system (VECTOR INFORNATIC "CANalyzer Pro") was used. With additional soft- and hardware it was possible to realize reading the internal tractor bus and the LBS at the same time or akting like an active bus partizipant and analyzing the bus simultaneously.
Measuring the bus load was done while starting and initializing the system till initialization was finished storing all data on the PC. Additional measurements were done during a simulated fertilizer application with variable rates.

The additional bus load resulting by adding GPS data on the bus (four CAN message frames per position) was also measured during simulations. Positioning data update rates from 1 Hz (1000 ms) to 4 Hz (250 ms) were realized.

To guarantee a save and reliable LBS function an average bus load of 40 % was declared as upper limit.

Results

Installation of the system caused only little problems. Difficulties were created by the still not defined physical layer of LBS. Additional problems caused incompatible software of the electronic controll units based on different versions of the standard. Both problems could be solved in discussions with the manufacturers.

All bus loads were measured with a period length of 2 seconds. They varied in a wide range (figure 1). The highest bus load was measured during initializing (I.), with about 26 %. The transmission of the terminal masks caused this peak.

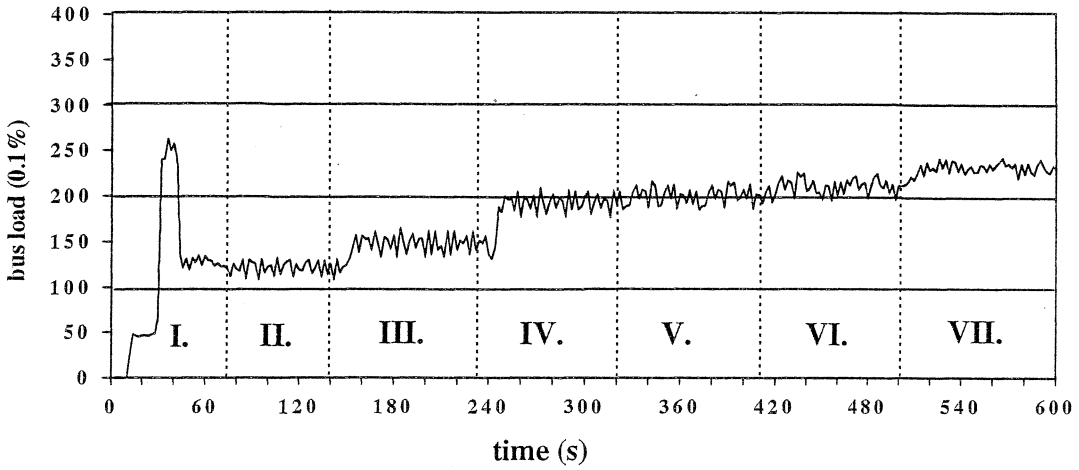

Figure 1: Bus load of a tractor fertilizer spreader system (LBS by DIN 9684, part 2-5).

After initialization the bus load droped to 12 % in a stationary mode (II.) while transmitting only basic messages and tractor display data. Activating the working menue for the fertilizer spreader (III.) created an increase of the bus load by 3 %. The start of the application (IV.) caused an additional increase of 4.5 % resulting in a bus load of about 19.5 %. In each single phase the changes of the bus load were very small.

Putting additional positioning data on the bus, the bus load increased with reduced update intervalls. A position data update rate of 1 Hz (V.) caused an additional bus load of 1 %, an update rate of 2 Hz caused 2 % (VI.) and an update rate of 4 Hz caused 4 % (VII.). An 1 Hz positioning update rate guaranties the neccessary position accuracy of ~ 1 m (vehicle velocity < 5 m/s) with still plenty of free bus capacity.

[1] DIN 9684, Teil 2-5: Schnittstellen zur Signalübertragung. Berlin: Beuth Verlag 1992, 1993, 1994.

[2] Auernhammer, H. und J.Frisch (Editor): Landwirtschaftliches BUS-System - LBS (Mobile Agricultural BUS-System - LBS). Münster Hiltrup: Landwirtschaftsverlag 1993 (ISBN 3-7843-1841-X).