HydraForce

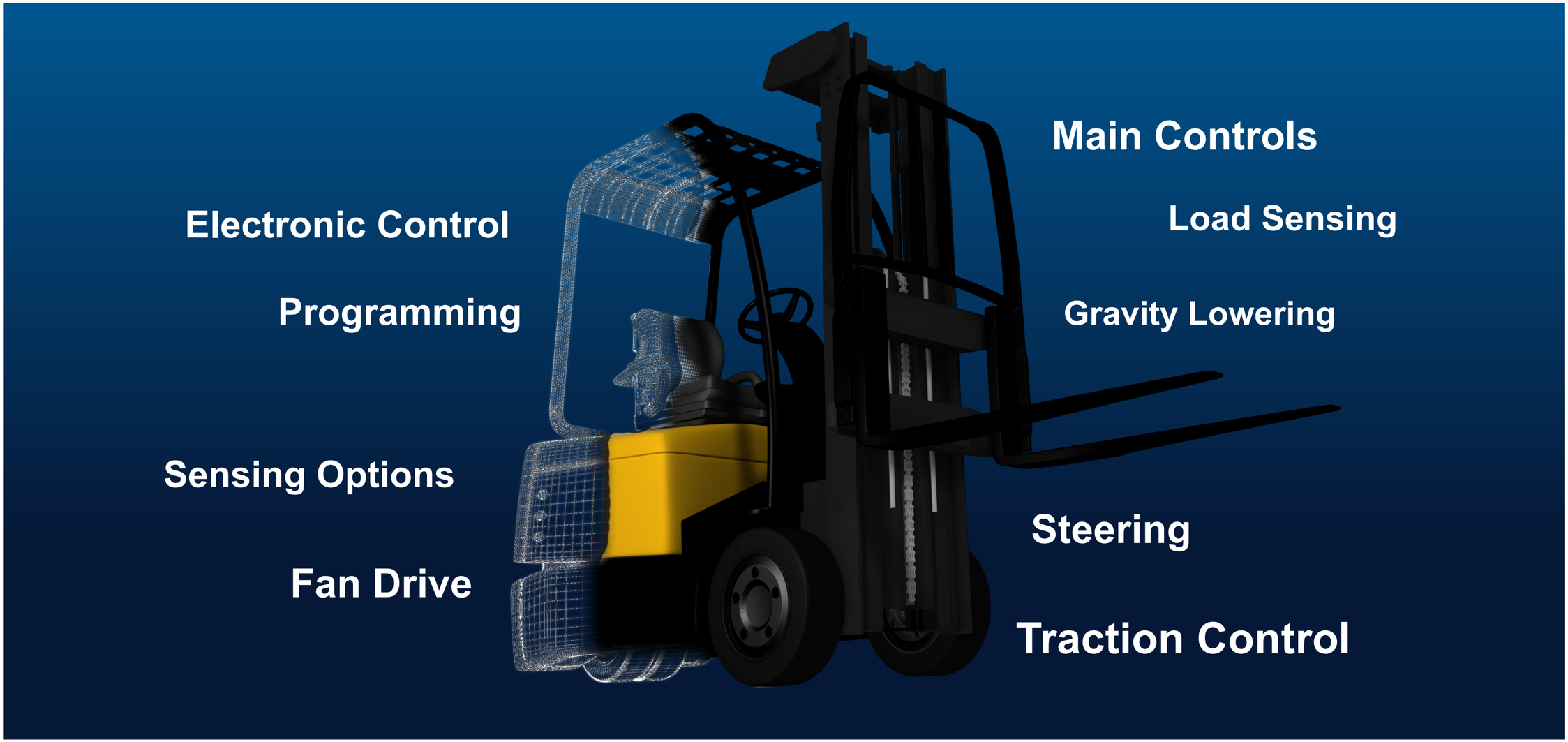
POWER FORWARD®

Electro-Hydraulic Control Solutions For

Material Handling

www.hydraforce.com

INNOVATIVE DESIGN
CUSTOMIZE TO APPLICATION
SAVE ENERGY
EASILY SERVICEABLE



TECHNOLOGY AND MATERIAL HANDLING

The material handling industry encompasses a variety of vehicles and machines that specialize in efficient lifting, rapid transport, and accurate placement of goods and materials of all sizes, shapes, and weights. Telehandlers and fork lifts are the mainstays of this industry, operating indoors in factories and warehouses, or outdoors on farms and construction sites. Safe lifting of materials and safety for the operator are paramount in this field and new safety regulations are requiring redesign of equipment.

There are many opportunities to improve the control, efficiency and safety of material handling equipment through the use of hydraulic cartridge valves.

CONTENTS

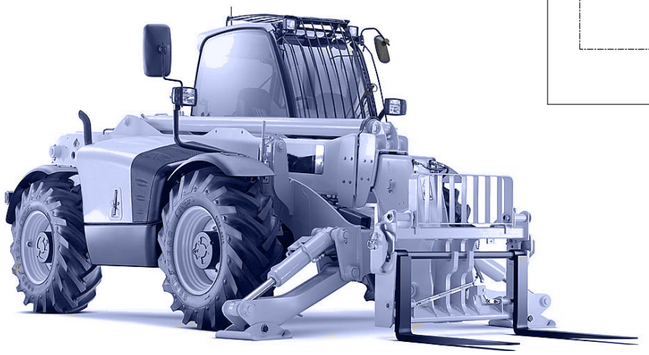
TELEHANDLERS - OVERVIEW

Telescopic handlers, or telehandlers for short, come in an amazing array of sizes, shapes, weights and heights, depending on the type of material they need to lift and carry. There are trends for telehandlers to reach higher, lift faster, use less fuel, hold more load, turn sharper corners, fit in tighter work spaces, and meet stricter safety regulations. Many telehandlers are equipped with four-wheel drive, so they need good traction and steering control, especially if travelling on rough or uneven ground.

Hydraulic cartridge valves may be small and compact, but they play a large role in accomplishing more efficient and responsive control of the tallest of telehandlers.

SAFETY WITHOUT COMPROMISE...

European safety standard EN 15000, introduced in 2010, requires material handling machines to automatically reduce speed before unloading to ensure stability. HydraForce multi-function cartridge valves can accomplish this without compromising performance.



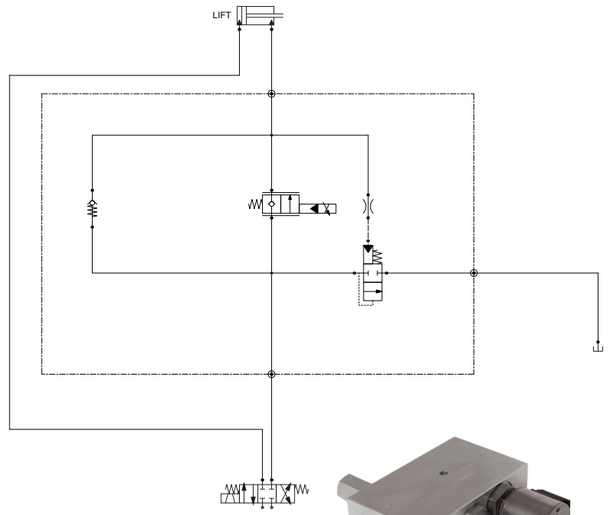
CONTROL OPTIONS FROM TOP TO BOTTOM...

From stabilizing and steering to telescoping the boom and holding the load, hydraulic cartridge valves work on every level in the telehandler market.

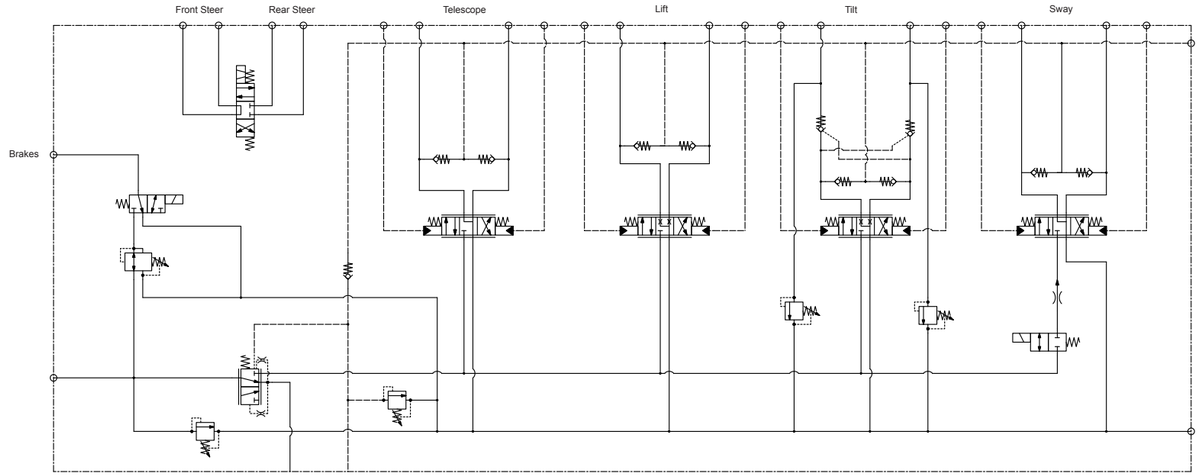
Piloted directional control valves provide cost-effective control of telescoping, lift, and sway functions. The pilot is controlled from the joystick in the cab.

These spring-centered electroproportional cartridge valves are available in several sizes and flow rates and can be further customized with several choices of spring-centered, symmetrical spools capable of meter-in/meter-out control. The lower flow tilt and sway functions make use of smaller sized valves, while the higher flow telescoping and lift functions use larger sized valves.

The circuit at right shows how piloted directional valves can be configured. It also shows a load-sense system designed to work with a load-sensing pump, brake charging with an accumulator, and priority steering.



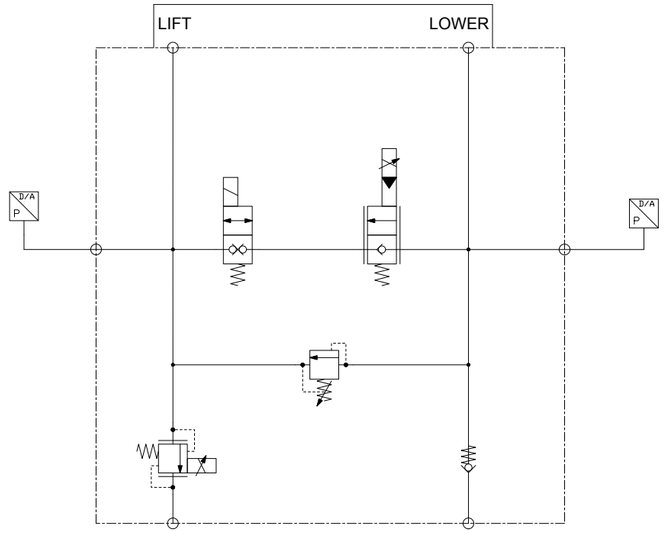
EN15000



From brakes and steering to telescoping the boom and holding the load, hydraulic cartridge valves work on every level in the telehandler market.

GRAVITY LOWERING...AN EFFICIENT ALTERNATIVE

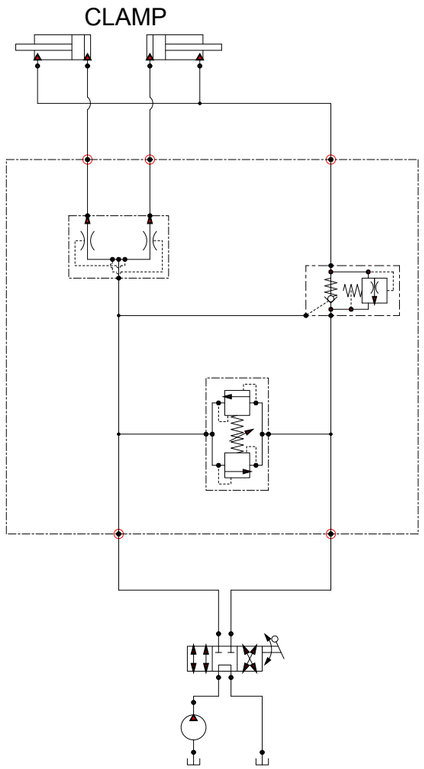
Gravity lowering, or using the force of nature for load-lowering rather than engine power, is another trend that is helping telehandlers save fuel and improve efficiency. This gravity-lowering circuit for a telehandler needs no pump output for lowering and regeneratively increases the speed of other machine functions. This innovative approach has saved one gallon of fuel per hour in some applications.



FORKLIFTS - OVERVIEW

The term, "fork lift truck" is almost a misnomer, as today's material handlers use a wide range of attachments to handle loads of any size, shape, temperature, and weight. Clamps or arms, rather than forks, are used for awkward loads, such as crates, bales or tires.

Powering and control of these attachments are ideal applications for compact hydraulic cartridge valves that can accommodate a range of flow rates and operating pressures. They also have the flexibility to locate controls on the attachment itself, simplifying the vehicle's main systems when attachments are not in use. Electronic control can further enhance position and load-sensing for material handling attachments.



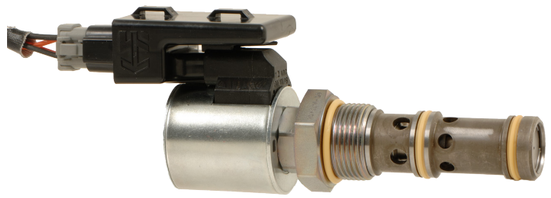
This circuit shows how you can control a carton clamp attachment. It uses a flow divider combiner to maintain equal pressure on both arms of the clamp.

FLEXIBLE, SIMPLE AND LOW COST CONTROL

Plug-in valve drivers, such as the HydraForce ExDR-0101A and ExDR-0201A provide flexible and self-contained control for material handling attachments. If only one more output is needed, use the ExDR-0101A. For one or two inputs or outputs, the ExDR-0201A can be used.

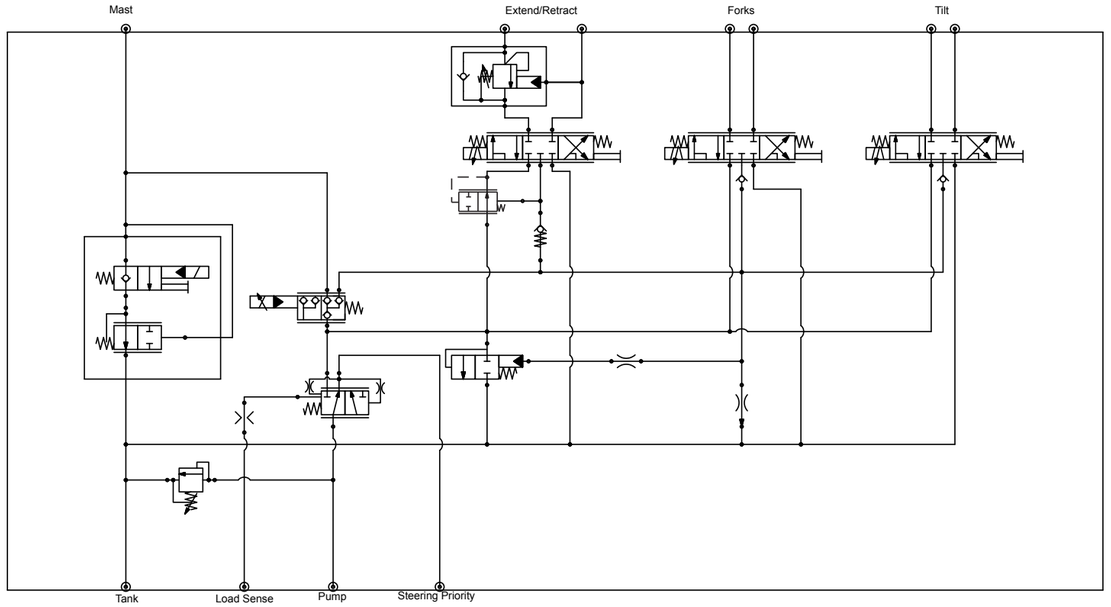
These controllers plug directly in to an electro-proportional valve and respond well to an independent voltage, current or resistance signal. They are a simple, low cost way to enhance the control of a hydraulic function.

Fan, transmission, and custom-configurable models of the ExDR valve drivers are available.



CONTROL of lift truck ATTACHMENTS is an ideal application for compact cartridge valves

INNOVATIVE DESIGN
CUSTOMIZE TO APPLICATION
SAVE ENERGY
EASILY SERVICEABLE



This circuit for a three-wheel electric counterbalance truck uses the force of gravity for lowering rather than hydraulic pump pressure, which saves energy and fuel. A previous manifold required pilot pressure to activate the lower spool.

This circuit used HydraForce multi-function SPCL valves for fast "closing" response. When the operator releases the joystick to stop the motion of the forks, they stop immediately. These valves also helped reduce the size of the manifold.

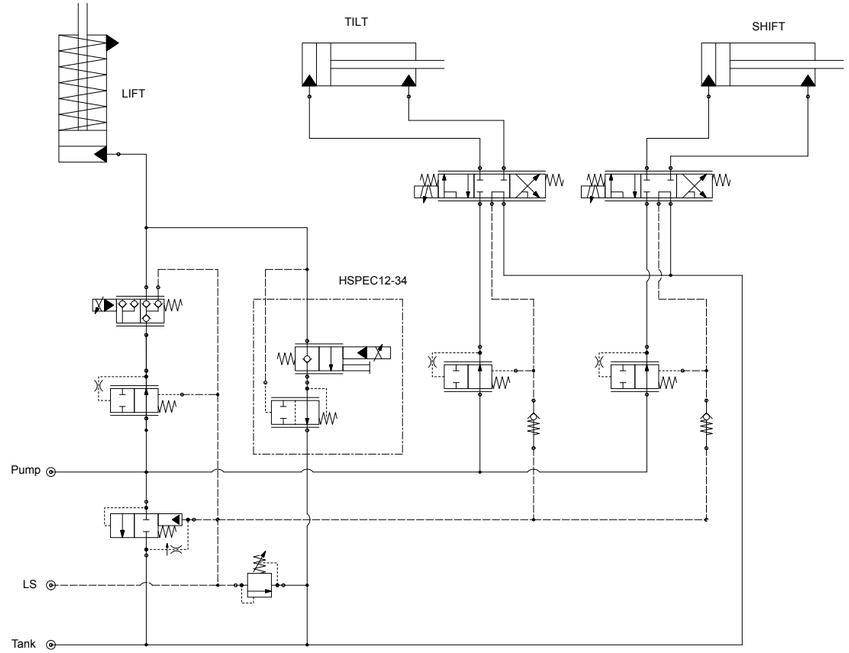
Multi-Function Valve Regulates Flow While Load-Holding

Multi-function valves are gaining popularity for use on the main controls of telehandlers and forklifts, thanks to their flow sharing and load holding capabilities. Main control functions include boom lift, tilt and load-holding.

Flow sharing is desirable whenever a machine needs to operate multiple work functions simultaneously.

Load holding with precise and stable flow control is especially desirable for material-handling equipment. Multi-function valves can be used to provide a choice between power-down and gravity-assisted lowering of the boom. By using the boom's structurally induced load pressure, the multi-function cartridge valve harnesses the natural force of gravity to provide smooth, stable lowering.

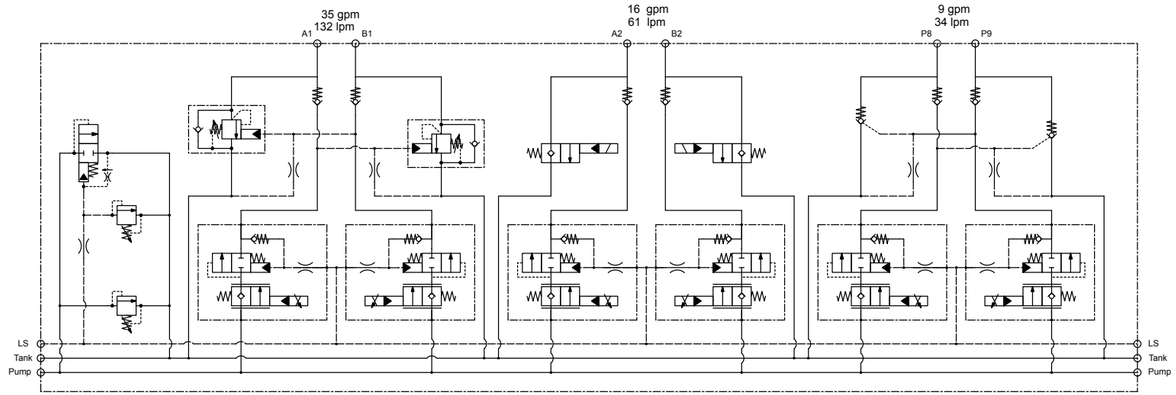
MAIN CONTROL FOR FORKLIFTS



This schematic shows a typical application for a single-acting lift cylinder. Multi-function HSPECxx-34 valves are used for the lowering function of this circuit.

BRIDGING THE GAP

Bridge circuits provide superior motion control performance by coupling flow-controlled meter-in with pressure controlled meter-out. Hydraulic flow is effectively shared between all functions with the use of HydraForce HSPECxx-30 valves. This feature enables more responsive and more flexibly packaged motor and cylinder control with post pressure compensation and a superior degree of controllability than other directional control options can provide.

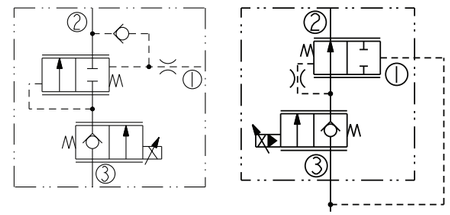


THE NEW HSPEC FAMILY

The new HSPEC family of multi-function cartridge valves ensures scalable flow capacity and precise control. With three sizes and flow rates to choose from, the HSPEC valve offers design flexibility for proper control of position and pressure.

HSPECxx-30 valves have a built-in post-compensator and load-sense valve, which enables more compact and efficient directional control packages. They come in several sizes and flow rates from 34 to 98 lpm (9 to 26 gpm).

HSPECxx-34 valves combine a proportional lowering valve with a pressure compensator and are ideal for lifting and lowering control of single-acting cylinders. When combined with the HSPECxx-30 valves, you can create a compact, cost-effective flow-sharing circuit that enables efficient use of available horsepower while offering controlled load lowering.



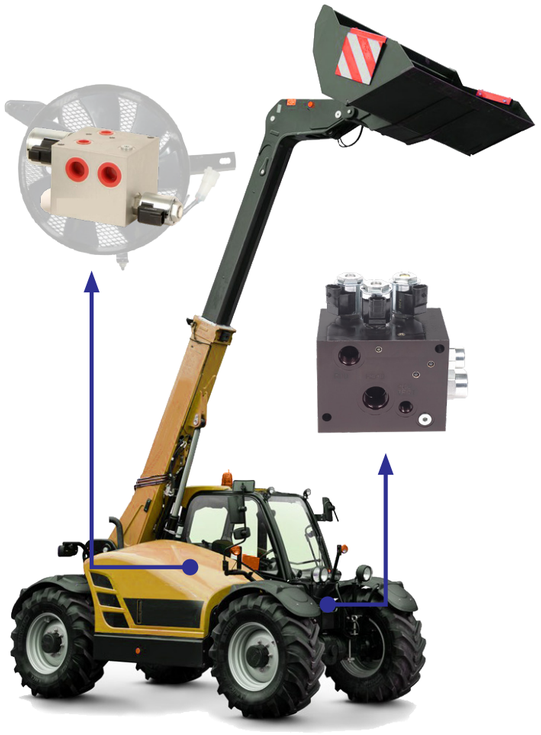
ACCELERATE RETRACTION 50% faster boom retraction

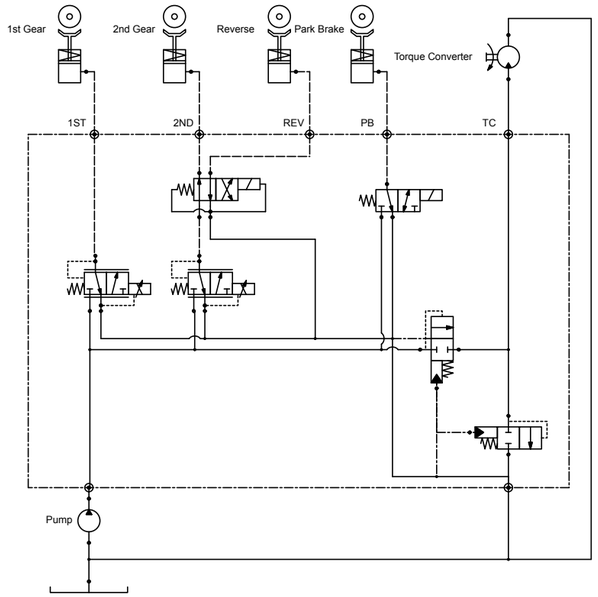
Hydraulic cartridge valves can be applied in ways that not only save energy but also provide better control of traction. In material transport, wheel slippage can be a problem, particularly with heavy loads on rough terrain.

One solution is a series-parallel hydrostatic drive with the HydraForce HTD10-40 torque divider. This pressure reducing/relieving valve adjusts its setting to half the inlet pressure, achieving efficient torque divisionregardless of differing motor speeds.

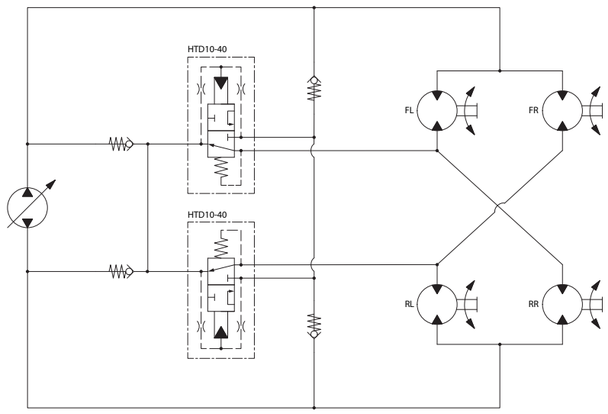
Fan drive systems match fan speed to cooling demand, saving energy and space. Compact fan drives can be reversible to help keep radiators clean.

ELEVATE your machine to the **FUTURE** **of** hydraulic controls





A typical two-speed transmission for a telehandler

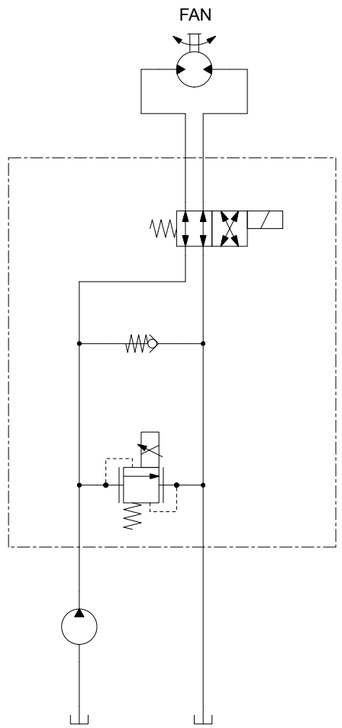


Four wheel drive series-parallel crossover with torque dividers for a telehandler

FAN DRIVE SOLUTIONS

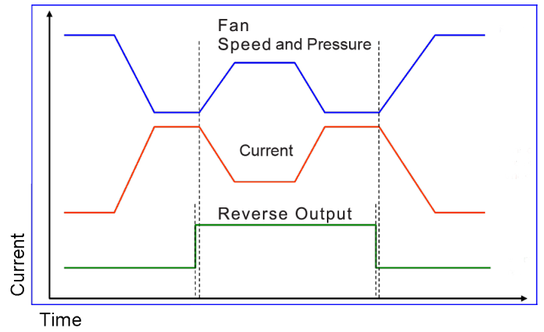
A small flow from the vehicle's hydraulics can operate a variable speed/reversible fan drive. Temperature sensors and proportional valves match fan power to cooling demand offering significant horsepower savings.

This proportional fan drive circuit includes a number of valuable features. The fan is reversible for radiator cleaning. Relief valves and anti-cavitation checks protect the motor from stalling and overrunning. And a pressure reducing/relieving valve coupled with temperature sensors forms the fail-safe speed control. This circuit operates even with a complete loss of signal. This system is compatible with load-sensing hydraulics.

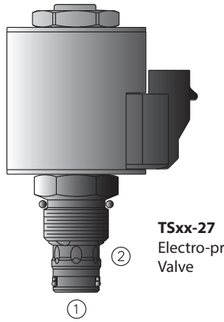


A basic fan circuit for a telehandler

FAN OUTPUT PERFORMANCE



Control valves with multiple temperature inputs can be used to provide variable fan speed control depending on air temperature, load and cooling requirements. If the radiator gets clogged, the electro-proportional valves can automatically reverse fan direction.



TSxx-27
Electro-proportional Valve

The TSxx-27 electro-proportional valve is often specified to control pressure to the fan motor. It can be driven by an electronic controller to provide variable fan speed for maximum cooling.

ERT 120
Temperature Sensor

The HydraForce ERT120 sensor is designed for use in demanding industrial applications. It can sense temperatures from -40 to 150° C (-40 to 300°F) and has a padded resistor for improved linearity of the input curve.

Steering and braking are the most important functions on on material handling equipment, and as such, they have priority over all other hydraulic demands.

HydraForce manufactures a range of priority, on-demand pressure compensators with dynamic load sensing for fast response. Priority control circuits often utilize one or more accumulators to store hydraulic energy for use upon demand.

PRIMARY STEERING AND BRAKE SOLUTION

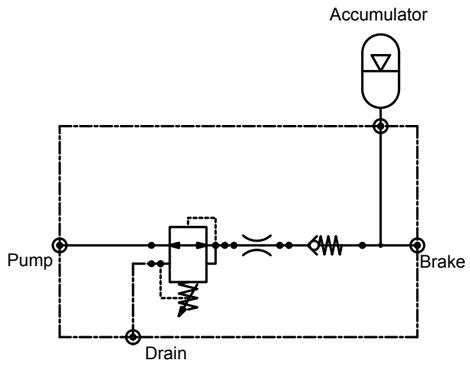
A typical circuit provides priority flow for steering while maintaining a predetermined range of pressure in the accumulator/s to ensure an adequate supply of oil to pump the brake seven times in the case of a loss of power.

If one accumulator fails, a load shuttle valve shifts over to protect the operational one. A pressure compensator valve provides priority flow in the required amount while allowing excess flow for auxiliary functions.

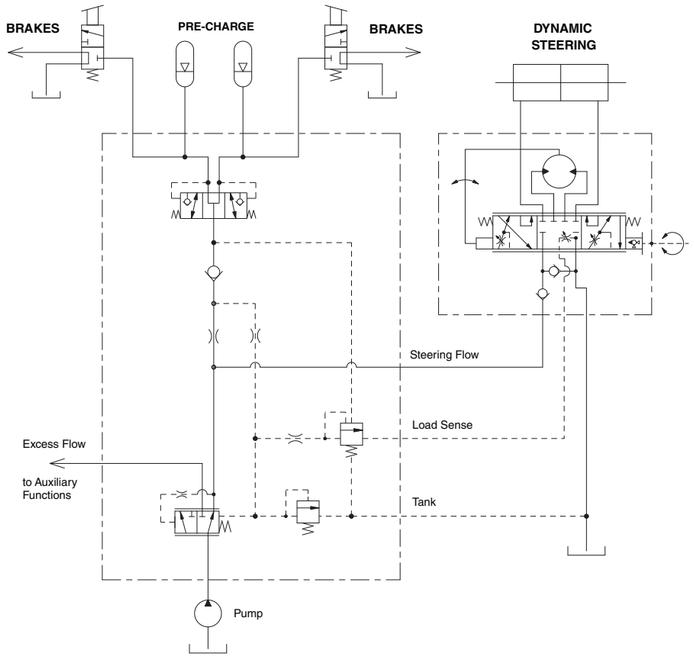
BETTER BRAKING

A simple brake circuit provides reduced pressure to power off the brakes. An alternative brake circuit includes a hand pump that can be used for emergency pumping of the brake.

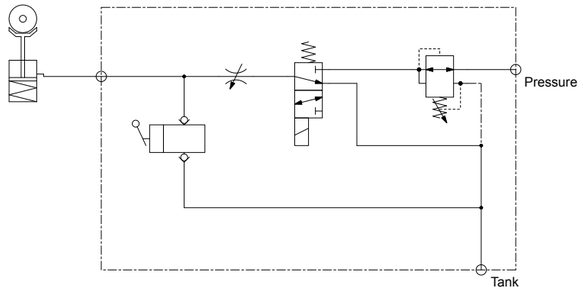
SIMPLE BRAKE CIRCUIT



TYPICAL PRIORITY FLOW CIRCUIT



ALTERNATIVE BRAKE CIRCUIT



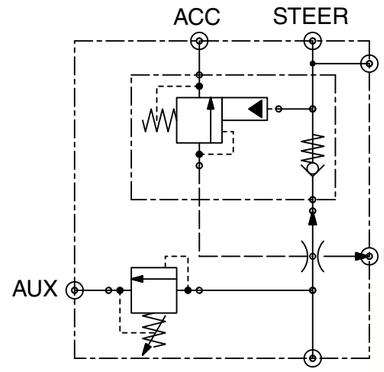
This circuit uses a solenoid valve to provide hydraulic pressure to power off the brake, a needle valve to control how quickly the brake is applied and released, and a hand pump to allow emergency braking.

INNOVATIVE DESIGN
CUSTOMIZE TO APPLICATION
SAVE ENERGY
EASILY SERVICEABLE

SPACE-SAVING PRIORITY CONTROL FOR BREAKING...

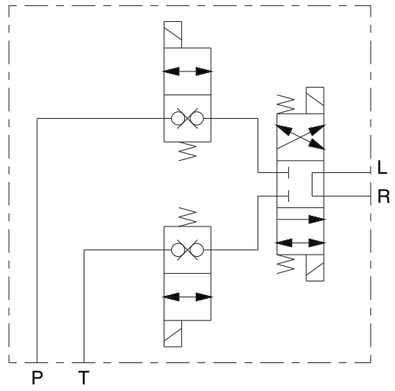
Space-saving solution uses the multi-function UPCV and FR valves with a high pressure relief valve for a total of three valves in the manifold.

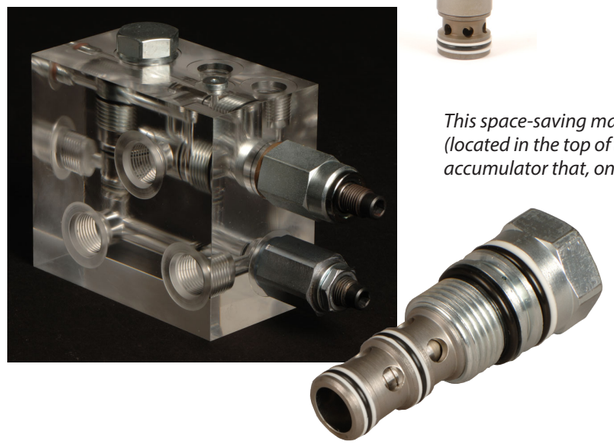
The UPCV valve is a piloted pressure unloading valve with an integrated check valve. The FR valve is a pressure-compensated flow regulator. The circuit below depicts how these two valves work together in a manifold.



...AND DYNAMIC STEERING

A steering mode selector valve with secondary lockouts is an efficient way to control steering on a telehandler.



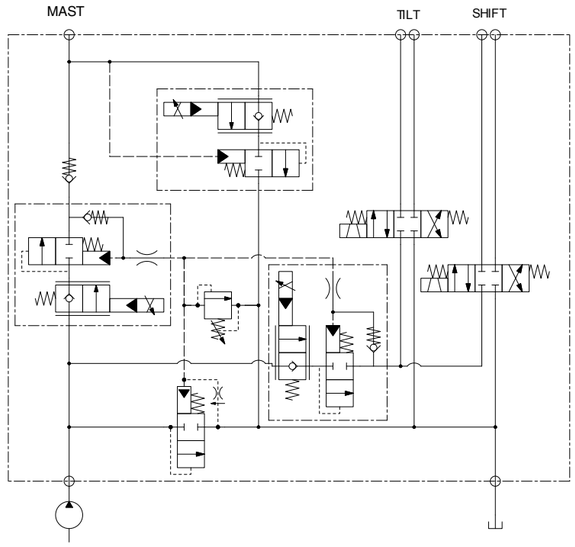


This space-saving manifold uses two multi-function valves. The ventable FR valve (located in the top of the manifold and pictured below it) sends priority flow to an accumulator that, once charged, assures adequate pressure at all times for the brakes. Once the accumulator is charged, the UPCV valve (pictured at left) automatically unloads the pressure to make it available for other machine functions.

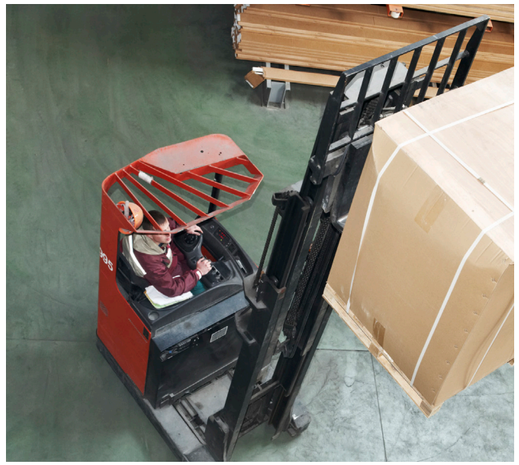
Full system controls involving the integration of electronics and hydraulics can make telehandlers and forklifts easier to operate. Whether your equipment needs just one more input or output for an attachment, or more fully integrated controls, HydraForce has the range of electrohydraulic options to suit your needs.

Integrating electronics doesn't have to be expensive or complex. Free programming software is available from www.hydraforce.com and libraries of pre-programmed functions, such as lift/lower and tilt/reach are available upon request from the HydraForce Electronics Support team. In many cases, by incorporating just a single electronic control unit, you can simplify several control functions. Your system can be designed with the flexibility to add more controls later.

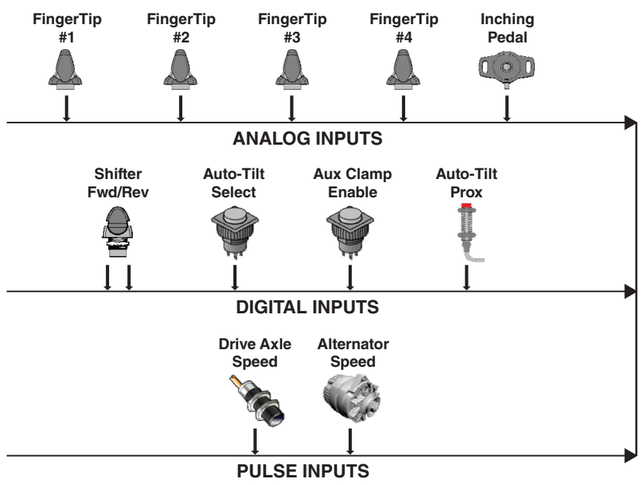
The use of higher flow electroproportional valves is another easy way to gain greater control of multiple machine functions. With greater flow, you can develop a flow-sharing scheme with the flexibility to handle auxiliary and priority functions.

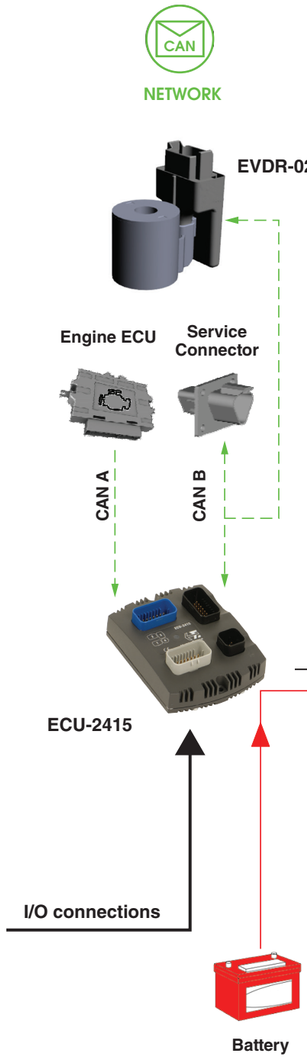


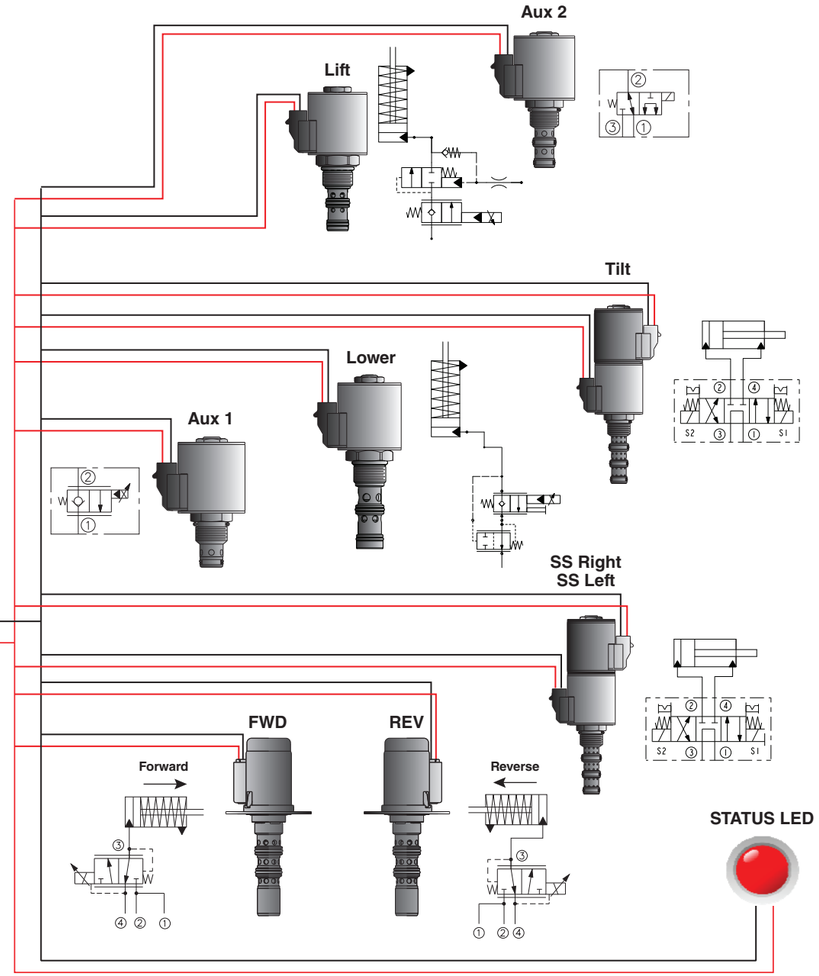
Flow-sharing with higher flow cartridge valves can provide full system control for lifting, lowering and auxiliary functions.



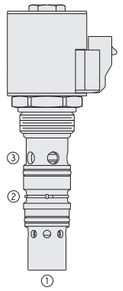
By incorporating just a single electronic control unit, you can simplify several control functions for a forklift or telehandler.







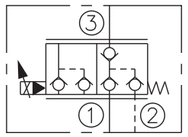
This diagram depicts a fully integrated electrohydraulic control system. Inputs and outputs are controlled by a single ECU-2415.



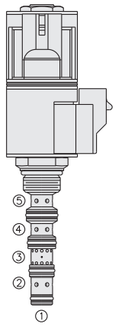
U.S. Patent 7,921,880

SPCL 16-30

Proportional Directional Control, 4-Port, Normally Closed with Check Isolated Load Sense

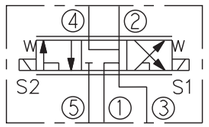


Flow: Up to 152 lpm/40 gpm
Pressure: 250 bar/3625 psi

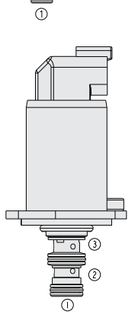


SP08-58D

5-Way Proportional Valve
with Integral Load Sense Port

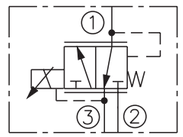


Flow: From 13 lpm/3.5 gpm to 30 lpm/8 gpm
Pressure: 240 bar (3500 psi)

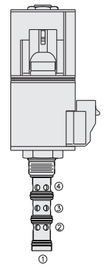


EHPR98-G3x

Proportional, Reducing / Relieving, Drop-in



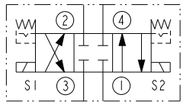
Flow: 4-6 lpm/1-1.4 gpm
Pressure: 20-30 bar (290-435 psi)



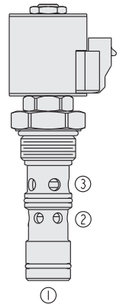
U.S. Patent 8,253,063

HSV12-47C

High Pressure Solenoid, Direct-Acting, Spool Type, 4-Port, 3-Position

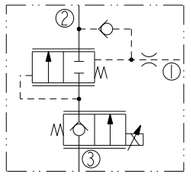


Flow: 57 lpm/15 gpm
Pressure: 350 bar (5075 psi)

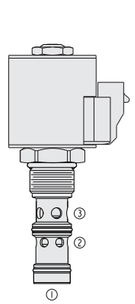


HSPECxx-30x

Proportional Flow Control Valve
with Integral Post-Pressure Compensator

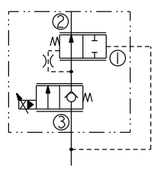


Flow: Up to 132 lpm/35 gpm
Pressure: 350 bar (5075 psi)



HSPECxx-34

Proportional Flow Control Valve
with Integral Compensator



Flow: Up to 106 lpm/28 gpm
Pressure: 350 bar (5075 psi)

OUR BREADTH OF PRODUCT

As the largest manufacturer of hydraulic cartridge valves in the world, HydraForce offers an extensive range of solenoid, electro-proportional, directional, flow, and pressure control valves. Last year, more than 200 new valves were introduced, including many high pressure and multi-function models. Cartridge valves for flow rates up to 379 lpm/100 gpm and operating pressures up to 350 bar/5,000 psi are sold individually, with housings or in manifold blocks. Valves can be custom-designed or standard product.

HydraForce designs, manufactures and supports valve, manifold and accessory products supported by heavy duty electronic machine control capabilities.

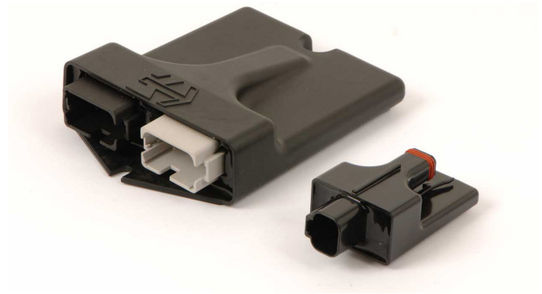
To request a free hydraulic integrated circuit (HIC) consultation, please visit:
http://info.hydraforce.com/Free-Custom-Circuit-Consultation/

INNOVATIVE DESIGN
CUSTOMIZE TO APPLICATION
SAVE ENERGY
EASILY SERVICEABLE

PROGRAMMABLE MACHINE CONTROLLERS

It's easy to add electronic control to your hydraulic application with the HydraForce line of electronic control units (ECUs) and electronic valve drivers (EVDRs).

HydraForce electronic controllers are designed to withstand the environmental demands of mobile, off-highway equipment applications. With flexible input and output configuration, these controllers can easily be customized for a wide variety of applications, including fan control, transmission and timed control applications, and more.



EVDR-ELECTRONIC VALVE DRIVERS

EVDRs are compact, economical and reliable electronic drivers for proportional solenoid valves. They mount directly onto the solenoid coil and are configurable using HF-Impulse software on a computer and serial cable or CAN to USB adapter.

EVDR-0101A

One input and one output. Input can be accepted from analog or digital operator interface devices.

EVDR-0201A

One or two outputs and one input that can be accepted from analog or SAE J1939 operator interface devices.

ECDR-0506A

Features six configurable inputs and five PWM outputs. This larger valve driver will be able to provide precise, repeatable control of four proportional valves and one on/off solenoid. The LED signal provides quick status check. The ECDR-0506A is CAN capable with CANopen and SAE J1939 protocols.

HF IMPULSE CONFIGURATION SOFTWARE

HydraForce has developed an easy-to-use configuration platform - HF-Impulse, available for free download from the HydraForce Electronics Portal at www.hydraforce.com/electronics. HF-Impulse allows you to flash devices with the latest firmware and configure all parameters for operation. You can configure any HydraForce electronic controller using HF-Impulse.

ECU-ELECTRONIC CONTROL UNIT

Model ECU-2415

Up to 39 digital, pulse, current measuring feedback and analog inputs along with 24 outputs consisting of up to 24 PWM or digital high-side drivers.

Model ECU-2820

Up to 52 inputs and 28 outputs consisting of up to 24 PWM or digital high-side drivers and up to four digital low-side drivers.

Model ECU-0809

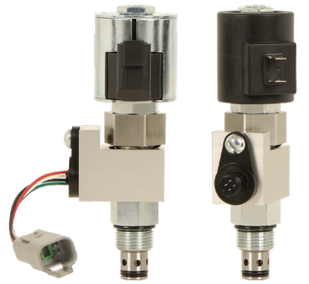
Features 8 flexible sourcing outputs, 9 flexible inputs, and 4 feedback inputs. This controller is built on a powerful 32-bit microprocessor and features a diagnostic indicator, unlimited F-RAM and CAN capability.

ECU 2415 and 2820

ECU 0809

SENSOR VALVE

Select HydraForce valves can be ordered with an integral position sensing option capable of transmitting an on or off signal. This new sensing solution was designed for interchangeable use with existing HydraForce cartridge valves, is compatible with manual override options and uses an industry standard cavity.



HEAVY DUTY SENSORS

HydraForce has accurate sensors designed for off-road applications.

Our temperature sensors are thermistor style with padded resistors.
ERT 120 – Output Signal: 5427.9 to 436.3 ohms

Our pressure sensors have 1% total error band accuracy, are IP67 rated.
ERP035 – for pressure ranges up to 35 bar (500 psi)
ERP414 – for higher pressures up to 414 bar (6000 psi)

OUR STORY

The HydraForce story began in 1985 when the company was founded near Chicago by several partners who saw the mobile equipment industry's need for quality hydraulic cartridge valves and manifolds delivered in a timely and responsive manner. They also saw the potential for engineering innovation and design flexibility offered by cost-effective and space-saving cartridge valves and hydraulic integrated circuits.

Since its founding, HydraForce continues to be a privately held company as it has grown to several manufacturing locations in North America, Europe and Asia, with a network of 120 stocking distributors who can offer local support across the globe.

To maintain our core competency of speed to market, HydraForce has invested in application technical support tools including i-Design, our free hydraulic system design sofware, which integrates seamlessly with 3rd party simulation software, monthly webinars on new products and application tips, and an online product catalog. All HydraForce products carry a five-year limited warranty against defects in material and workmanship.

OUR QUALITY AND MANUFACTURING GUARANTEE

All three HydraForce plants in North America, Europe and Asia follow the same manufacturing processes and standards to ensure global consistency in product quality.

- All products 100% tested
- Use of Lean and Six Sigma practices
- New product introduction tools such as:
  - Advanced Product Quality Planning (APQP)
  - Production Part Approval Process (PPAP)
  - Failure Mode and Effect Analysis (FMEA)
  - Statistical Process Control (SPC)
- Continuous improvement through Kaizen
- Responsive delivery with Kanban throughput system

OUR VISION:

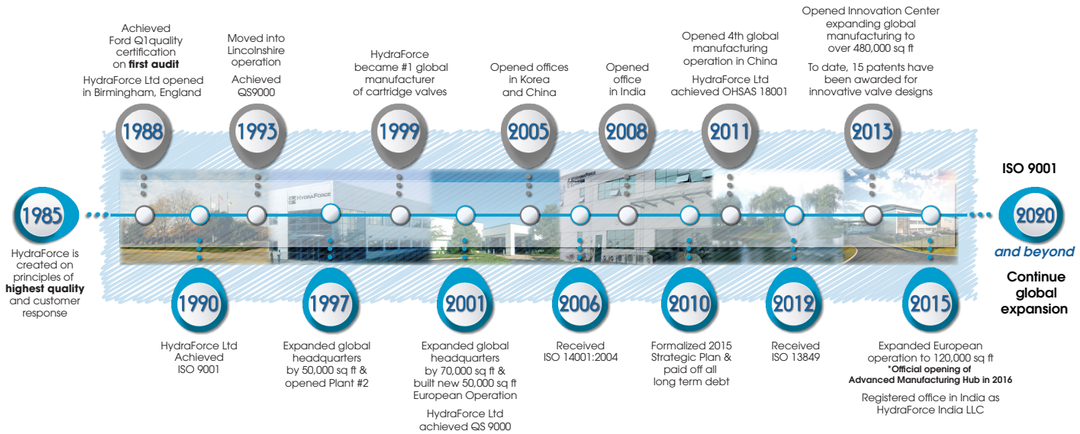
"To be an independent provider of innovative technical solutions that can change the world."

OUR MISSION:

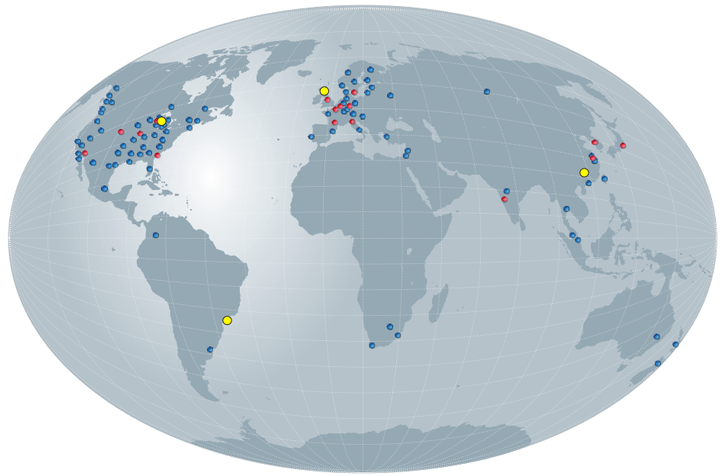
"To provide our customers with the highest quality hydraulic valves and the most responsive customer support in the world."

INNOVATIVE DESIGN
CUSTOMIZE TO APPLICATION
SAVE ENERGY
EASILY SERVICEABLE

HYDRAFORCE TIMELINE

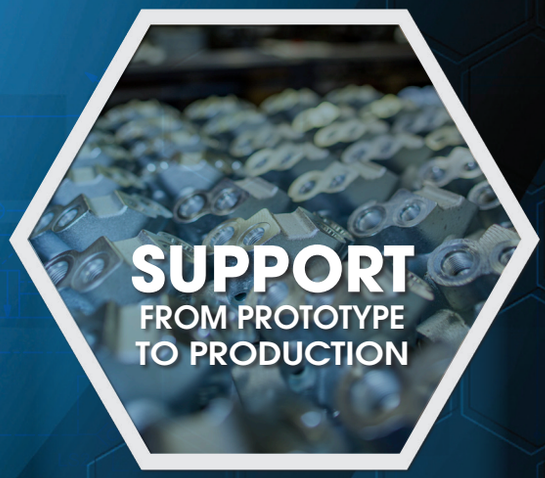


WORLDWIDE SUPPORT



WHY CONSIDER HYDRAFORCE?

- World's largest privately owned cartridge valve manufacturer focused on EH system controls
- Broadest range of cartridge valves
- Designed EH systems for mobile equipment in every industry



- **Free design support**
- **Simulation software**
- **Fast prototypes**

- **Integrate sensors, fittings, ancillary valves, and other custom components into a single manifold**
- **Simplified circuit design**
- **Consolidated or distributed hydraulic systems**

- All manifolds are end-of-line function tested
- Use of Lean and Six Sigma practices
- Five year warranty on valves and manifolds

RoHS COMPLIANT HydraForce valve and manifold products comply with the European Council and Parliament RoHS directive 2002/95/EC limiting the use of hazardous substances. For all other products, consult factory.