

# Retrofitting port cranes set to boom

*Terminal operators' low-appetite for port cranes in 2017, does not mean that there is no business for spreader manufacturers. Retrofitting is on the agenda, especially for spreaders with container weighing functionality.*



Figure 1: The life span of spreaders is about 10 to 12 years, the first CiA 444 generation products introduced between 2006 and 2008 are actually coming of age (Photo: Kalmar)

Growing global container traffic is one of the major factors driving the global shipping container market. The global container traffic is growing progressively after a steep decline in 2009. The steep decline in container traffic growth is mainly because of the after-effects of the global recession in 2008. The global shipping container market is one of the few markets that showed a quick recovery after the recession. Technavio has published a market research report. It reports an annual growth of around nine percent for the global shipping container market in the period from 2018 to 2022.

Another trend is the retrofitting of port cranes. Bromma, one of the market-leading spreader suppliers,

provides additional functionality to improve the spreader performance. Retrofit products include CANopen serial crane communication, HIS (Height Indication System), INRS (Impact Noise Reduction System), LED indicator lamps, SCS (Spreader Control System), TTDS (Twin-Twenty Detection System), and load sensing. The mentioned CANopen interface to the crane complies with the CiA 444 profile series. Bromma's spreader are using also embedded CANopen networks. They enable for example the automation of twistlock handling when a container is loaded or unloaded from a vessel. This was the missing link in a fully automated container terminal. Bromma has introduced its ALP twistlock handling system in 2015. ▶

## Container weighing by the spreader

In order to balance the load of a vessel, it is necessary to know the weight of the container. Spreaders able measuring the weight of the grabbed container avoids separate weighing equipment and saves time in the container handling. Since 2016, all export containers need to provide the Verified Gross Mass (VGM). The challenges for the actors in the supply chain to comply with the requirement are several. One of the biggest is how to establish the VGM. Where to weigh? What equipment to be used and what are the requirements on the equipment? The local authorities of each country define the formal requirements related to accuracy and to certification.

A review of the various technologies available for weighing in a terminal boils down to two main alternatives: weighbridges and spreader twistlock based load sensors. When reviewing these two technologies, there are a number of characteristics, which distinguish them. Different characteristics do not mean that one technology is better or more suitable than the other but the characteristics will influence the logistic flows and procedures in the terminal in different ways.

Weighing bridges are a long-time established technology, which is and typically has been used to measure the weight of vehicles. This is the technology that offers the highest "equipment accuracy". The weight of the container-loaded trucks is measured and when the empty vehicle is leaving it is measured again. Another option is to deduct the



Figure 2: CANopen load sensors are installed in the twistlocks of the spreader to measure the weight of the container when lifted (Photo: Tecsis)

kerb weight from the total weight to determine the container weight.

If the typical situation in a container terminal is that the trucks leave the terminal empty after delivering the container, weighing the empty vehicle on the way out might not be such a big additional step but in many terminals that is not the case. In fact, some countries have programs and directives established to encourage the trucks not to leave the terminal empty. It is therefore assumed that weighing the empty truck needs to impose an additional step in the logistic flow that many want to avoid. ▶



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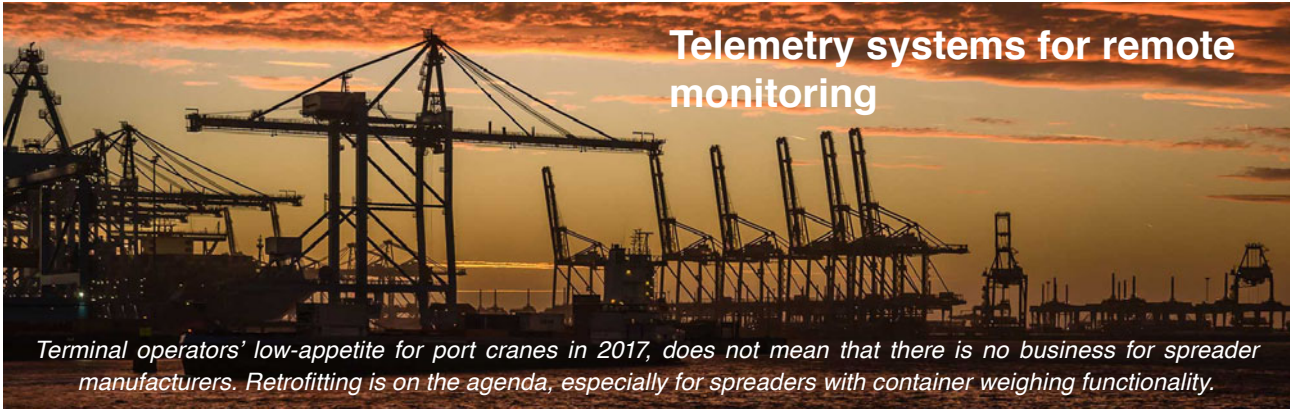
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## Telemetry systems for remote monitoring

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"We are using the CAN interfaces in straddle carriers and other container handling equipment to collect data," said Carmelo Occhipinti from Datamatic. Via the Ethercan gateway by Kvaser this data is forwarded to the terminal operating systems (TOS) to analyze it. "The result is the optimization in the use of machineries and personnel, greatly reducing inefficiencies in operations, increasing profits and customer satisfaction," Occhipinti added. It is a challenge when connecting computing units to heavy machinery such as a crane, because of the physical conditions: vibration, dust, and dirt ingress are the most commonplace. Gustavo Gasparini from Kvaser's Italian distributor explained: "The Ethercan provides greater stability of connection than USB because Ethernet permits a small disconnection from time to time."

A port's success primarily depends upon efficient use of equipment and personnel. A focal point is the cranes, which are becoming increasingly state-of-the-art and consequently, valued in the millions of euros or dollars each. Just like any other expensive assets such as drill rigs, agricultural, or construction equipment, machine monitoring via CAN has the potential to enhance container terminal operating efficiency by minimizing downtime due to maintenance issues.

Datamatics Group's Neptuno TOS solution integrates data generated by the port's many machine sensors with container-related data, providing an overview of the entire terminal's activities. A crane system typically has five or more CAN-connected ECUs. The Ethercan Light HS CAN-to-Ethernet gateway is used to

connect the crane's CAN network to a rugged PC in the cabin. Combining CAN data with inputs from proprietary sensors, cameras, and positioning information, enables to create a comprehensive crane telemetry system that feeds information to the TOS.

Carmelo Occhipinti explained: "CAN allows us to collect data in real-time on the crane's operating parameters, such as fuel consumption, crane lift angle and extension, load weight, move duration, grasp engagement, etc. We use this information to produce a variety of dashboards and KPIs to analyze operating conditions and provide feedback to help the customer optimize the use of their cranes. For example, an alarm is transmitted to the maintenance director if the crane's tire pressure goes below a certain threshold, as tires at optimal pressure save at least 10 percent of the fuel used. This type of real-time monitoring applies to all the crane's main components, avoiding unplanned stops and reducing the risk of equipment damage."

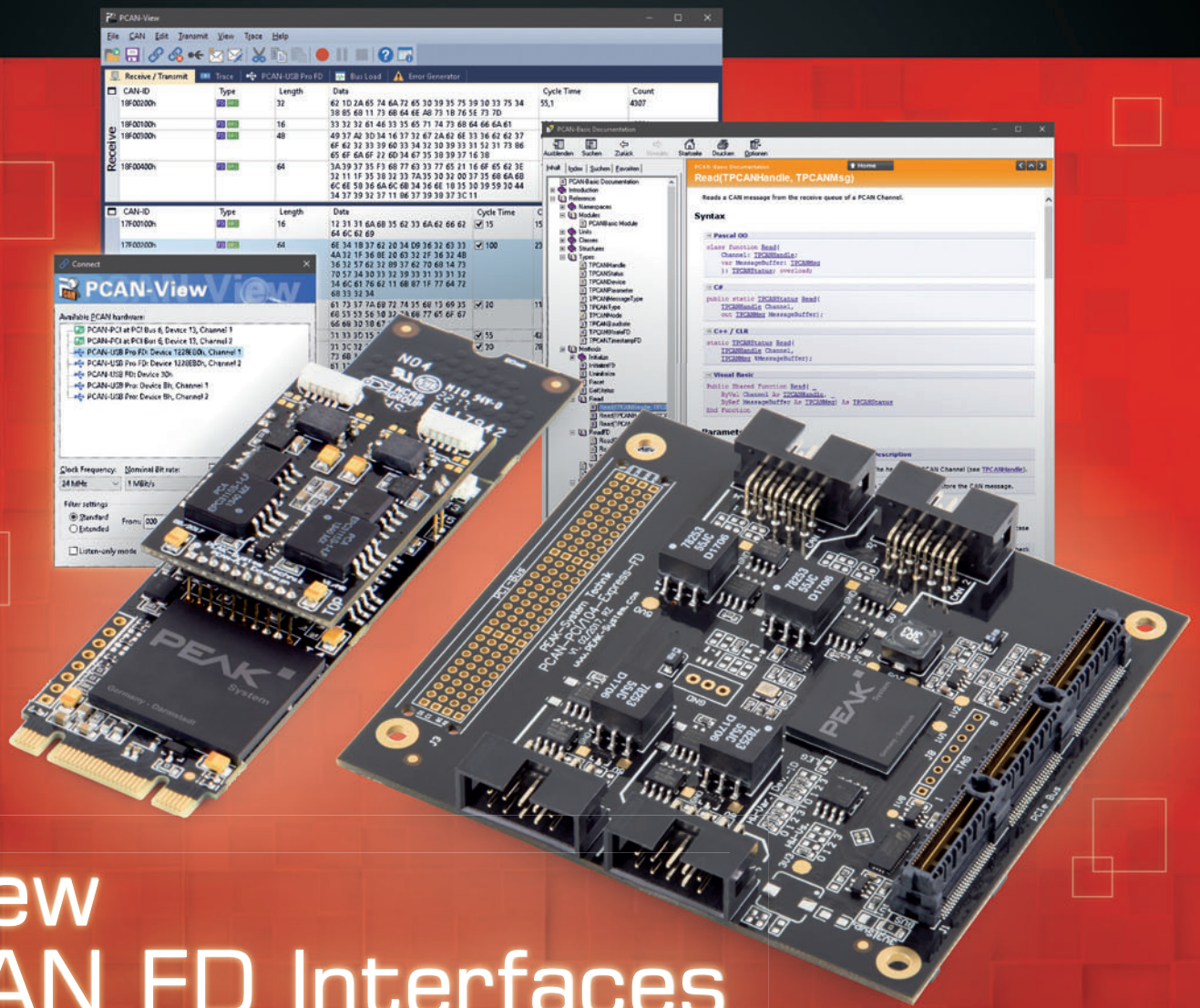
All crane movements are transmitted in real-time to the TOS, including critical data such as the exact route taken by the crane to place the container in the stack (so that the cost of every movement can be calculated). The system also enables containers to be located with high precision, reducing the time and effort to find containers. Occhipinti said: "All the Kvaser interfaces that we tested and have used are optimal products and we are very happy to integrate them in our solutions. Moreover, Datajob has given very effective support, helping in all project phases and providing a very professional service."

When kerb weight is used to calculate the container weight, additional factors influence the container weight accuracy. The definition of kerb weight is the total weight of a vehicle with standard equipment, all necessary operating consumables such as motor oil, transmission oil, coolant, air conditioning refrigerant, and a full tank of fuel, while not loaded with either passengers or cargo". The definition may differ slightly between nations and as an example some European countries include the driver weight of 75 kg. The volume of a typical fuel tank is 500 l. The density of diesel is 0,8 kg/l, which means that the weight of the fuel in a full tank is 400 kg. Since the truck will in some cases arrive in the terminal with a low fuel level the inaccuracy added to the container weight from this factor is actually up to 400 kg. Also the driver's weight is not always

75 kg. Additional inaccuracies can be caused by extra "stuff" in the driver cabin, e.g. a cooler with drinks and food.

Load sensors installed in or on the twistlocks have the advantage that they measure just the weight of the container. The measure that is obtained is the gross mass of the container without the need to subtract tare weight. The inaccuracy specification for twistlock-based systems is typically  $\pm 1$  percent of the full-scale meaning that the measurements are typically within  $\pm 400$  kg, i.e. lower than the process inaccuracies in the discussion above.

When two 20-foot containers are loaded on a truck, the weighing bridge cannot distinguish between the individual weights of the two containers. A possible procedure for obtaining the individual weight is to unload one of



# New CAN FD Interfaces

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- CAN bit rates from 20 kbit/s up to 1 Mbit/s
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- CAN termination can be activated through a solder jumper, separately for each CAN channel
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- Measurement of bus load including error frames and overload frames on the physical bus
- Induced error generation for incoming and outgoing CAN messages
- Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)

## ■ PCAN-PCI/104-Express FD

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- CAN FD support for ISO and Non-ISO standards switchable
- CAN FD bit rates for the data field (64 bytes max.) from 20 kbit/s up to 12 Mbit/s
- CAN bit rates from 20 kbit/s up to 1 Mbit/s
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- CAN termination and 5-Volt supply can be activated through solder jumpers, separately for each CAN channel
- PCIe data transfer via bus master DMA
- DMA memory access operations with 32- and 64-bit addresses
- Measurement of bus load including error frames and overload frames on the physical bus
- Induced error generation for incoming and outgoing CAN messages
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the containers, weigh the vehicle again, and then apply the math to achieve the individual weights.

When spreader twistlock-based systems are employed, individual 20 footers can be weighed as there are sensors in each of the eight twistlocks on a spreader for twin-lifting.

The Bromma weighing solution consists of CANopen load sensors mounted on the spreader twistlocks. The system captures the weight during the crane lifting cycle meaning that there is no extra step to be introduced influencing terminal productivity and space requirement. Bromma's twistlock based container weighing system has been certified to comply with the OIML R51 requirements.

Several companies offer CANopen load sensors. Tecsis provides its F9205 twistlock sensor, which complies with the Solas (safety of life at sea) requirements. This requirement for measuring accurate weight of containers for the marine transportation plays a huge role in driving the demand of container weighing systems. Tecsis's load sensor is shock and vibration resistant and comes in an IP67 enclosure. Besides CANopen, it supports also the J1939 application profile. The CAN interface is available at an M12 connector with a pin-assignment as recommended in CiA 303-1. The sensor is suitable for all kind of spreaders and can be used for reach stacker, straddle carriers, and rubber-tired gantry (RTG) cranes, for example. The measurement range is 0 t to 23 t. The supply voltage is  $8 V_{DC}$  to  $30 V_{DC}$ . The relative linearity error is  $\pm 0,5 \%$ .

Brosa is another supplier of CANopen load sensors for spreaders. The products are designed for harsh environments and temperature compensated from  $-40 \text{ }^{\circ}\text{C}$  to  $+80 \text{ }^{\circ}\text{C}$ . They have a high long-term stability and interference immunity of 200 V/m. The sensors are IP67- or IP69-rated. The CANopen Safety versions comply with performance level (PL) c or d. The supplier can also provide PL e certified sensors. Brosa offers also a force sensor washer with the certificate R60 of OIML (International Organization of Legal Metrology) for container weighing. The international recommendation R60 describes the general and metrological requirements for load cells and how to verify them.

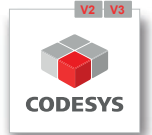


Figure 3: The SCS4 unit is the latest generation of Bromma's spreader controllers connecting the CANopen network embedded in the spreader and the optional CANopen interface to communicate with the crane or straddle carrier (Photo: Bromma)

Lasstec has developed a twistlock load sensing and operational safety system connectable to CANopen networks. It features multiple inputs for twistlock sensors. The safety system is suitable for single and twinlift spreaders – for tandem lifts one system per spreader is used. It can be integrated into new and existing installations without modifying the spreader. The sensors are inserted into a small hole drilled into the center of the

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Figure 4: Bromma has delivered crane spreaders to 500 terminals in 90 nations, since more than 10 years they use embedded CANopen networks as well as an optional CANopen interface to communicate with the crane controller (Photo: Maersk)

twistlock. The hole is so small that it does not affect the structure of the twistlock. The sensors are totally insensitive to repetitive shock loads, vibrations, EMI, humidity, and they resist overloads. The data is processed on the spreader and sent through the spreader communication channel or sent parallel to the crane PLC and to the TOS. No re-calibration is required throughout the life of the sensors. The system meets the IMO (International Maritime Organization) requirements.

### CANopen as spreader interface

The spreader needs communication to the crane or the straddle carrier. Historically, there are different options. One of them is CANopen. The spreader suppliers have developed the CiA 444 CANopen profile series to achieve interoperability. Bromma and some crane manufacturers were the driving forces.

The Swedish spreader supplier Bromma provides an Anybus gateway for the crane, so that the crane controller can communicate with the spreader controller. The gateway by HMS (Sweden) converts the crane controller interface (e. g. Devicenet, Ethernet, Modbus, Profibus, or Profinet) to CiA 444 or BCAN (Bromma CAN) and vice versa. The IP20-rated gateway comes as kit complete with a 10-m CAN cable and an 120-Ω termination resistor.

Bromma offers also the SCS4 spreader control system. It provides detailed information about the spreader to the operations manager, not just a few LEDs indicating that there is a problem. Accurate diagnostic data is key to shortening downtime duration and eliminating the need for

time-consuming spreader change-outs. Operational information, such as events, alarms, and trend data, is stored in the spreader controller – even after the spreader has been disconnected. This gives service personnel the opportunity to review and analyze data in order to further improve spreader productivity.

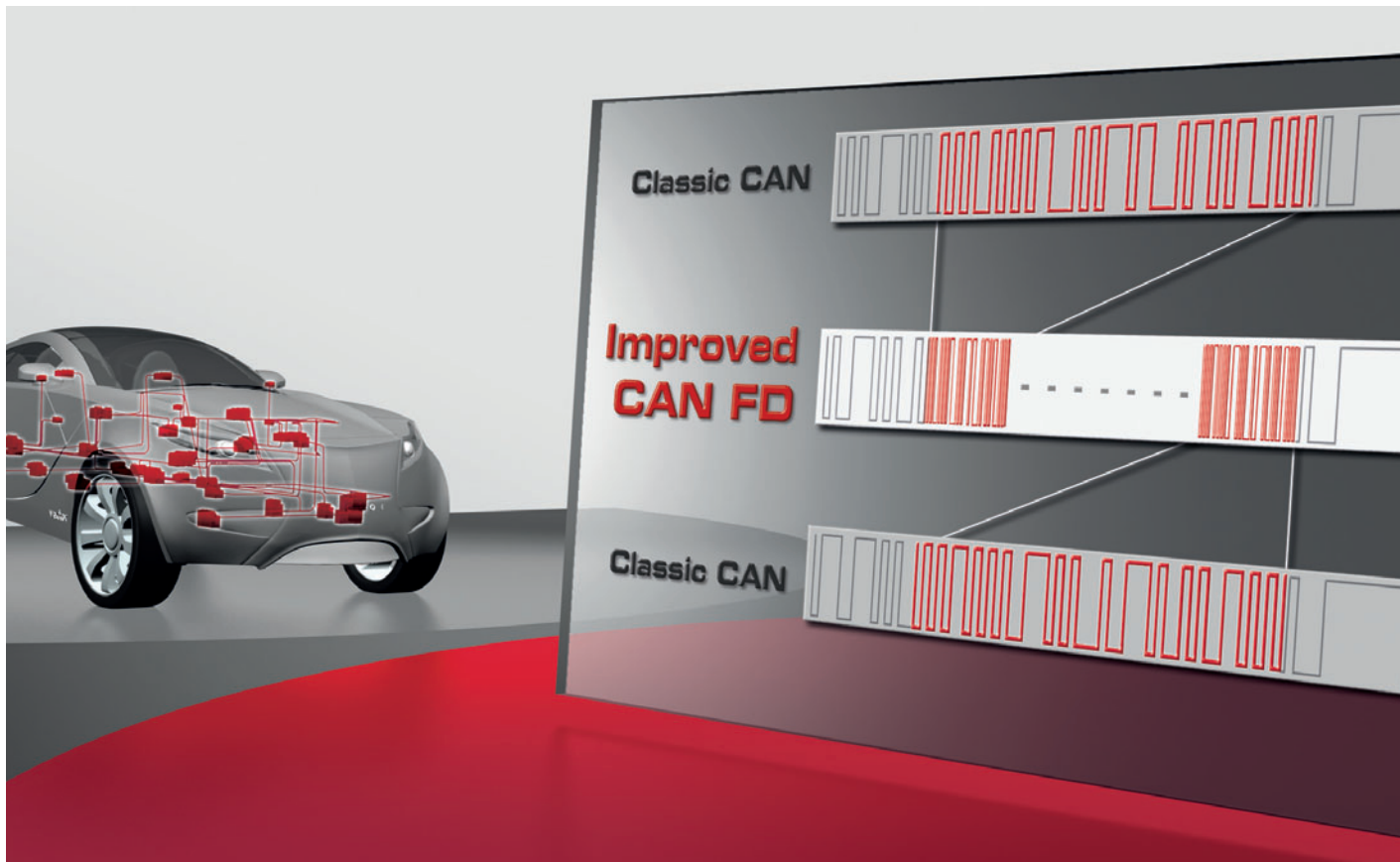
The embedded spreader control unit manages all motions of the spreader controlled from the driver's cab over CANopen. All commands are processed safely by the spreader ECU. Lifting allowance is monitored by the ECU and implemented on the reach stacker to ensure safe container handling, for example.

Also other spreader manufacturers support CANopen connectivity. VDL's yard crane spreaders are optionally available with a CiA 444 compliant CANopen interface. The same is valid for the company's ship-to-shore spreaders. ◀



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