Standardised electronic interfaces for spreaders

Olga Fischer, Technical Manager, CAN in Automation (CiA), Nuremberg, Germany

Container-handling machines (e.g. ship-to-shore cranes, mobile harbour cranes, straddle carriers, rail mounted gantry cranes and rubber-tyred gantry cranes) are an important business in the increasing market of logistics and transportation. These machines and their spreaders have to exchange command and status information. In the past, the manufacturers bilaterally agreed upon the interface between the crane and spreader, so it was not possible to use a spreader from another manufacturer without re-programming the crane controller. With increasing functions of spreaders, this has become more complicated. This was the reason why several spreader and crane manufacturers started specifying an open interface standard. Customers and classification authorities demanded new spreader control functions, which is another reason why the interface between container-handling machine and its spreader was standardised.

The specification was developed under the umbrella of the non-profit CAN in Automation (CiA) organisation. CiA is the international users' and manufacturers' group for Controller Area Network (CAN), developing CAN-based higher-layer protocols and device profiles together with its members. CiA's special interest group (SIG) Crane/Spreader decided to use high-speed CAN as communication interface, and CANopen as application layer. The developed CiA 444 CANopen device profile for container-handling machine add-on devices specifies also the content of the data to be communicated. This includes the process data (commands and status information), configuration parameters as well as diagnostic data (emergency error codes and failure reports).

The profiles specify the CANopen interfaces for crane spreaders (part 2) and for spreaders of straddle carriers (part 3). Part 1 specifies the general definitions. Here definitions for physical layer, such as transmission rate and cabling recommendations are given. The profile may be extended by additional parts, if further add-on device interfaces have to be standardised.

The following leading crane and spreader manufacturers and service providers jointly developed the CiA 444 profile within the special interest group: Bromma, Gottwald, ifm electronic, NSL Engineering (RAM Spreaders), Kalmar, Liebherr, Noell, Sontheim Industrie Elektronik, Stinis, and VDL Containersystemen. The goal of this standardisation activity was to achieve interoperability and partly interchangeability of spreaders without much reconfiguration effort.

CAN and CANopen

CANopen is a standardised application layer (EN 50325-4) for CAN, an internationally standardised serial bus system (ISO 11898-1/2). The CAN serial bus system with possible transmission rates of maximum 1 Mbit/s, was originally designed for the use in passenger cars, and is therefore very reliable and suitable for outdoor applications. Nowadays almost each passenger car in the world deploys (mostly two) CAN networks. The CANopen application layer is the standardised solution for embedded control systems. It is applied in many machine control systems, in medical electronics, and in a broad range of off-highway vehicles.

Compared with human-communication CANopen would be a certain language (e.g. English or German) with its grammar and basic vocabulary, which uses the Latin set of characters (CAN data link layer) printed on a paper-sheet (CAN physical layer). The CANopen device profiles define certain 'phrases' in order to 'speak' with a device in a standardised way.

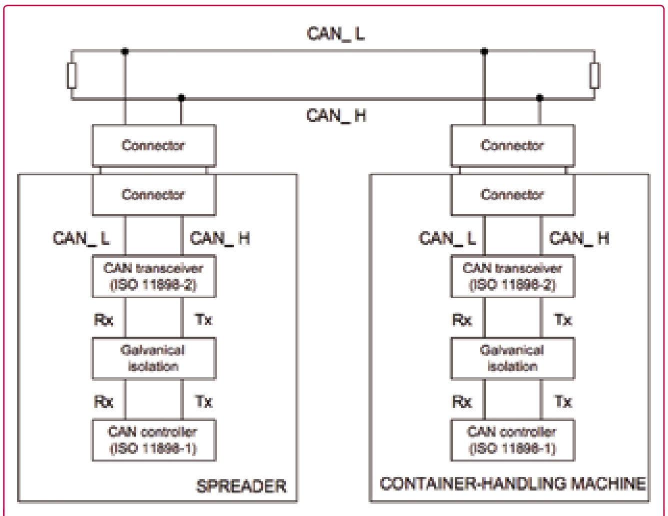

Figure 1. Container-handling machine communicates with its spreader via CAN.

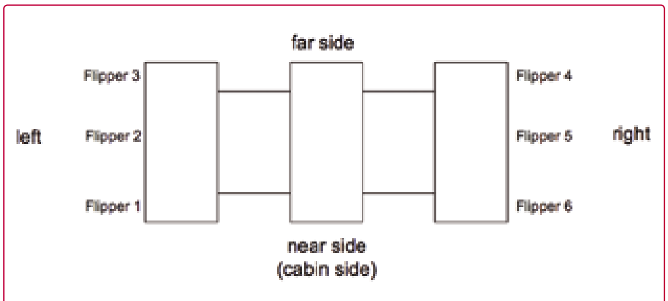

Figure 2. Definitions for crane spreader (CiA 444-2) directions and flipper locations.

Technical details

Default transmission rate of 50 kbit/s shall be supported by the devices following the CiA 444 device profile, thus allowing network lengths up to a maximum 1 km. Other transmission rates e.g. 125 kbit/s at 500 m, or 250 kbit/s at 250 m, and 500 kbit/s at 125 m, may be supported as well. No specific connector is defined. During profile development, it was also considered that retrofitting of older cranes and spreaders without a CANopen interface should be possible.

The CiA 444 profile defines that the container-handling machine controller is the network management (NMT) master controlling the NMT status (initialisation, pre-operational, operational, stopped) of the spreader. Both devices have to provide the 'Heartbeat' functionality, which indicates that a device is still 'alive' and is in the required NMT status.

The device profiles for crane spreader (part 2) and for straddle carrier spreader (part 3) are designed scalable for different spreader classes (class 1 to 4), whereby the higher class provides the higher functionality. The classes define which process data from the

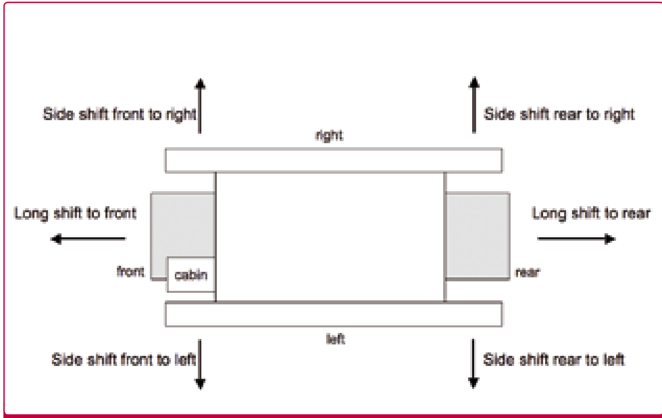

Figure 3. Definitions for straddle carrier spreader (CiA 444-3) directions.

appropriate spreader are evaluated by the container-handling machine controller. Depending on the spreader functions the spreader manufacturer supports only the required class. The crane (or straddle carrier) controller has to support all defined classes.

Parts 2 and 3 of the profile have a similar structure and content using different definitions for directions and other container-handling machine specific parameters. Specified spreader control messages, which are sent from the container-handling machine controller, enable handling of the spreader functions (enable/disable, lock/unlock, tilt, shift etc.). Differentiation between operation modes (e.g. single or twin mode) and control of the telescope position are possible. The spreader gives its process status feedback to the crane controller via specified spreader status messages. The crane (straddle carrier) status bytes inform the spreader whether the crane is currently hoisting up or down, has an eccentric load (part 2), or has a slack of rope. Additionally, the profile defines several actual values (e.g. telescope and twin-set position, load) as well as some rated values (e.g. capacity, main current and voltage) and general information (e.g. spreader model and manufacturer, allowed distance between spreader and container).

Standardisation benefits

Using a CANopen profile, a device provides a standardised communication interface offering defined control possibility, status information and process data. CANopen device profile structure allows also for extensions in case an additional or more complex functionality is required. Beside of standardised functionality, the manufacturer may define and use specific information to be exchanged with the device.

A CANopen device profile gives the system designer (e.g. crane manufacturer) a complete overview on all supported and all possible device functions. The system designer has to learn the structure of a certain device control interface for one time and can reuse his knowledge for further devices following the same profile. The crane manufacturer may choose suitable spreaders from a broad range available on the market. A substitution by a spreader following the same CANopen profile, and produced by a different manufacturer, may be done easily. Also the spreader manufacturer benefits from the standardization: He may sell spreaders with a standard-interface to different container-handling machine manufacturers. The spreader manufacturer may sell higher volumes, as the device provides the same interface with a variable functionality. Thus a 'win-win-situation' for both sides is given.

Standardised device behaviour reduces not only the effort of system integration, but also for system maintenance. Off-the-shelf CANopen tools (e.g. for configuration, monitoring, diagnostics) available from different sources may be used. Tested and practice-proven CANopen protocol stacks are also available on the market.

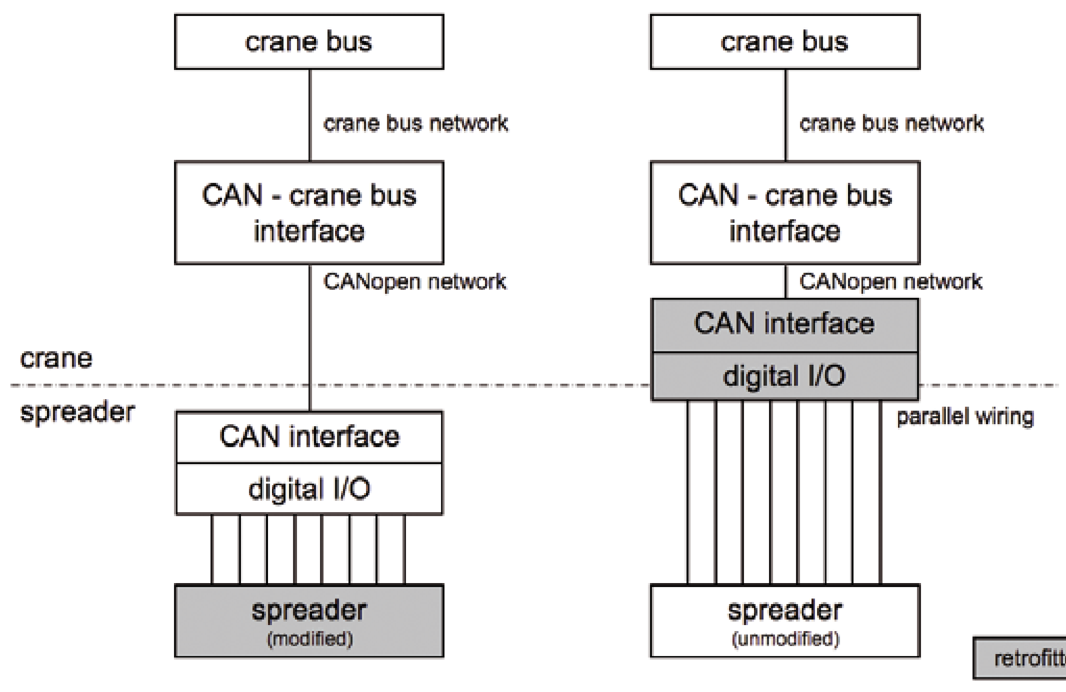

Figure 4. Connecting option for an 'old' crane (retrofitted) and a 'new' spreader.

Usage with further CiA specifications

CiA has also released an application note and implementation guideline (CiA 808), which should help the system designers to implement the connection between the container-handling machine and the spreader. It explains the different ways to physically connect spreader to machines with or without CANopen interfaces.

The CANopen device profile for RFID (radio frequency identification) devices (CiA 445) may be used for integration of an RFID reader/writer into the CANopen network connecting container-handling machine and spreader. Thus, the read information evaluated by the crane controller could be also used for spreader control. Implementing the CiA-302-7 framework for CANopen-to-CANopen gateways allows access of all devices in all CANopen networks. Systems that use CANopen in the crane control system, the crane/spreader network, and the spreader can be diagnosed from one single point with one tool.

Some spreader devices for the embedded spreader control system also use proprietary networks or the AS-Interface bus-systems. In order to have access to the single embedded modules of the spreader, the CANopen spreader interface may use the CiA 446 CANopen-to-AS-Interface gateway. Diagnostics and configuration of the embedded AS-Interface network from the crane (straddle carrier) controller is then possible. Gateways according to CiA 446 may service up to 16 AS-Interface bus systems.

ABOUT THE AUTHOR

Olga Fischer, born in 1978, began her career with a degree in Electrical Engineering from the Georg-Simon-Ohm University of applied sciences Nuremberg, Germany in 2005. Since March 2006 she has been working as a Technical Manager for CAN in Automation international users' and manufacturers' group.

ABOUT THE ORGANISATION

CAN in Automation is the international users' and manufacturers' group for CAN. The non-profit association was founded in 1992 and is supported by over 500 members. CiA members develop CANopen profiles. CiA representatives participate in international standardisation bodies. CiA organises marketing activities, offers CAN/CANopen trainings, presents papers at conferences and provides public relation activities on CAN technologies. CiA also offers CANopen conformance certification, the CAN Newsletter and product guides for CAN, CANopen and J1939-based products and services.

ENQUIRIES

CAN in Automation (CiA)
Kontumazgarten 3
DE-90429 Nuremberg
Germany

Tel: +49 911 928 8190
Fax: +49 911 928 81979
Email: headquarters@can-cia.org
Web: www.can-cia.org