

# » Application Story «

Kontron ThinkIO in Transportation



## Kontron heavy-duty industrial PC ThinkIO Delivers High-Performance Control for Mining Trucks

### New Brains for Mining Giants

Mining trucks are huge transport vehicles used on open-cast mines all over the globe, and the T 282 C made by Liebherr is the most powerful model in the world. High-performance PLC units are required to control these vehicles and to ensure they operate reliably. For its dump truck, Liebherr chose the heavy-duty industrial PC ThinkIO from Kontron.

Liebherr's heavy-duty mining trucks work hard transporting coal, diamonds and copper in places like the United States, Africa and Chile. These vehicles have tires that are 13 feet high – more than twice as tall as a full-grown adult – and weigh in at 11,660 pounds, making them the biggest in the world. More impressive is the payload capacity of these beasts. Liebherr's T 282 C can carry up to 363 metric tons at a top speed of 40 mph and that with a relatively low empty vehicle weight of 237 metric tons.

A mining truck of this size needs to be able to control all vehicle components efficiently and reliably. For example, it features continuous acceleration and deceleration, which helps reduce wear and tear on parts. This means that when the driver accelerates or brakes, the system logs the position of the pedal and then converts this information into a command for the electric traction motors located on the rear axle. To ensure the motors get enough energy to perform the command, the necessary rotational speed has to be communicated to the diesel engine. A generator converts the engine's mechanical power into electrical power that sends exactly the right amount of drive to the wheels. Steering works in a similar way. When the driver turns the wheel, the torque for the two power trains is calculated separately for each according to the steering angle, enabling the mammoth truck to get around the corner safely.

Handling all these complex, high-speed control processes requires a powerful, reliable programmable logic controller (PLC). These computer components act as the brain of the vehicle. The brain must be able to work dependably under the harsh conditions of mining because all vehicle components apart from the hydraulic steering and brakes depend on it. If the brain shuts down, the entire truck comes to a halt – and that can lead to significant losses in terms of haulage.

## High-performance giant

In spring 2009, Liebherr decided to equip its mining trucks with a new and more powerful control unit. One of the main requirements the PLC had to fulfill was the ability to work reliably in extreme temperatures without a cooling fan. Due to the harsh conditions the trucks operate in, the PLC could not include any components sensitive to shocks and vibrations, such as fans and hard drives.

Another requirement concerned the other end of the temperature range. Mining trucks need to function flawlessly in regions with extreme climates, such as in Chile, where they might be working at 4,500 meters above sea level, or in Canada, where temperatures can plunge to double-digit subzero temperatures in the winter. The unit has to manage a cold start even in these conditions.

Liebherr also needed a PLC with four independent CAN bus interfaces. The truck is equipped with a variety of devices that all have to be connected to the control unit via a field bus.

These devices include certain inverters for the power train and peripheral sensors for recording temperature and pressure values. Liebherr wanted to be able to group the devices by function and importance. This would mean that, for example, one CAN bus would handle only data necessary for the power train, while another would transfer less critical signals. This set-up is designed to make the trucks more reliable.



Image 1: A mining truck of this size of a house – the Liebherr mining truck T 282 C

## File system facilitates fault diagnosis

The PLC also offers a file system that makes it possible to archive operating data and then retrieve them during maintenance and fault diagnosis. This “condition monitoring” allows engineers to identify, for example, excessive wear and tear on vehicle components such as the air filter. Using the saved information, they can identify what parts need to be replaced soon. Users can retrieve fault files using an Ethernet interface or USB stick and then analyze them at their leisure. This system gives maintenance staff access to up-to-the-minute information on the truck's sensors and actuators.

Technical requirements aside, Liebherr also wanted to find a PLC manufacturer with a strong, sustainable market position. The devices have a service life of at least ten years and replacement parts must be available far beyond this period, so Liebherr wanted a PLC provider that could be counted on over the long term and could guarantee that it can supply its device or a compatible follow-up model for at least ten years. In their search for a suitable supplier, the Liebherr team came across Kontron. The longtime available Kontron heavy-duty industrial PC ThinkIO met all the requirements the team had identified. The Kontron ThinkIO works with a 1.06 GHz Intel® Celeron® M processor and runs Linux OSADL and CoDeSys Version 2.3. Developed specifically for use in harsh environments, it can handle temperatures from -68 to 140 °F and is shock and vibration resistant. The standard version of the Kontron ThinkIO only has one CAN bus interface, but Kontron modified it for Liebherr with an additional board to provide the four interfaces required. Furthermore, thanks to Kontron's market strength as one of the world's largest manufacturers of embedded computer technology, Kontron also inspired the confidence in Liebherr to be the ideal partner for a reliable and long lasting relationship.

## Two become one

One of the major advantages of the Kontron heavy-duty industrial PC ThinkIO is its processing power. Liebherr wanted its new control system to be at least four times as fast as the previous version. Kontron's ThinkIO met this target and more, performing at six times the speed of Liebherr's previous solution. The Kontron ThinkIO's processing power allowed functions previously divided between two control units to be combined into a single device – without even touching on the PLC's performance limits. So despite the high level of integration, there is plenty of scope for future add-ons, which will save time and money down the road.

Another plus of the Kontron ThinkIO is the graphic interface. The graphic display is useful for drivers and service staff because it gives them on-screen access to important information on payload, faults, temperatures etc. From diesel engine diagnostics to brake wear, the central PLC can record and display on screen everything that can be saved as electronic data and that is essential to vehicle operation.

The graphic interface can connect the monitor in the driver's cab directly to the PLC. Previously this required installing and programming a separate visual display device and PLC. Integrating these functions into one device has cut down on time and effort in a number of ways, such as making it unnecessary to update three separate programs for every add-on.



Image 2: ThinkIO-Duo/-Solo DIN Rail PC, fanless, scalable to 1.2 GHz Intel® Core™ Duo

## Already in action

A number of mining trucks are now working with the Kontron heavy-duty industrial PC ThinkIO. The first went into operation in late 2009, which means Liebherr engineers have had nearly two years of experience with the new technology. Project manager Bernd Sommer is especially pleased with the new system, "With one unit instead of two handling all the functions, we've been able to take a big step forward in terms of development – everything goes much faster now." Liebherr is very happy with the PLC's functions and performance, and since early 2010 it has been fitting all its mining trucks with the Kontron heavy-duty industrial PC ThinkIO.



**Andrea Mayer**

Product Marketing Manager  
at Kontron Modular  
Computers

### Technical specifications

<b>Processor</b>	Intel® Celeron® M processor ULV 423, 1MB cache, 533 MHz FSB
<b>Memory</b>	512 MB DDR-SDRAM, 2GB CF onboard, soldered 512kByte MRAM, External CompactFlash (I+II) or microdrives possible
<b>Ethernet</b>	2x 10/100/1000 Base-TX
<b>USB</b>	2x USB 2.0
<b>Serial ports</b>	1x RS232 with all handshake lines
<b>Digital input</b>	7x 24V, triggerable and opto-isolated, depending on mass
<b>Digital output</b>	2x 24V / 0.1 A optoisoliert; kurzschlussfest
<b>Relay output</b>	2x 24V / 0.1 A opto-isolated, short-circuit-proof
<b>DVI-I</b>	1 watchdog output (max. 32 VDC / 1A)
<b>RTC</b>	Gold Cap capacitor
<b>Status LEDs</b>	4x three-color: IDE / power, temperature, bus, application
<b>Run/Stop</b>	1x switch
<b>Reset</b>	1x button
<b>Field bus</b>	4 CAN interfaces, Layer 2 with SJA1000
<b>Modular IO</b>	Interface to WAGO-I/O-System 750
<b>Operating system</b>	Embedded RTLinux with RT preempt patch for the Linux kernel (OSADL), CoDeSys 2.3 runtime including target and web visualization
<b>Power supply</b>	24V DC (-20%/ +30%)
<b>Ambient temperature</b>	-68 to 140 °F
<b>Dimensions (LxWxH)</b>	224 x 100 x 70 mm



The Liebherr T 282 C is the most powerful mining truck in the world: It can carry up to 363 metric tons at a top speed of 40 mph



The Kontron heavy-duty industrial PC ThinkIO displays important information on payload, faults, temperatures etc on a graphic display in the driver cabin.



Starter



Developed specifically for use in harsh environments, The Kontron ThinkIO can handle temperatures from -68 to 140 °F and is shock and vibration resistant. For Liebherr Kontron customized the heavy-duty Industrial PC to provide the four CAN interfaces.

## About Liebherr

The Liebherr family business was founded in 1949 by Hans Liebherr. The huge success of the first mobile, easy-to-assemble and affordable tower crane put the company on a firm footing. Today, Liebherr is not only one of the world's leading manufacturers of construction vehicles; it also has an outstanding reputation as a supplier of technically innovative, user-oriented products and services in numerous other fields. Meanwhile the once family-run company has grown into a group of over 100 companies with a total of 32,091 employees, and Liebherr is present on every continent.

## About Kontron

Kontron is a global leader in embedded computing technology. With more than 40% of its employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators.

Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchanges under the symbol "KBC". For more information, please visit: [www.kontron.com](http://www.kontron.com)

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