Electrohydraulic Components

designed for use in electrohydraulic braking and/or electronic throttle control applications

Electronic Pedals, Digital Valve Controllers, and Electrohydraulic Valves
What are Electrohydraulic Brake Systems?

Electrohydraulic brake systems are the combination of electronics and hydraulics to create a more versatile brake system. The electronics provide control flexibility, while the hydraulics supply the power.

Electrohydraulic braking offers many advantages over traditional hydraulic braking systems. These advantages can be exploited to provide improved system performance and greater comfort for the operator. Valves can be moved away from the cab and closer to the brakes, reducing plumbing costs. Remote operations are easily handled without having to duplicate the valving. Vehicle controls can be improved by implementing a variety of control schemes such as electrohydraulic brake systems, anti-lock brake systems (ABS), and traction control systems (TCS). These systems are a result of hydraulics and electronics combining to create brake systems that provide value added features for the machine operator.

About this Catalog

Pages 3 through 6 provide functional diagrams of a variety of electrohydraulic brake systems. These functional diagrams are not detailed representations of actual systems, but are meant to provide an overview of various brake system configurations that might be considered using electrohydraulic technology.

Pages 7 through 11 provide information on MICO components that can be used in the design of an electrohydraulic brake system. Please consult MICO engineering about your application. Components that might be better suited to your application may not be presented in this catalog.

What does MICO have to offer?

The products shown in this catalog are designed for use in electrohydraulic braking and/or electronic throttle control applications. MICO offers a complete electrohydraulic package, which includes a variety of electronic pedal configurations and sensing options, digital valve drivers, and a variety of electrohydraulic brake valves (EBV).

Typical applications for these new products would be drive-by-wire, electrohydraulic braking, machines with multiple operator stations, remote control operation, or propel and inching pedals for hydrostatic drive systems. In throttle applications, the pedal can be configured to interface directly to the engine's electronic control unit. MICO® electronic pedals provide force feedback, proportional to pedal rotation, with rotary sensors to provide one or more analog outputs that are proportional to pedal rotation. Both treadle and suspended pedal models are available.

The MICO® Digital Valve Driver is designed to accept dual inputs from an electronic pedal and convert the signal into current needed to drive the MICO® Electrohydraulic Brake Valves. MICO® Electrohydraulic Brake Valves are full power brake valves used for modulating output pressures, up to 207 bar (3000 PSI), in proportion to the input current. When used in properly designed systems, these valves can provide hydraulic power for normal and emergency power-off braking for electrohydraulic brake systems, anti-lock braking systems, and traction control systems.

In addition to these components, MICO can provide full power brake systems with ABS, traction control, or both, for vehicles that require up to eight channels of control.
Electrohydraulic Brake Systems

Electrohydraulic Brake System (See Figure 1)
These systems provide flexible control while complying with requirements of primary and secondary braking standards. Dual pedal angle sensors send signals to redundant input valve drivers that control the brake valves. Features of this type of system include:

- Ability for designers to remove the brake valve and the hydraulic hoses from the operator station
- Provides primary and secondary braking to meet industry standards
- Pedal force feedback is proportional to pedal angle
- Programmable pressure vs. pedal angle functions
- Easy to add additional remote operator stations
- Automated braking can be programmed to occur based on inputs from other sensors or controllers
- Operator warning and vehicle stop light control
- Fault diagnostics for easy troubleshooting

Electronically Enhanced Full Power Brake System (See Figure 2)
The addition of electrohydraulics to enhance a hydromechanical full power system allows designers to add control flexibility to the brake system while maintaining the hydromechanical tradition and redundancy of the single modulating brake valve. The pedal angle sensor, electronic control unit (ECU), and electrohydraulic modulating brake valve are used to provide programmable pressure vs. pedal angle function to the brake system. Features of this type of system include:

- Provides primary and secondary braking to meet industry standards
- Programmable pressure vs. pedal angle functions
- Easy to add additional remote operator stations
- Automated braking can be programmed to occur based on inputs from other sensors or controllers
- Many of the benefits of electrohydraulic braking, with the back-up of hydromechanical braking
- Operator warning and vehicle stop light options
- Brake pressure controls are in parallel - brake receives highest pressure of hydromechanical or electrohydraulic valve
Electrohydraulic Brake Systems

**Full Power Brake System with ABS** (See Figure 3)
Vehicle safety can be improved with the use of an anti-lock brake system giving operators control even in poor traction conditions. A typical hydromechanical full power brake system is shown consisting of a pump, accumulator charging valve, dual accumulators, and tandem modulating brake valve. ABS valves are normally open, which allow the tandem modulating brake valve to control braking pressure proportional to operator input force at the brake pedal. Speed sensors send electronic pulses, at a frequency proportional to wheel speed, to the ABS electronic control unit (ECU). The ABS electronic control unit algorithm determines how much current is sent to each of the ABS valves. When the ABS valve receives current, pressure from the tandem modulating brake valve is blocked to the brake and pressure at the brake relieved. This allows the wheel to continue turning rather than slipping excessively. See MICO® Hydraulic Brake System with ABS Brochure (form number 80-950-243.)

**Full Power Brake System with Traction Control** (See Figure 4)
A full power brake system with traction control can help maintain traction in poor traction conditions. A typical hydromechanical full power brake system is shown consisting of a pump, accumulator charging valve, dual accumulators, and tandem modulating brake valve. Electrohydraulic brake valves are normally open, which allow the tandem modulating valve to control braking pressure proportional to operator input force at the brake pedal. Speed sensors send electronic pulses, at a frequency proportional to wheel speed, to the traction control system electronic control unit. The TCS electronic control unit algorithm determines how much current is sent to each of the electrohydraulic brake valves. When the electrohydraulic brake valve receives current, pressure from the accumulators is used to modulate pressure to the brakes. This stops the wheel from turning excessively and improves the vehicle's traction. The check valve reduces the pressure drop through the electrohydraulic brake valve when the tandem modulating brake valve is applied to fill the brake cylinders. This series circuit is also an option to the parallel circuit, Figure 2, for doing electronically enhanced braking. See MICO® Hydraulic Brake System with Traction Control Brochure (form number 80-950-258.)
Electrohydraulic Brake Systems

Electrohydraulic Brake System with ABS and Traction Control (See Figure 5)

When designers want to remove the brake valve from the cab, electrohydraulic brake systems should be considered. ABS and traction control can be added as shown in the previous examples. However, in this system the electrohydraulic brake valves control the brake system at all times. Each key component in the system has redundancy to assure reliability. Features of this type of system include:

- Provides primary and secondary braking to meet industry standards
- ABS and traction control for improved control
- Programmable pressure vs. pedal angle functions
- Ability to easily add additional remote operator stations
- Automated braking can be programmed to occur based on inputs from other sensors or control systems
- Operator warning signal and vehicle stop light control
- Fault diagnostics for easy troubleshooting
- Simplest system for electrohydraulic control of each brake pressure

Electrohydraulic Brake System with Inching Control (See Figure 6)

This system allows the machine operator to have proportional inching and braking control in one pedal. The first part of pedal travel is devoted to inching control. The second part controls braking. There can be a step in pedal effort at the midpoint of pedal travel to indicate to the operator that further pedal travel results in application of the vehicle’s brakes. During inching the electrohydraulic controller interprets the inching signal and controls the transmission or clutch by means of an electrohydraulic pressure modulating valve. During braking the electrohydraulic controller interprets the braking signal and controls the amount of braking by means of a second electrohydraulic brake valve. Features of this type of system include:

- Ability for designers to remove the brake valve and hydraulic hoses from the operator station
- Elimination of complicated linkages and valves for control of inching and braking
- Pedal force feedback is dual gain and proportional to pedal angle
- Programmable set points and gains for inching and braking
- Operator warning and vehicle stop light control
- Fault diagnostics for easy troubleshooting
Electrohydraulic Brake Systems

Hydraulic Brake System with ABS and Traction Control (See Figure 7)

Hydraulic brake systems with ABS and traction control can improve vehicle performance and operator safety. A system of this type provides shorter stopping distances, improved vehicle stability, and enhanced traction for vehicles driven under extreme operating conditions. These are important concerns for the drivers and occupants of vehicles operated on and off the highway.

The basis of this system is a hydromechanical full power brake system consisting of a pump, accumulator charging valve, dual accumulators, and a tandem modulating brake valve. To obtain the ABS and traction control features, electrohydraulic brake valves, a pilot section for the tandem modulating brake valve, speed sensors, pressure transducers and an electronic control unit are added. See MICO® Hydraulic Brake System with ABS and Traction Control Brochure (form number 80-950-261).

Electrohydraulic Brake System for Trailers (See Figure 8)

This is a very simple way to provide full power braking on the trailer. This system works with any type of tow vehicle brakes including brake fluid, air brakes, or full power. For best performance the pressure rating of the transducer should be as close as practical to the maximum expected vehicle brake pressure. The valve driver, or controller, and electrohydraulic brake valve can be mounted wherever it is most convenient.

Additional features such as spring applied hydraulic release brakes, break-away switches, stop light control, and operator warning lights can be easily added. Features of this type of system include:

- Trailer brakes proportional to tow vehicle brake pressure
- Trailer brakes can be actuated at a stop, unlike surge brakes
- Break-away switch can be easily added
- Automated braking can be programmed to occur based on inputs from other sensors or control systems
- One trailer system works with any tow vehicle system
- Fault diagnostics for easy troubleshooting
**DESCRIPTION**

The MICO® T-Series Valve Driver is programmed to work with MICO Electronic Pedals and MICO Electrohydraulic Brake Valves. The controller is configured to accept dual inputs for redundancy. It also provides a pulse width modulated current control output to drive electrohydraulic brake valves. Dither current is provided to optimize the performance of the electrohydraulic brake system. Maximum valve current is adjustable to allow the maximum brake pressure to be set at maximum pedal travel.

Other configurations can be provided for inching systems, trailer braking systems, parking plus service brakes, or differential locks. Please consult MICO, Inc. for further details on custom programs.

**FEATURES**

- Unique redundant input signals allow multiple operator stations or redundant input sensors
- Accepts analog voltage inputs
- Ignores input signals below 1.0 Vdc eliminating requirements for neutral switches in pedals
- Output current remains at IMAX when input signal is above 4 Vdc, so pedal travel wear does not effect brake pressure
- Provides regulated 5 Vdc power supply for external sensors, such as those in MICO Electronic Pedals
- Output signal is PWM current regulated – assuring consistent performance even as coil resistance varies with operating temperatures and supply voltage changes
- Maximum current, IMAX, is adjustable to set maximum output
- Diagnostic LED’s are provided for easy troubleshooting
- Can be powered by 9 to 32 Vdc
Electronic Pedals with Brake Valve Interface

DESCRIPTION
The MICO® Electronic Pedal is designed for use in electrohydraulic brake and/or electronic throttle control applications. It provides force feedback proportional to pedal rotation. A rotary sensor provides one or more analog outputs that are proportional to pedal rotation. A variety of pedal configurations and sensing options are available.

The pedal can be mounted to a MICO® Single or Tandem Modulating Brake Valve. This configuration is especially well suited to machines with hydrostatic transmissions. The sensor output is used to destroke the transmission and the brake valve applies the brakes when deceleration requirements exceed the transmission's capabilities.

Typical applications include drive-by-wire, electrohydraulic braking, machines with multiple operator stations, and propel and inching pedals for hydrostatic drive systems.

For throttle applications, the pedal sensor can be configured to interface directly to the engine's electronic control unit.

FEATURES
- Robust design for brake and/or throttle applications
- Ergonomic designs configured to your application
- Enclosure protects sensor from mechanical damage
- Variety of sensor options available
- Sensors include diagnostic regions for monitoring wiring and sensor integrity
- Adjustable return stop allows initial position to be controlled
- Stainless steel pins with bushings for harsh environments
- Single or tandem modulating brake valve can be integrated into pedal

OPTIONS
- Right or left side sensor mount for a variety of cab layouts
- Firewall or floor mounted designs
- Ergonomic variations: feedback torque range, initial pedal angles, and pedal angle range
- Various connector configurations

Not all model code combinations are available. Please call MICO, Inc. for availability.

ELECTRONIC PEDAL MODEL CODES

<table>
<thead>
<tr>
<th>EP B</th>
<th>T 44</th>
<th>L P</th>
<th>B M 000</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Family</td>
<td>Electronic pedals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Pack</td>
<td>B = Brake springs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I = Inching springs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T = Throttle springs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V = Valve mounting spring pack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K = Step in force at end of stroke</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td>S = Suspended</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T = Treadle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedal Angle at Normal Position</td>
<td>20 = 20°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(See pedal angle chart)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Options</td>
<td>R = Right side sensor locator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L = Left side sensor locator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor</td>
<td>C = One potentiometer plus a low power (SPDT) switch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D = Single proportional hall effect - normally low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H = Single proportional hall effect - normally high</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J = One potentiometer plus idle validation and transmission kick down (SPDT) switches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P = Three potentiometers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Exit From Base</td>
<td>A = Sensor cable exits through mounting surface and switch cables are internal to cab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B = Through mounting surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F = Exit downward when suspended away from operator when treadle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = Exit upward when suspended towards operator when treadle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S = Side out exit parallel to axis of pedal rotation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Cable Connection</td>
<td>A = Metri-pack 150 plus Deutsch DTM04-3P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D = Deutsch DT04-3P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M = Metri-pack 150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Cable Length</td>
<td>000 = No cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>040 = 40 centimeters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unique Identifier</td>
<td>U = Non-standard (contact MICO, Inc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P = Proprietary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dimensions will vary slightly between units and are to be used for reference purposes only.
Sample configurations shown. Contact MICO, Inc. for more detailed mounting dimensions.

Pedal Angle Chart

<table>
<thead>
<tr>
<th>Sensor Codes (See page 8)</th>
<th>P</th>
<th>C or J</th>
<th>D or H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treadle (Pedal at normal position)</td>
<td>20°, 30°, or 40°</td>
<td>24°, 34°, or 44°</td>
<td>15°, 25°, or 35°</td>
</tr>
<tr>
<td>Suspended Pedal (Pedal at normal position)</td>
<td>58°</td>
<td>62°</td>
<td>53°</td>
</tr>
<tr>
<td>Pedal Rotation to Full Apply</td>
<td>25°</td>
<td>29°</td>
<td>20°</td>
</tr>
</tbody>
</table>

Contact MICO, Inc. for other pedal angle options.
EBV Series Electrohydraulic Brake Valve

U.S. Patent Number 6,802,330

DESCRIPTION
The MICO® Electrohydraulic Brake Valve, EBV series, is a full power valve for modulating output pressures up to 207 bar (3000 PSI) in proportion to the input current. This valve, in a full power brake system, provides hydraulic power for normal and emergency power-off braking for electrohydraulic brake systems, anti-lock brake systems, and traction control systems.

FEATURES
- Patented design makes maximum use of the solenoid stroke and force to improve reliability and performance
- Valve can be remotely mounted - moving the hydraulic plumbing noise away from the operator
- Direct acting valve simplifies design, which eliminates the continuous flow and small orifices of a pilot valve
- Low valve leakage keeps accumulator sizes small for emergency power-off braking
- High force solenoid reduces the effects of friction and contamination
- Low resistance coil allows full pressure output with low input voltage, higher temperature operation, or continuous use

- Optimized specifically for the unique performance characteristics of full power braking or clutching applications
- Manual override provides a way to mechanically open the valve if electrical power is lost

OPTIONS
- Various output pressure ranges
- Various circuit configurations, hydraulic apply spring release (HASR), traction control, ABS, spring apply hydraulic release (SAHR), etc.
- Multiple valves and accessories integrated into a single housing
- High impedance coil options for controllers with limited current capability
- Brake pressure with no current can be zero, maximum, or intermediate values

Sample configuration show. Other configurations are available - Contact MICO, Inc.
EBV VALVE MODEL CODES


Product Family
Electronic modulating brake valve

Valve Function
A = ABS antilock brake valve
M = HASR modulating brake valve
R = Reverse modulating brake valve
S = SAHR modulating brake valve
T = Electronic traction control valve

Housing Options
D = Dual
M = Monoblock single valve
P = Sandwich mounting
S = Subplate mounting

Porting
B04 = G 1/4 BSPP ports
S06 = SAE 6 ports per SAE J1926
S08 = SAE 8 ports per SAE J1926
S99 = Mixed SAE ports
N04 = Subplate mounting

Check Valve Options
A = Accumulator check from P to accumulator port
B = Check from modulating valve port to brake port
C = Reverse flow check from B to P
N = No integrated check valves

Electrical Connection
D = Deutsch DT04-2P

Coil Voltage
012 = 12 Vdc standard
014 = 12 Vdc high impedance
024 = 24 Vdc standard
028 = 24 Vdc high impedance

Manual Override Option
R = Manual override
N = No manual override

Seals
N = Nitrile
V = Viton

Pressure Range
35 = 35 bar EBV-S
36 = 36 bar EBV-M, EBV-T
50 = 50 bar EBV-M, EBV-S, EBV-T
88 = 88 bar EBV-S
90 = 90 bar EBV-M, EBV-T
139 = 139 bar EBV-S
143 = 143 bar EBV-M, EBT-T
150 = 150 bar EBV-A
197 = 197 bar EBV-S
200 = 200 bar EBV-M, EBV-T

Unique Identifier
Blank = Standard product
P = Proprietary
U = Non-standard (contact MICO, Inc.)

Not all model code combinations are available. Please call MICO, Inc. for availability.
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PRODUCT LINE:

Brakes
Caliper Disc Brakes
Multiple Disc Brakes

Brake Locks
Electric
Mechanical

Controls
Electronic Controls
Hydraulic Throttle Controls
Pedal Controls
Switches
Transducers/Sensors

Cylinders
Drive Axle Brake Actuators
Slave Cylinders
Wheel Cylinders

Master Cylinders
Boosted Cylinders
Hydraulically and Air Actuated
Straight Bore Cylinders
Two-Stage Cylinders

Valves
Accumulator Charging
Electrohydraulic Brake
Park Brake
Pressure Modulating

Miscellaneous Components
In-line Residual Check Valves
Pump with Integrated Valves
Reservoirs

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