

# Kalmar DCF360-450CSG Toplift container handlers 36 – 45 tonnes



# Introduction

# Welcome

Let us introduce to you the details about the new ultimate top-lift handler – the Kalmar DCF-series.

These heavy-duty container handlers have been developed exclusively for ports and terminals with strong demands on productivity and high quality operation. This is a machine, which has long been asked for among demanding terminal operators all over the world.

So what about the special benefits?



## The Two basic elements in container handling.

The decision to develop a “brand new” machine came after getting input from terminal operators for a basic type of machine, but with superior performance characteristics. We then decided to build a family of integrated top-lift handlers that would surpass all existing machines.

Drawing on our global experience we know that there are two basic elements in container handling that ensures success in the working day on every port and terminal. Two elements in the mind of operations, financial and purchasing managers, but also in the mind of drivers and maintenance staff.

These two elements were our top priority in the design and development of the Kalmar DCF.

### Technical solutions are only the tool. Not the goal.

There is new leveraging technology under the skin of the DCF in order to provide the best everyday performance and availability.



We have examined and evaluated every nut, bolt and component to ensure we provided a machine with the highest possible specification.

When appropriate simple technical solutions were available we have applied them, and when the need was for more sophisticated systems we have installed them to boost your uptime and productivity.



The technical optimisation of the Kalmar DCF means that you will get the best technology available but still have the feeling of having a reliable, simple, safe and hard working machine.

### Providing the highest possible throughput.

This is what it's all about. But of course you have to add “at the lowest lifetime cost possible”. To reach such a goal you need to focus on specific critical targets.

## Ergonomics

# The heart of top performance in top-lift handling

To obtain the maximum out of your investment, you can never underestimate the importance of the drivers' working environment. High throughput demands full driver concentration and efficiency to keep up the container moves, but also to avoid injuries and costly damages.

This is what ergonomics is all about. Being comfortable and aware.

The driver environment in Kalmar DCF is the comfortable Spirit Delta high visibility cabin; appreciated by professional drivers, proven on thousands of Kalmar container handlers all over the world.

### We focus on four important ergonomic areas:

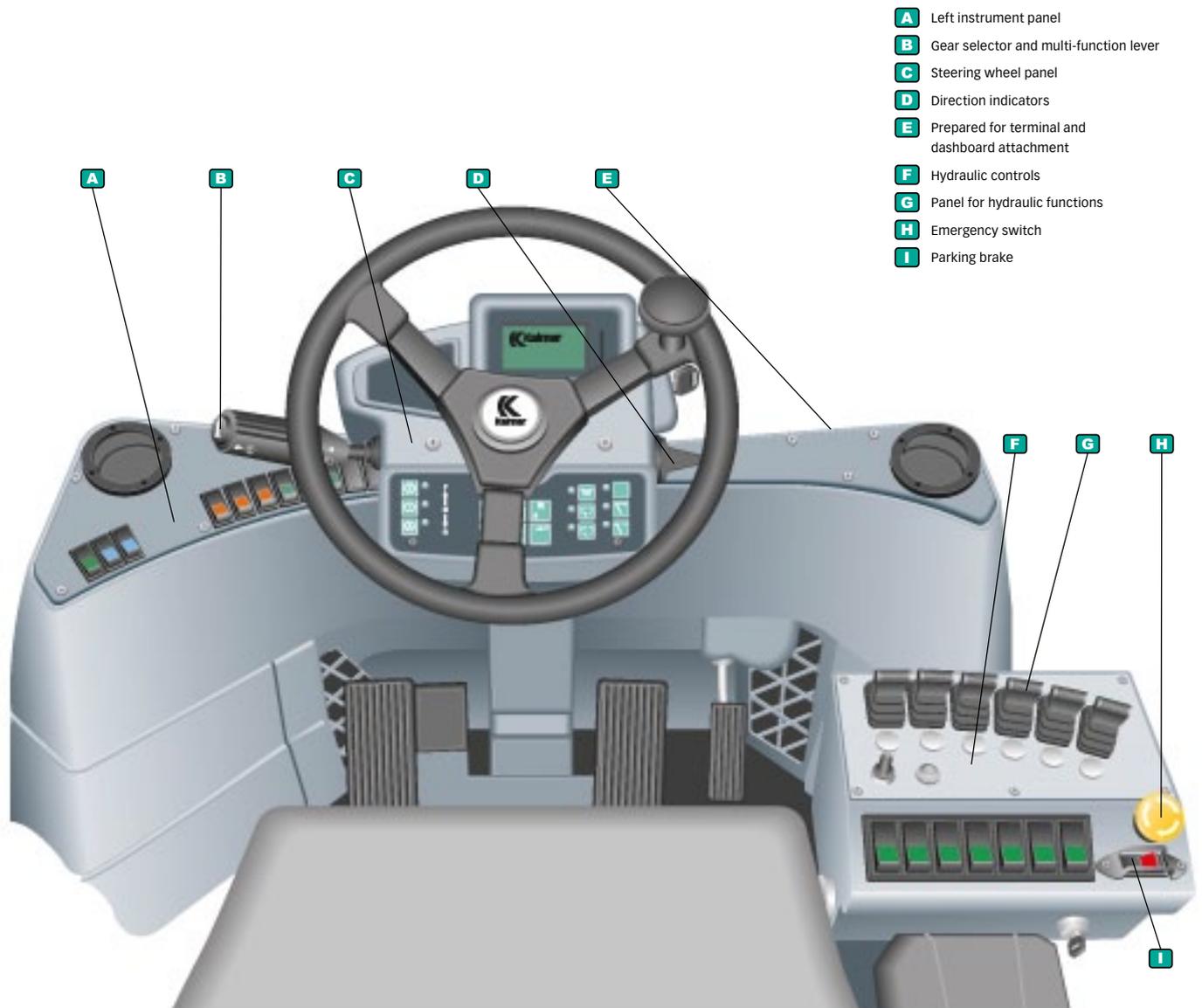
- Operation
- Visibility
- Sound and vibrations
- Climate

The result is a cabin where everything is optimised to improve driver performance.

### Consider this:

- Individually adjustable controls, steering wheel and seat.
- Intuitively positioned instruments.
- Switches and buttons with lights.
- Comfort pedals.

- Electronic accelerator.
- Central operation/warning display.
- Separately suspended and isolated cabin.
- Shock absorption to minimise vibrations.
- Maximum sound level inside is 70 dB (A).
- Generous interior dimensions and floor space.
- Optimised visibility – 360° all around.
- Electronically controlled heating/ventilation.
- Filters for fresh air and recirculation.
- High performance air conditioning system, optional.
- Pollen filter, optional.



## Capacity and dimensions

# Matching your handling and throughput needs

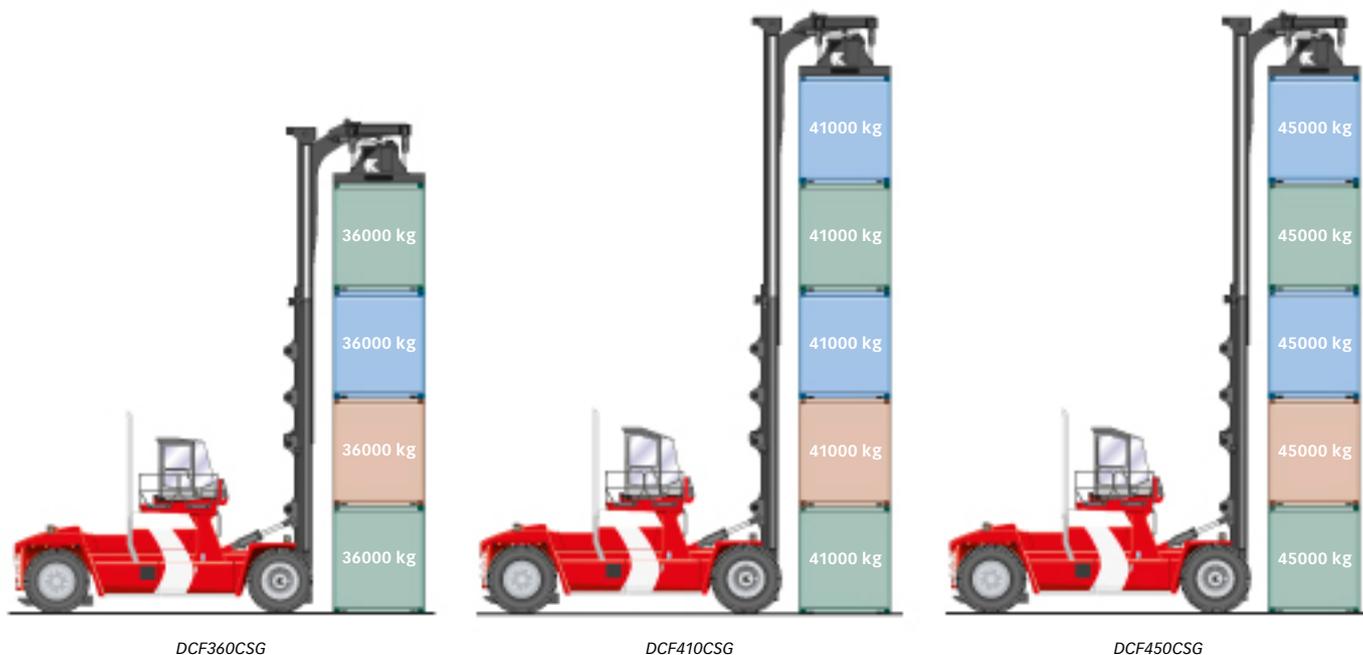
When we designed the Kalmar DCF top-lift we already knew the detailed status of all the main alternatives on the market. Hence, we designed a machine which meets or exceeds the specifications of the others – on the spec sheet and in reality.

You can choose between three basic models, each optimised according to lifting capacity – stability – overall dimensions – weight – top-lift speed and driving performance.

Three models cover container handling between 36 – 45 tonnes capacity, 20’-40’ containers and up to five high stacking at full capacity. This means that you may easily find the right machine or combination of machines to suit your operational requirements.

The design of the chassis, mast, carriage and spreader has resulted in machines with very good dimensional-, stability- and operational characteristics.

In spite of its size and capacity the Kalmar DCF has a short turning radius. Together with the optimised visibility and good manoeuvrability it saves terminal space and makes the machine a smooth operator in confined aisles. The counterweight and lifting height requirements have been matched with a modern chassis to keep down the overall weight but with no sacrifice in stability.

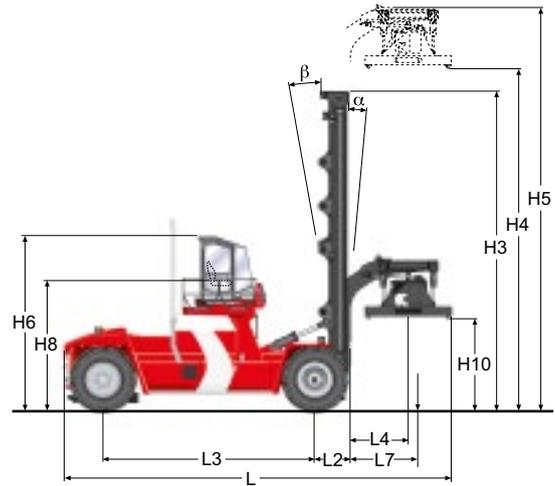
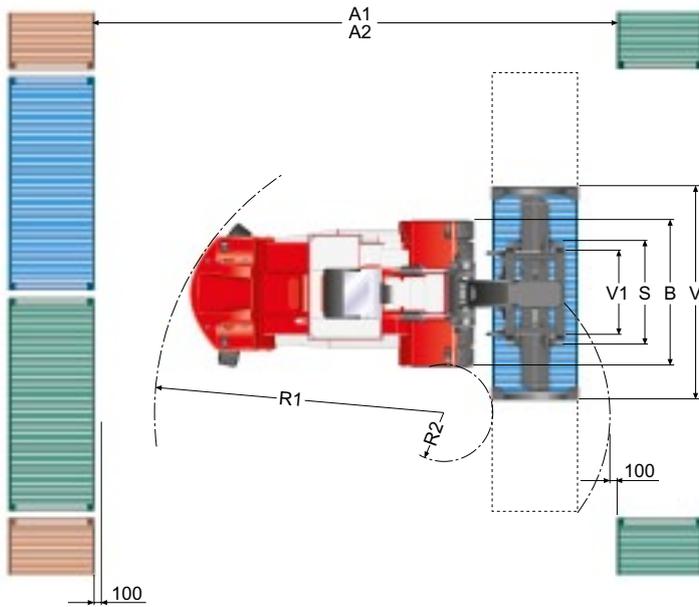


Capacity and weight					DCF360CSG	DCF410CSG	DCF450CSG	
Lifting capacity	Classification				kg	36000	41000	45000
	Load centre	attachment retracted	L4	mm	1750	1750	1750	
		attachment extended	L7	mm	1955	1955	1955	
Weight	Service weight				kg	66400	69750	75000
	Weight front axle	unloaded			kg	41300	42290	44000
		at rated load			kg	94800	101450	110500
	Weight rear axle	unloaded			kg	25100	27460	31000
		at rated load			kg	7600	9300	9500

The mast and carriage are computer designed and optimised (FEM and Catia V5) which allowed for a decrease in the front axle weight. Together with Kalmar's integrated high capacity

spreader it allows you to fully utilise the capabilities of mast tilt, slewing, extension, sideshift at full lifting height and full capacity. No compromises.

Additionally, we have ensured that every single detail, component and system have been selected and manufactured to provide the highest possible reliability.



Dimensions				DCF360CSG	DCF410CSG	DCF450CSG	
Truck	Truck length, with attachment	L	mm	10970	10970	11020	
	Truck width	B	mm	4450	4450	4450	
	Truck height	H6	mm	4650	4720	4720	
	Seat height	H8	mm	3560	3630	3630	
	Distance between front axle center – front side of mast	L2	mm	900	900	950	
	Wheelbase	L3	mm	6000	6000	6000	
	Track (c-c), front – rear	S	mm	3020 – 2820	3020 – 2820	3020 – 2820	
	Turning radius,	outer	R1	mm	8660	8660	8660
		inner	R2	mm	1090	1090	1090
	Ground clearance	min. under truck		mm	280	280	280
	Min. track with for 90° stacking	with 20' container	A1	mm	11990	11990	11990
		with 40' container	A2	mm	14680	14680	14680
Standard duplex mast (5 high 8'6", 5 high 9'6")	Height under twistlocks	4-high – 5-high mast	H4	mm	12090	15160	15160
		min.	H10	mm	2080	2160	2160
	Mast height,	min.	H3	mm	7700	9190	9190
		max	H5	mm	15170	17170	17170
Mast tilting, forwards – backwards		$\alpha - \beta$	°	5 – 10	5 – 10	5 – 10	
Attachment	Width, min – max	V	mm	12170 – 6070	12170 – 6070	12170 – 6070	
	Hydraulic slewing		°	±3	±3	±3	
	Side shift, ± either side center	V1	mm	400	400	400	
	Levelling		°	±5	±5	±5	

## Lifting performance

# In the palm of your hands

The lifting equipment of Kalmar DCF is an integrated assembly consisting of mast, carriage, spreader, hydraulics and control system. This is to ensure you get a reliable and good running machine with high availability even after long shifts and high load stresses.

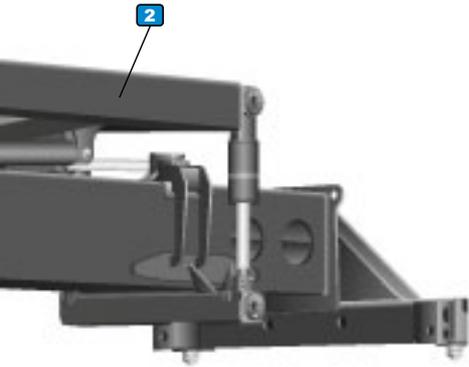
A major objective in the development process has been to combine optimum functionality for the driver together with high performance in lifting and load handling.

To leverage operational productivity it's essential that the driver has full control over every moment of the handling sequence. This starts with the 360° visibility from the Spirit Delta cabin and is followed by the open design of the mast and gantry. The visual contact with the stack, container corners, twist-locks and spreader is optimised.

Fine-tuning the spreader to handle uneven levels or loads, mast tilt, extension, twist-lock landing is accomplished utilising a powerful electronic support feedback and control system.



Performance			DCF360CSG	DCF410CSG	DCF450CSG	
Lifting speed	unloaded	m/s	0,42	0,42	0,42	
	at rated load	m/s	0,25	0,25	0,25	
Lowering speed	unloaded	m/s	0,31	0,31	0,31	
	at rated load	m/s	0,36	0,36	0,36	
Driving speed	unloaded	forward	km/h	26	26	26
		reverse	km/h	26	26	26
	at rated load	forward	km/h	23	23	23
		reverse	km/h	23	23	23
Gradeability	at 2 km/h	unloaded	%	38	38	38
		at rated load	%	27	27	27
	max, unloaded	%	38	38	38	
Drawbar pull	max	kN	368	368	368	



### 1 Mast

The Kalmar DCF has as standard a duplex free visibility mast, made of high strength steel to provide a long life with minimal deflection at high lifting heights. Maximum lifting height is 15160 mm or five containers high under the twist-locks. The mast is equipped with the new Kalmar high speed lifting system, which provides very fast handling of loads up to 22 tonnes.

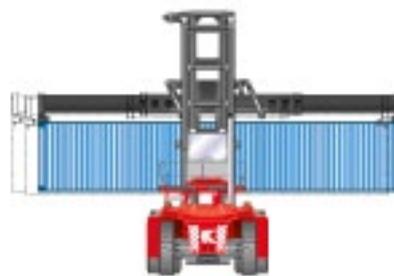
The mast is made for high reliability and simple maintenance. It requires only two hoses and one cable passing over the mast roller to feed the hydraulic and electrical functions of the spreader.

### 2 Carriage

The integrated gantry with high-strength roller bearings makes for a secure and durable setup. The benefits of an integrated gantry are increased capacity and a decreased loss of load centre. The gantry is a completely new design, made of solid steel instead of welded beams, which improves reliability and see through visibility.

Key functions:

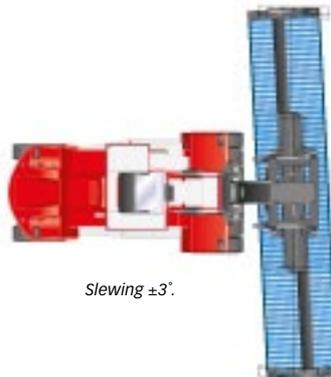
- Levelling – corrects the inclination of the spreader to uneven containers.
- Slewing – compensates when the machine is not positioned 90° to stack.
- Side-shift – compensates when the machine is positioned right or left of the container.
- Extend/Retract – extends the capability when loading/unloading trucks or rail cars.



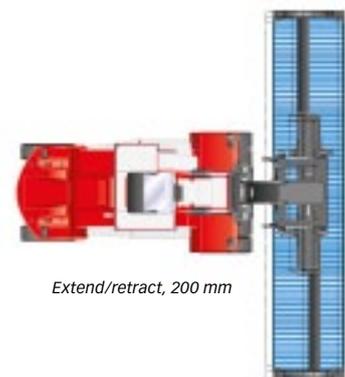
Sideshift  $\pm 400$  mm



Levelling 5°



Slewing  $\pm 3^\circ$



Extend/retract, 200 mm

### 3 Spreader

The integrated spreader is suspended from four (4) hydraulic cylinders, which compensate for unevenly loaded or stacked containers. Powered pile slope is optional. The spreader is easily adjustable with the touch of a button for 20' or 40' containers and can be side-shifted 400 mm either side of centre. Two additional hydraulic cylinders provide precise control of the slewing function.

The mechanical and electrical safety inter-lock systems prevent locking or releasing the twist-locks if the spreader is not properly positioned on the container. It also prevents lifting of the spreader when the twist-locks are not fully engaged or fully released.

The lowering interrupt system prevents chain slack once it is landed on the container. Lights on the instrument panel and spreader indicate proper use of the spreader and locked/unlocked twist-locks.

The Kalmar spreader will handle all ISO standard containers ranging from 20' to 53' long and 8' wide to 8'6" wide. All containers must have the standard ISO 20' or 40' footprint.

## Driving performance

# The basic set up is a key factor for high productivity

Optimised ergonomics. Perfect matching of capacity. Efficient lifting.

The fourth key factor for high top-lift productivity is the basic machine set up. Heavy loads and high lifting speed, for example, put critical demands on the engine and hydraulic power support. Fast positioning during the stacking cycle requires precise control with tight turning radius, effective and reliable brakes and high engine torque. Fast transportation requires good stability, reliable brakes and smooth transmission.

Of course, all the working components and systems have to cope with the most demanding stresses during long shifts and heavy operations everyday.

We have put highest priority on overall technical reliability. Looking at the choice of each component, long running cycle times and how it all comes together. We have incorporated into the DCF several major components and systems from our extremely reliable DRF reachstacker. More than 1000 of these machines have been delivered in the past few years and have proven the durability of the components and systems, and its low running costs.

### 1 Chassis

The frame forms the basis of the machine's lifting and manoeuvring characteristics and was designed exclusively for a top-lift operation. The beam construction, along with its width, makes the DCF stable, torsion resistant and service-friendly.

The frame is 3D modulated (Catia V5) and designed (FEM) in order to eliminate critical tensions under various kinds of strain. The mechanically welded chassis has been optimised according to strength, weight and stability.

### 2 Engine

The Cummins and Volvo engines provide power for driving and the working hydraulics. The engines are low-emission turbo diesels with fuel injectors and intercoolers. The design of the combustion chambers, along with the precise fuel injection control, ensures more efficient combustion to provide lower emissions with increased torque and power. The engines meet the Tier 3 requirements, and the sound and vibration standards.

The radiator is a 3 chamber design with a single fan to provide cooling for the engine and transmission. The engine cooler's separate expansion chambers are fitted with a level sensor that indicates low coolant level.

### 3 Transmission

The transmission transfers power from the engine to the hydraulic pumps and drive line. The engine and gearbox control systems work together to find the optimum balance between power and fuel economy at any given time. The transmission system consists of a torque converter and a gearbox. The gearbox is automatic, but can partly be shifted manually.

### 4 Drive line

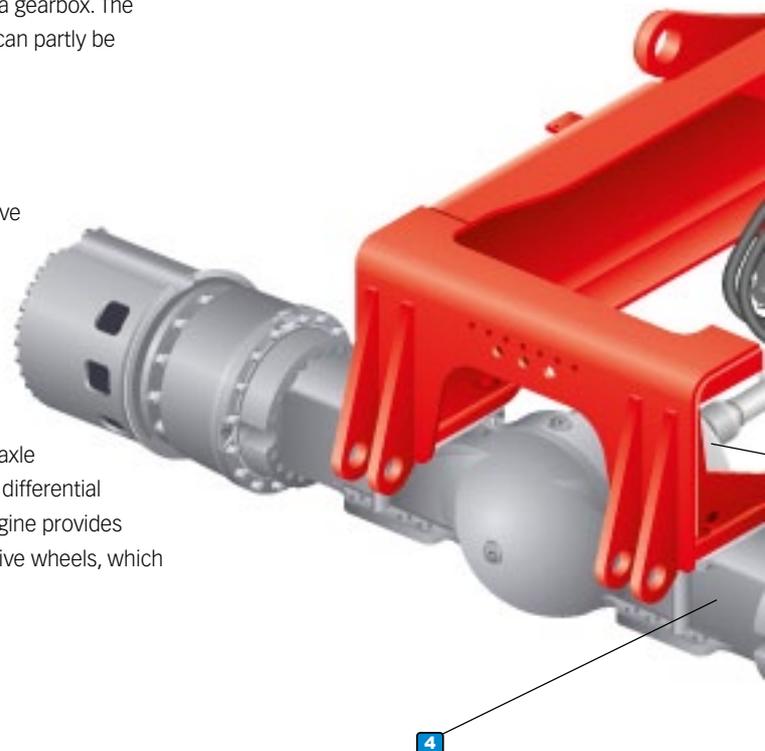
The propeller shaft and drive axle transfer the power from the transmission to the driving wheels. The mountings on the propeller shaft are fitted with cross-flanges for optimum strength. The drive axle gears down in two stages, differential and hub reduction. The engine provides maximum torque at the drive wheels, which spares the transmission.

### 5 Steering system

The steering axle is built from a single piece of high strength steel, which means as fewer parts requiring less maintenance and higher structural integrity. The suspension points on the steering axle utilise a maintenance-free plastic. The hydraulics that feed oil to the steering cylinder is optimised for enhanced driving feel. The orbitrol and the priority valve jointly provide gentle yet precise steering movements.

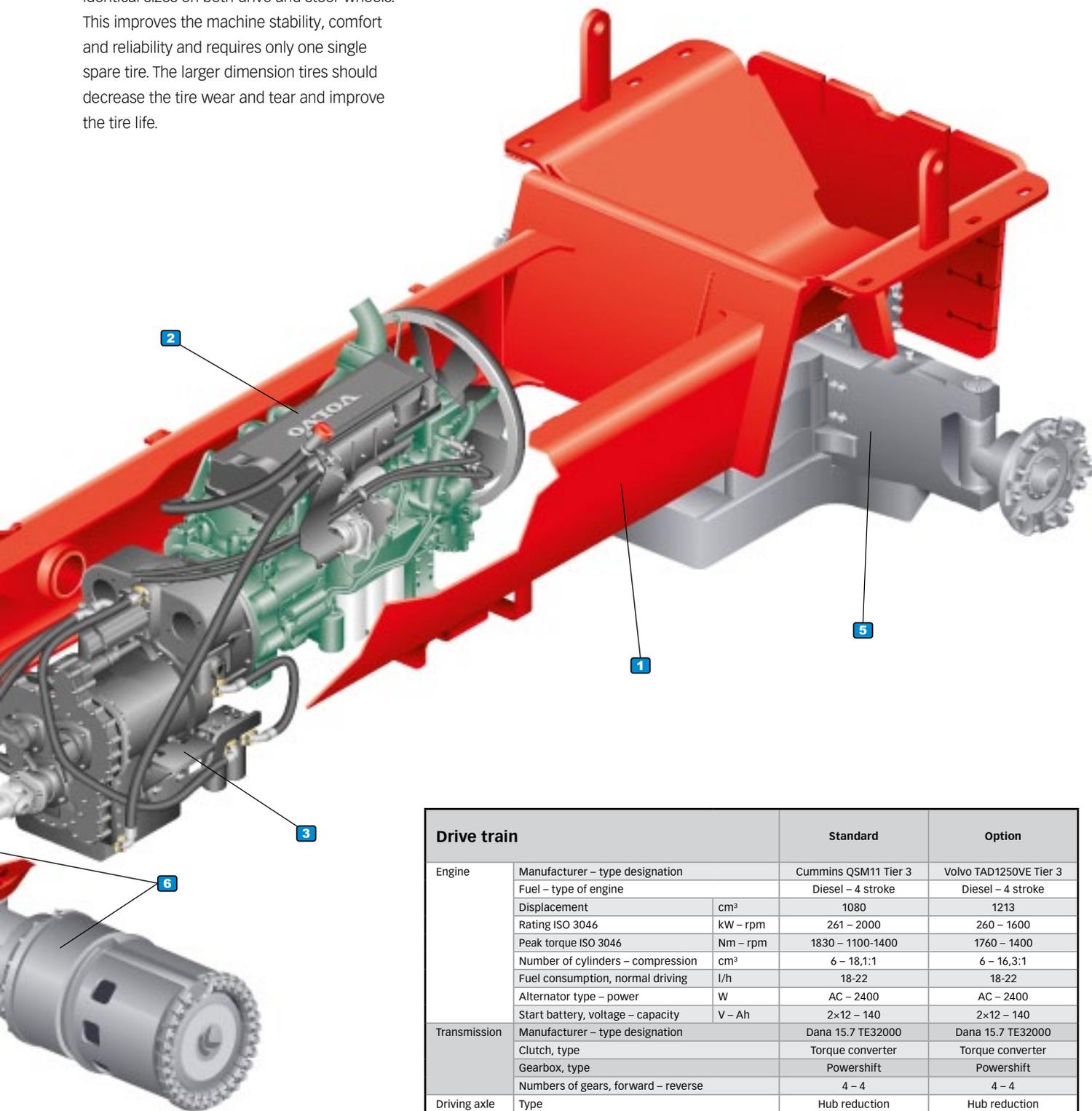
### 6 Brakes

The brake circuit is separated from the hydraulic system and has its own tank, cooler and high-pressure filter. A temperature transmitter in the brake oil tank regulates the cooling fan. The foot-brake valve, which controls the oil feed to the brakes, is sensitive enough so that the driver can brake optimally yet gently. The parking brake is activated automatically when the ignition is turned off.



## Wheels and tyres

Tires are an important cost factor to consider when improving operational performance. Therefore the Kalmar DCF410 and 450 are fitted with 18.00x33 tires, all models use identical sizes on both drive and steer wheels. This improves the machine stability, comfort and reliability and requires only one single spare tire. The larger dimension tires should decrease the tire wear and tear and improve the tire life.



Drive train		Standard	Option
Engine	Manufacturer – type designation	Cummins QSM11 Tier 3	Volvo TAD1250VE Tier 3
	Fuel – type of engine	Diesel – 4 stroke	Diesel – 4 stroke
	Displacement	cm <sup>3</sup> 1080	1213
	Rating ISO 3046	kW – rpm 261 – 2000	260 – 1600
	Peak torque ISO 3046	Nm – rpm 1830 – 1100-1400	1760 – 1400
	Number of cylinders – compression	cm <sup>3</sup> 6 – 18,1:1	6 – 16,3:1
	Fuel consumption, normal driving	l/h 18-22	18-22
	Alternator type – power	W AC – 2400	AC – 2400
	Start battery, voltage – capacity	V – Ah 2x12 – 140	2x12 – 140
Transmission	Manufacturer – type designation	Dana 15.7 TE32000	Dana 15.7 TE32000
	Clutch, type	Torque converter	Torque converter
	Gearbox, type	Powershift	Powershift
	Numbers of gears, forward – reverse	4 – 4	4 – 4
Driving axle	Type	Hub reduction	Hub reduction

## Intelligence

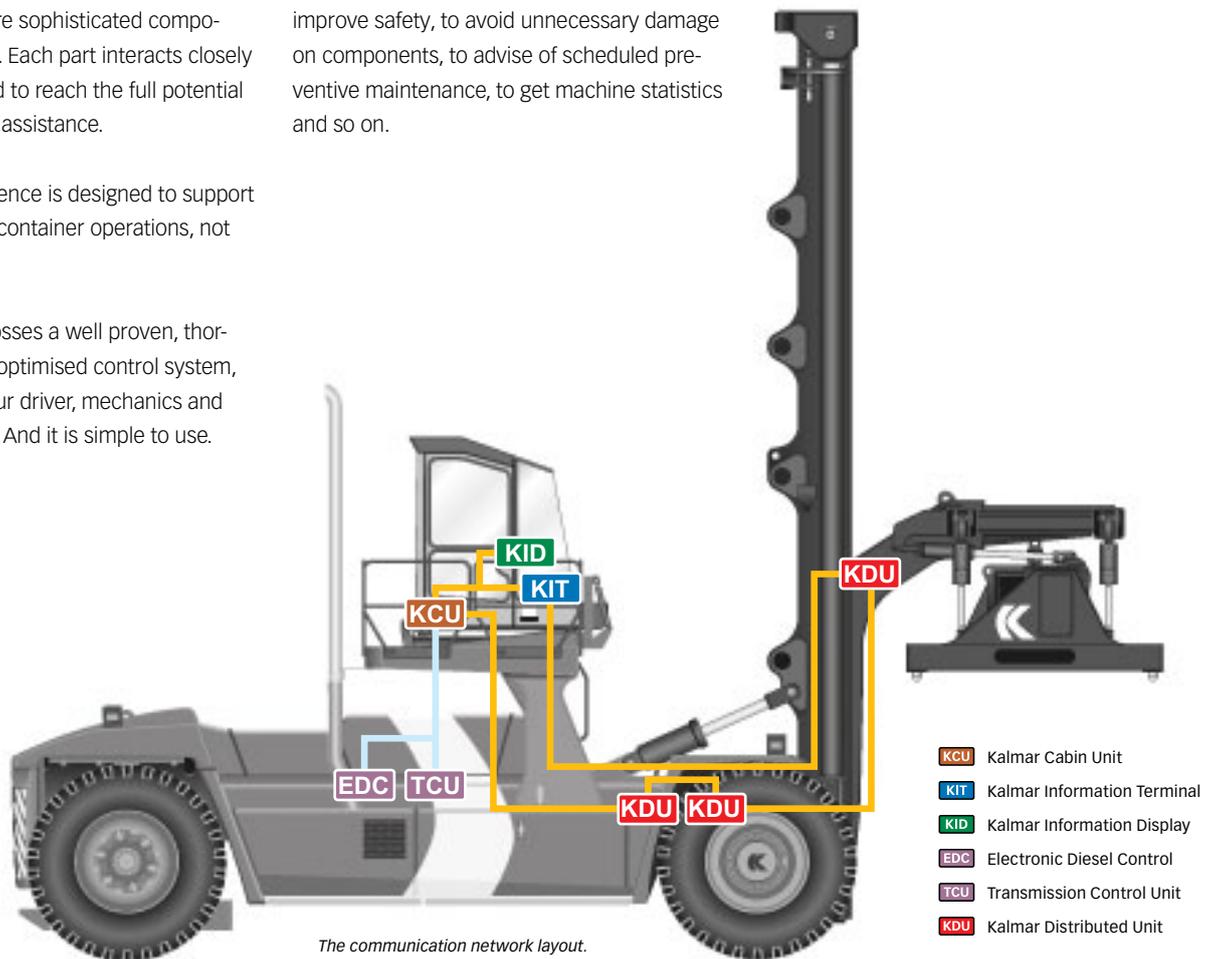
# The simple way to put bits and pieces together

All vehicles today – cars, highway trucks, wheel-loaders, cranes etc – are constructed with more and more sophisticated components and systems. Each part interacts closely with the others and to reach the full potential requires computer assistance.

This built-in intelligence is designed to support and leverage your container operations, not confuse it.

The Kalmar DCF possesses a well proven, thoroughly tested and optimised control system, which supports your driver, mechanics and financial controller. And it is simple to use.

It is designed to get the most out of the machine during the top-lift operations, to improve safety, to avoid unnecessary damage on components, to advise of scheduled preventive maintenance, to get machine statistics and so on.



*The communication network layout.*

### The reliable distributed control system.

Two things are needed for a command initiated by the driver to result in a particular function, or for several functions to work together: power-feed and communication.

The power-feed supplies the machine's electrical or electro-hydraulic functions with voltage. The communication system controls and checks that the functions have been activated, waits in standby mode or indicates faults.

Both the power-feed and communication system form an integrated network distributed to the critical areas of the machine. The main components of the network are the control units (nodes). Each node has its own processor and integrates with each other. All communication, control signals and signal information are sent via data buses. All nodes in the network are talking and listening to each other.

The data transfer is secured by a CAN-bus (two-wire) technology, which means high reliability and extremely low risk for disruption. CAN-bus loops have been used in the Kalmar machines since 1995.

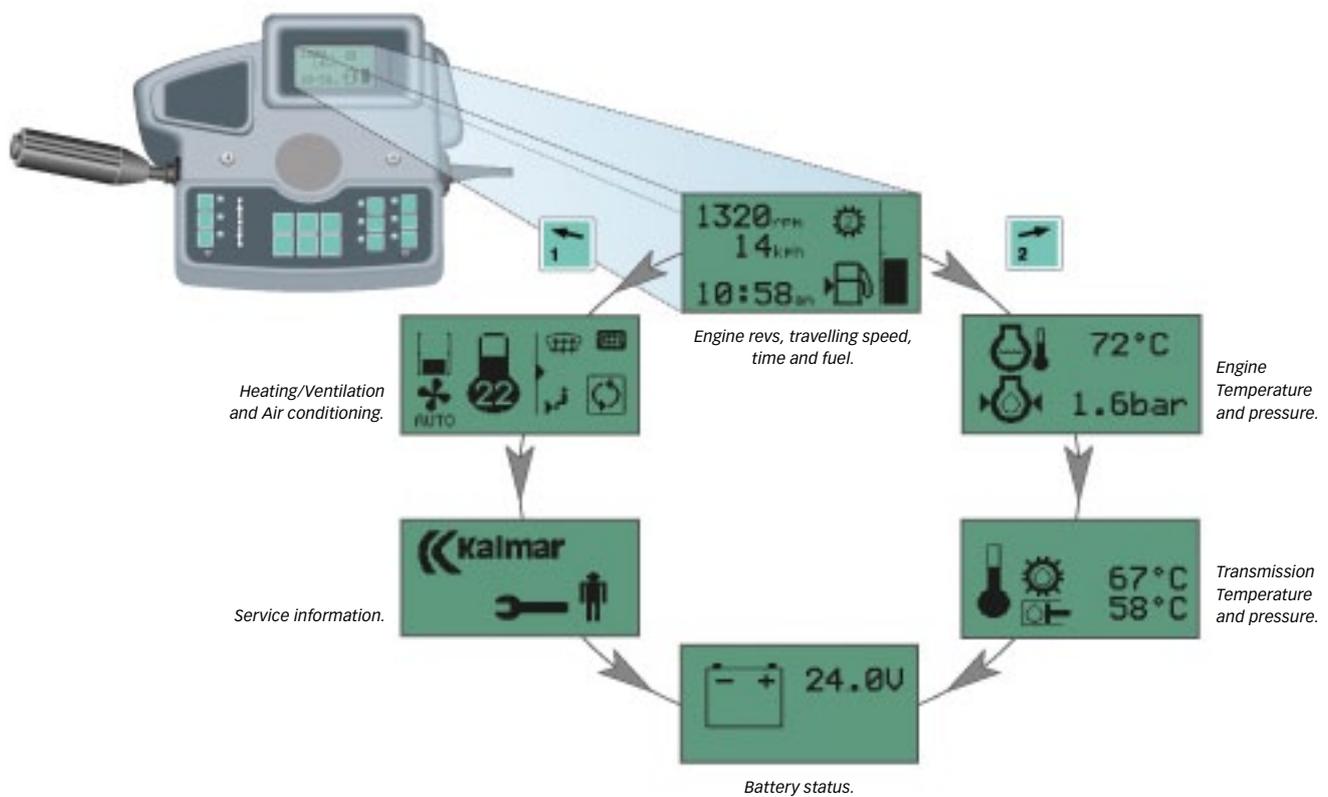
The power-feed for the functions are supplied separately via distribution boxes located in the cabin. The power is distributed and guided by instructions generated from the communication network.

**Control functions – support the driver.**

The driver and machine communicate very simple via the Kalmar Information Terminal and the Information Display located right in front of the driver in the cabin. The two-way communication – from the driver to the machine and opposite – is handled by the KCU (Kalmar Cabin Unit) which is the control node for the entire network.

Information to the driver comprises alarm warnings, operating details and action-guided information. Messages, status, fault indications etc are presented on the Information Display, while warnings and other monitoring indications are presented to the left.

Messages are only presented when they are relevant to the driver and the operation, so the driver can focus on the job instead of checking meters and indicators.



## Availability

# We have made sure your investment becomes profitable

To understand the full potential of your investment requires being aware of the details, features and technical matters in a machine like the Kalmar DCF.

But when it comes to availability it is critical that it operates constantly and is kept in good condition with an absolute minimum of maintenance and repairs.



### Less stops and no stops.

The Kalmar DCF is designed for long shifts, which means that you may have to replace the driver before you have to call it in for fuel. The good weight/engine power relationship combined with a fuel tank designed for 50 hours of operation make these machines run the extra hours you want them to.

The service intervals have been extended to 500 hours, which means that you don't have to take the machine out of work more than 6 times a year (3000 hours utilisation).

The DCF is designed for fast daily inspection and preventive maintenance. All checkpoints are easy accessible and concentrated to specific locations. Lubrication free components or central lubrication points have been utilised. The wet disc brake system is practically maintenance free.

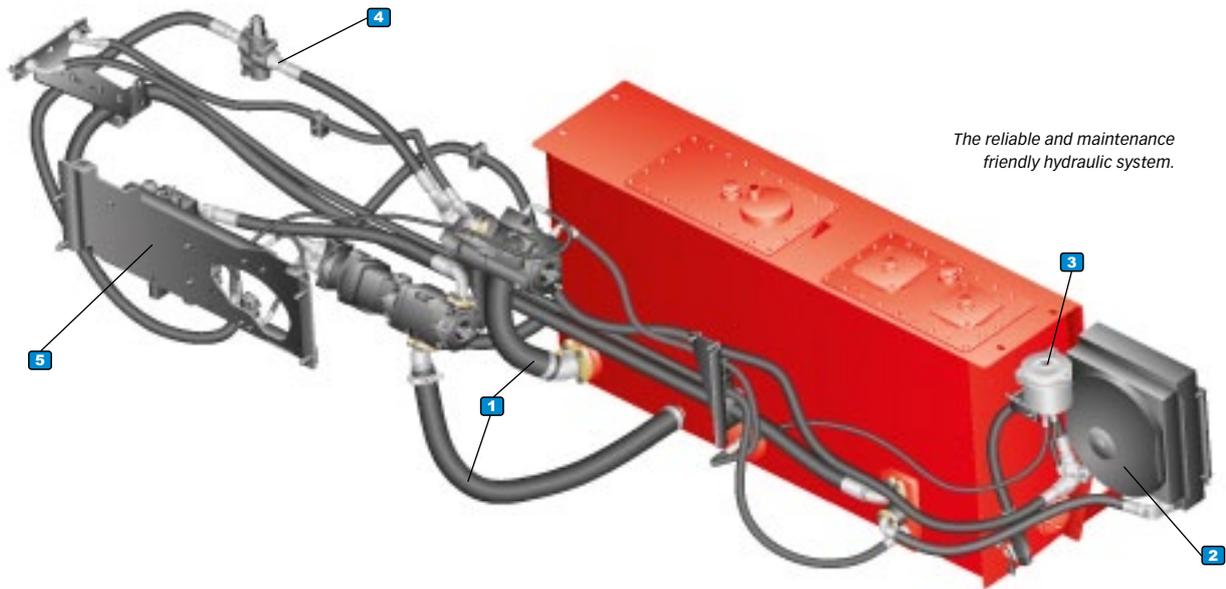
The indicator and monitoring support built into our control system make sure that the machine won't be misused or maintained incorrectly. The driver and mechanics will always get indications and guidance in time to avoid unnecessary and costly wear and tear or technical breakdowns. No unwanted stops.

### Reliability starts already at the concept stage.

One of the guiding principles in designing the DCF was to minimise the number of potential sources of error. Therefore the machines consist of as few components and moving parts as possible. The functionality and operational reliability is assured by extensive testing.



*Fewer components makes for increased reliability, only two hoses and one harness runs over the mast wheel.*



The reliable and maintenance friendly hydraulic system.

### The hydraulic system is critical.

No other part of the machine is working so hard under continuous pressure. To secure the reliability we have minimised the number of hydraulic components and couplings.

The main valve has an integrated servo which helps increase precision and control over the oil flow. The hydraulic oil is fed to the carriage and spreader by a variable piston pump, which saves a lot of power and energy compared to continuous oil circulation. Another innovative solution – the valve for the gantry and spreader functions has been mounted on the gantry. The result is an instant and accurate connection between lever and function. This also minimises the number of hydraulic components in the chassis.

In order to maintain optimum functionality in the system even under extreme operating conditions, cleaning and cooling of the hydraulic oil is highly efficient. The hydraulic brake circuit is separated from the main system and is fitted with its own filters.

### Other improving features:

- 1 Large dimensions of hydraulic hoses improves the hose's lifetime (slower flow, less friction and less heating).
- 2 Thermostatic cooling of both the main system and the brake system improves the oil lifetime (temperature control, optimised working temperature).
- 3 High density filter improves the oil lifetime (clean oil).
- 4 ORFS – leak proof couplings all around improves reliability (minimises leakage).
- 5 All main hydraulic components at ground level are gathered on a separate plate, bolted to the chassis and therefore simple to remove.



### A safe communication network

The control and monitoring system is the new Kalmar control system, but already successfully applied in more than 1000 Kalmar machines worldwide.

This new redundant CAN-bus system is proven to be excellent in functionality and reliability. The network of control nodes allows for less wiring and connectors which reduces the number of sources of error. The power-feed for each node and the transfer of control signals are independent of the other nodes, which means the risk of disruption becomes minimal. The redundant design means that there are always two paths to choose to maintain communication, which results in extra safety and reliability.





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