



EAT•N

Telehandlers

Application Notes

Fluid Power in Motion

Solutions for Telehandlers.



Eaton has the products and capabilities to provide complete system solutions for your application needs. World class hydraulic components, electronic controllers and software are just part of the value Eaton brings to make your applications deliver the power, in fluid power. Tough applications require the experience and knowledge that Eaton can provide and this application information will help you get started. Contact your Eaton representative for further information or visit us on-line at www.hydraulics.eaton.com.



Types of Telehandlers

Telehandlers are rough-terrain utility fork lifts. They get their name from the characteristic telescoping boom that supports the forks. They typically are four wheel drive and usually have four wheel steer for maneuverability in close quarters.

Telehandlers range in load capacity from about 5,000 pounds to over 10,000 pounds. They can set a load at a maximum height ranging from around 20 feet to over 50 feet. Engine horsepower is not a major criteria for telehandlers, with most machines falling in the 80 to 120 horsepower range.

Typical Hydraulic Functions

- **Hoist and Forks** – This is almost always done with proportionally controlled, double-acting cylinders, with counterbalance valves built into the hoist cylinders. The fork tilt function typically has a “master/slave” circuit that provides fork auto-level as the boom raises or lowers. (see schematic)
- **Boom Extend** – This is done with a long double acting cylinder with counterbalance valves built in. The extension is typically multiplied by a chain mechanism.
- **Steering** – Usually this is a steering control unit on a priority flow control circuit. Typically there is a three position four way valve that selects between normal, coordinated all wheel, and crab steer modes. (see schematic)
- **Brakes** – The park brake is typically a spring applied, hydraulically released brake, usually part of the axle assembly. It’s also typical to use a brake valve and the hydraulic system for the service brakes.
- **Frame level** – This is usually part of the main hydraulic valve, but sometimes is found as an add-on option. Since the machine is typically used on unlevel ground, this double acting cylinder can power-tilt an axle to level the machine.
- **Stabilizers** – Also called outriggers, this function is typically done with double acting cylinders and pilot-operated check valves for load holding. This can be an option, and many machines do not have them.
- **Aux function** – This broad category can be anything from a tool circuit to a powered fork rotate. It’s just an extra circuit or two, sometimes proportionally controlled and usually an add-on option.



General Circuit Notes

Today, the trend is toward using a load-sensing piston pump as the only pump in the system, moving away from the fixed double gear pump.

The telehandler function is changing. With skid-steer loader attachments and hydraulic tools readily available, machines are usually required to be much more than just an extended reach forklift.

Even though telehandlers are being used with an ever-growing list of attachments and accessories, their hydraulic duty cycle is still relatively light. In fact some machines do not even have oil coolers.

The largest flow requirement is the boom lift, but usually the telescope function takes the same flow. Other functions are generally flow limited.

Propel is generally not done as a hydraulic function on Telehandlers.

Circuit Design Considerations

Telehandlers are not designed as aerial work platforms, but they do get used that way. When designing a circuit, think about holding people in the air, not just construction material.

The telescope cylinder circuit and mechanism has to be designed for "pull" loads as well as lifting. As an example, look at back-dragging with a bucket attachment.

The telescope cylinder needs to have the air bled out of it. Otherwise, the extension function tends to "chatter".

If you use a master/slave arrangement for fork level, be sure to consider the end-of-stroke conditions. You need to relieve the excess oil when the fork tilt cylinder bottoms out. Be sure to size this relief function based on the possible slave oil flow.

Consider using an externally vented counterbalance valve on the fork tilt cylinder, primarily because of the back-pressure associated with getting oil back to tank.

Eaton Products found on Telehandlers

The steer selector function has been done successfully on a number of machines using a Cetop-3 (DG4V3) valve with a tandem center spool.

- The service brake function has been done successfully on a number of machines using an Eaton YBV brake valve.
- Series 10 steering units are the right size for this application.
- The 420 pump or PVM would be a good choice, depending on the size of the vehicle.
- Screw-in cartridge valves are an excellent choice for most of the auxiliary functions.
- Consider Ultrasonics for a new application on the boom and fork control.

Hydraulic Functions

Functions typically driven and operated by the hydraulic system:

- Steering
- Ground drive / propel
- Mast lift
- Mast tilt
- Mast lift and tilt load holding
- Auxiliary attachment controls
- Cooling fan drive on larger systems
- System design considerations
- Review all applicable standards
- Define operating envelope
- Evaluate performance / cost compromises
- Select and properly size all components
- Evaluate ergonomics

Product families typically used for hydraulic systems

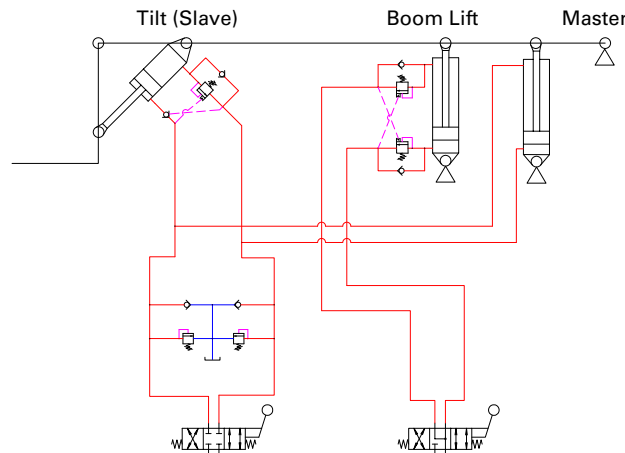
- Open loop steering control unit
- Closed loop steering control unit
- Medium or heavy duty closed loop piston pump
- Medium or heavy duty closed loop piston motor
- Open loop piston pump
- Open loop gear pump
- Open loop disc valve motor
- Open loop VIS motor
- Open loop spool valve motor
- Open center directional control valve
- Flow and load sensing directional control valve
- Cartridge valves
- Cartridge valve manifold assembly
- Filtration
- Oil cooler
- Fluid conveyance

Basic formulae for sizing*

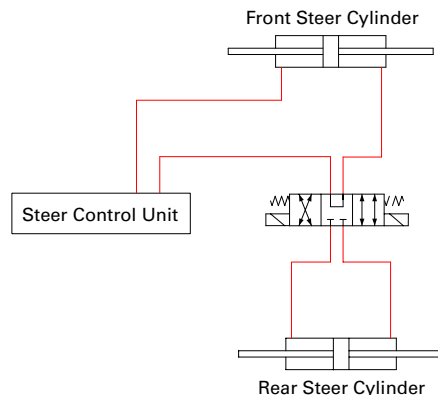
Pump Output Flow	$(GPM) = \frac{RPM \times Displ (cid) \times Vol Eff}{231}$ $(LPM) = \frac{RPM \times Displ (cc) \times Vol Eff}{1000}$
Pump Input Power	$(HP) = \frac{GPM \times PSI}{Tot Eff \times 1714}$ $(KW) = \frac{LPM \times Bar}{Tot Eff \times 598}$
Hydraulic Motor Speed	$RPM = \frac{GPM \times Vol Eff}{Displ (cid) \times 231}$ $RPM = \frac{LPM \times Vol Eff}{Displ (cc) \times 1000}$
Hydraulic Motor Torque	$(inlb) = \frac{PSI (\delta) \times Displ (cid) \times Mech Eff}{6.283}$ $(N-m) = \frac{Bar (\delta) \times Displ (cc) \times Mech Eff}{62.83}$
Cylinder Force	$(lbs) = Area (square\ inches) \times PSI$ $(N) = Area (square\ mm) \times Bar \times 10$
Cylinder Speed	$(in/min) = \frac{GPM \times 231}{Area (square\ inches)}$ $(mm/min) = \frac{LPM \times 1000}{Area (square\ mm)}$
Steering unit disp	$(cid/rev) = \frac{Cyl Vol (cubic\ inches)}{Number\ of\ Revs}$ $(cc/rev) = \frac{Cyl Vol (cc)}{Number\ of\ Revs}$
Vehicle Ground Speed	$(MPH) = \frac{RPM \times 60 \times Tire\ Radius (ft) \times PI}{5280}$ $(KPH) = \frac{RPM \times 60 \times Tire\ Radius (m) \times PI}{1000}$

Typical Circuits

Master/Slave Auto Fork Level



Telehandler Steer Circuit



Typical circuit for Normal, Crab, or Coordinated steering

* The following calculations may also need to be considered with regards to sizing:

- Basic formulae are general in nature and do not take into account efficiency losses for individual components.
- Cylinder pressures and speeds for mast lift, tilt, and aux., functions
- Torque and displacement calculations for propel loop
- Gradeability and travel speed calculations
- Over speed calculation
- System Hp calculations under all operating conditions
- Power range calculation
- Mechanical and volumetric efficiencies
- Product life
- Cooling capacity
- System pressure drop calculations
- Line flow velocity calculations

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