Introduction

The term *Counterbalance Valve* has become generally accepted globally for valves that perform the following functions in mobile equipment:

- Load Holding: securing the last commanded position of an actuator by preventing fluid from escaping work chambers, usually in a leak free mode.
- Motion Control: maintaining positive effort of an actuator in all conditions, even in cases where the load can work with forces of gravity.
- Overcenter Control: preventing the load from running ahead of the power supply to the actuator in cases where the work of the actuator transitions from a positive force in the requested direction of movement to a negative force in the same direction
- Free upstream flow into the actuator through a check valve; for example for load lifting.
- Pressure relieving (with open center spool in the directional valve) for pressure surges in the actuator work chamber caused,for example, by oil expansion due to heating, etc.

Valvole Italia offers a wide range of counterbalance valves to best suit the performance needs of a large number of applications. This first catalog only shows the standard range of components, but of course our team of hydraulic, service and design engineers is available to support our Customers to:

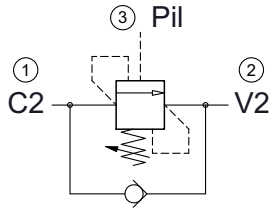
- Customize blocks and solutions to better fit each application
- Customize, when needed, the valves function and components design in order to reach the proper performance level required by the application

Important features for Valvole Italia counterbalance valves

- Low leakage when closed: maximum 5 drops/min when valve closes with reseat pressure applied to load holding port
- Standard maximum operating pressure 350 Bar (5000 PSI), and optional maximum working pressure of 420 Bar (6100 PSI).
- Reliable and stable hydraulic performance over full temperature range, -30°C – 100°C (-22F – 212F).
- Wide range of pilot ratios from 2:1 to 24:1
- High level of contamination resistance: the critical components of the load holding valve are hardened and are not subjected to performance degrading damage with normal levels of fluid contamination. However, good system design considerations should be made to maintain ISO 4406 19/17/14 for all high pressure components.
- Unsealed or Sealed Pilot Piston: the pilot piston can be provided with a glide ring for reduced hysteresis which allows a very low level of leakage which is beneficial for bleeding air from the pilot chamber on commissioning. The pilot piston can also be provided with positive seals for critical low flow or master/slave circuits where no leakage through the pilot chamber can be tolerated.
- Setting Adjustment in CLOCKWISE direction. Most hydraulic components are made with setting adjustment mechanisms following the convention that adjustment made in a CLOCKWISE direction INCREASES the set value. Some counterbalance valve companies have created components where COUNTERCLOCKWISE adjustments INCREASE the set value. However the latter feature is achieved mechanically, the increasing adjustment in a COUNTERCLOCKWISE direction is not intuitive and therefore may be unsafe.
- Fixed or Adjustable Setting: counterbalance valves can be produced with fixed or adjustable settings. Adjustable setting valves can be provided with tamper indicating caps.
- Reseat: in the product datasheets which follow, the reseat value indicated is obtained with valve set at maximum setting value allowed; this reseat value (in percentage of the setting) decreases with decreasing setting values.

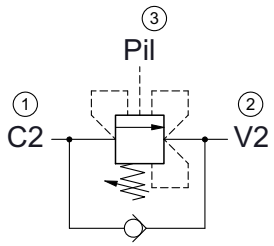
There are several versions of counterbalance valves designed to optimize machine performance, efficiency and stability based on the fact that some level of backpressure will always exist while the valve is in operation.

NORMALE standard counterbalance valve



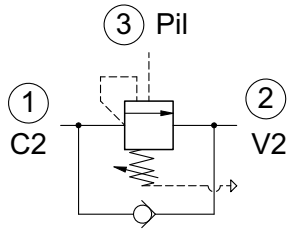
Port (1) is the load port; Port (2) is the exhaust port and Port (3) is the pilot port. The spring chamber on the NORMALE counterbalance valve is drained/connected to port (2). In this case, backpressure has effects on both the relief and pilot opening pressures since it pushes the relief piston in the closed direction and it opposes the pilot piston too.

COMPENSATA compensated counterbalance valve



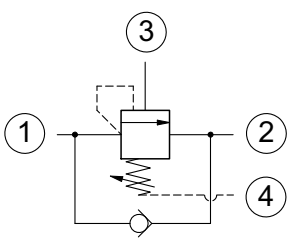
The spring chamber is connected to the exhaust port (2), however, this valve type has a special configuration on the relief piston that allows the relief opening independently from any back pressure. The pilot opening pressure, instead, remains influenced by backpressure at port 2. These valves may be employed in those applications that require to relieve pressure at the established pressure setting value, independently from any backpressure in the return line. They are frequently fitted in systems with directional valves with closed center spools equipped with port relief valves

VENTILATA vented counterbalance valve



The Vented counterbalance valve has a vented spring chamber. Both the relief and the pilot opening of the valve are independent from backpressure at port 2. These valves must be used only in conjunction with directional valves with closed center spools and equipped with port relief valves. This version of counterbalance valve will be more efficient in systems with high backpressure or line losses between the counterbalance valve and the directional control.

DRENATA drained counterbalance valve



The drained counterbalance valve incudes a fourth port which allows the spring chamber to be connected either to tank line (sump) or other pressure sources in the system. In case the drain line is connected to tank pressure, the performance can be similar as the vented counterbalance valve as far as the pressure in the drain line is close to zero. These valves type can be used when the application boundary conditions makes it preferable to avoid a vented spring chamber, or in various special applications as regenerative circuits.

The following information concerns Valvole Italia valve series 79, 31NPS, 34, 43, and the cartridge valves included in this catalog.

Determining the Proper Pressure Setting of a Counterbalance Valve

The pressure setting (P_s) of a counterbalance valve must be at least thirty percent higher than the maximum load induced pressure (P_L).

$$P_s \geq 1.3 \bullet P_L$$

Determining the Opening Pressure of a Counterbalance Valve

The pilot pressure to open the counterbalance valve (or pressure to lower the load) depends on the valve setting, pilot ratio, load induced pressure, and pressures at the valve outlet and/or in the spring chamber. Following discussion and calculations use these variable definitions:

P_S **Counterbalance Valve setting**

R_{Pil} **Counterbalance Valve Pilot Ratio**

P_L **Load Induced Pressure**

P_B **Pressure at the Counterbalance Valve Outlet (Backpressure)**

P_{pil} **Pilot pressure required to open the counterbalance valve (Load Lowering Pressure)**

P_R **Pressure at port 1 required to open the relief function of the counterbalance valve**

α **Cylinder bore area / cylinder annular area**

The effects of backpressure on the pilot opening pressure and on the relief opening pressure of the valve are different, depending on the valve type.

These effects should be considered when selecting null conditions for directional control valve, design of plumbing and the ability for the counterbalance valve to function as a relief valve. For example the influence of back pressure can often be used to help stabilize functions as it creates a type of feedback helping the counterbalance valve to regulate the load during lowering. However, in cases where backpressure exists, system efficiency is in general compromised.

For a normal valve, it must be considered, that the backpressure has also effect of the relief opening pressure, with a factor = $R_{Pil}+1$. So, in case of backpressure, not only the pilot opening, but also the relief setting of a NORMALE counterbalance valve becomes higher.
The relief opening pressure (at port 1) of a standard type (NORMALE) counterbalance valve can be calculated as follows:

$$P_R = P_S + P_B \bullet (R_{Pil} + 1)$$

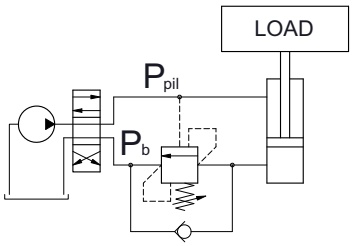
Example:
NORMALE counterbalance valve with 4:1 pilot ratio, with
> *nominal relief setting of 350 bar*
> *and backpressure of 10 bar*
has an effective relief opening at:
350 + 10(4+1) = 400 Bar.*

If we consider the case of:

- a standard counterbalance valve (sensitive to backpressure) and a vented valve
- fitted to a double acting cylinder with a certain area ratio,
  α = cylinder bore area / cylinder annular area
- ideal situation of absence or negligible effect of seal friction

The P_{pil} required to start opening the valve can be calculated as follows:

In case of load pushing the cylinder rod and valve fitted to the full bore side



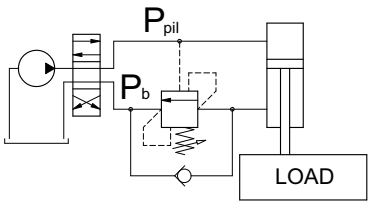
NORMAL valve (as represented in the picture on the left)

$$P_{Pil} = \frac{P_S - P_L + P_B \bullet (R_{Pil} + 1)}{R_{Pil} + \frac{1}{\alpha}}$$ often simplified as $$P_{Pil} = \frac{P_S - P_L + P_B \bullet (R_{Pil} + 1)}{R_{Pil}}$$

VENTED valve

$$P_{Pil} = \frac{P_S - P_L}{R_{Pil} + \frac{1}{\alpha}}$$ often simplified as $$P_{Pil} = \frac{P_S - P_L}{R_{Pil}}$$

In case of load pulling the cylinder rod and valve fitted to the annular chamber



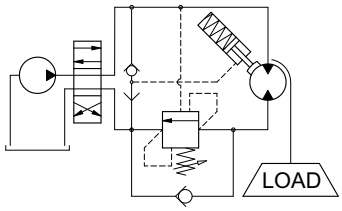
NORMAL valve (as represented in the picture on the left)

$$P_{Pil} = \frac{P_S - P_L + P_B \bullet (R_{Pil} + 1)}{R_{Pil} + \alpha}$$

VENTED valve

$$P_{Pil} = \frac{P_S - P_L}{R_{Pil} + \alpha}$$

In case of valve fitted to an equal area actuator or to a hydraulic motor where α=1



NORMAL valve (as represented in the picture on the left)

$$P_{Pil} = \frac{P_S - P_L + P_B \bullet (R_{Pil} + 1)}{R_{Pil} + 1}$$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Counterbalance Valve Technology Advances

In general, the use of lower pilot ratios can help to achieve more stable functions/systems, but on the other hand this also creates a loss of efficiency of the function/system.
The specific requirements of each application and the boundary conditions of the system have to be taken into account in order to select the proper valve for each function, also considering the relevant characteristics of the other components which have an influence on the valve behavior (main directional valve, pump, control system, actuator, etc.).
Basing on these inputs **Valvole Italia** supports the Customers and Partners to select the most suitable load holding valve, and can also offer support in order to achieve a fine tuning of the valve on the application in order to keep the optimum pilot ratio (to support the system efficiency) and at the same time reach the desired stability, controllability and reactiveness of the movement.

In order to find the proper tuning to keep

- High pilot ratio => higher efficiency
- Good stability and controllability of the movement
- Good reactivity, also in cold conditions

depending on the valve type, different strategies are possible and **Valvole Italia** can propose different devices to control the signals that determine the quality of the load handling / motion control.
Simply put, the counterbalance valve performance must match the system dynamic in which it is installed: this includes hydraulic system reaction as well as machine rigidity or stiffness.
To advance counterbalance valve performance, optimizations have been made around the core of the counterbalance valve – The Load Holding Piston and Seat. Creating better flow paths, and extending the stroke of the load holding piston allows for larger flows (or less pressure drop) in the same or smaller valve packages. Furthermore, the modified flow passages and longer stroke allows for customization of the load holding piston to create area gains that best match the machine system dynamic over the opening time of the counterbalance valve. This also allows for designs of load holding pistons (poppets) which have either a very linear open area gain, or one that is progressive. Both of these techniques support better more stable transitions as the counterbalance valve regulates to safely control load lowering movements, and allows for increased speed of actuators in a predefined cavity or space.

Valve Packaging, Flexibility, Labeling, Branding, and Life

Valvole Italia has adopted all best practices into the design and manufacturing of counterbalance valves. Having a sharp focus on the single function of load holding allows those best practices to be installed in a flexible way such that no single process must inhibit innovation of product or Customer support.
Being flexible means the company can flow with industry demands on technical and commercial issues, while always expanding the technology on which the company survives.

Every consideration is made with the Customer in mind.

An example is the labeling of products. Incorporating laser labeling technology into the manufacturing process means that the identification of the finished valves can easily be whatever the Customer wishes. This includes Customer part numbers, logos, and a data matrix which will direct end users or machinery service centers and dealers to Customer-selected source of support for replacement parts, service information and warranty data. The service life of a counterbalance valve should match the service life of the machine in which it is installed. Since the counterbalances valves of **Valvole Italia** are designed and tested to criteria exceeding market standards, the warranty which covers that product from normal service life failures also exceeds industry standards. All **Valvole Italia** products are provided with a 30months warranty from the manufacturing date marked on the valve.

> Technical Data

Detailed information about product performance, selection and installation can be provided by our Customer Engineering Department: the following paraghraps provide a general summary of specifications and guidelines, with the aim to provide a general guidance only.

Hydraulic Fluids

Mineral oil based hydraulic fluids suitable for hydraulic systems can be used in combination with **Valvole Italia** valves, with physical lubricating and chemical properties as specified by:

> *MINERAL OIL BASED HYDRAULIC FLUIDS HL (DIN 51524 part 1)*
> *MINERAL OIL BASED HYDRAULIC FLUIDS HLP (DIN 51524 part 2)*

For use of environmental friendly fluids please consult **Valvole Italia**.

Fluid viscosity

Exception made for cases in which different specifications are indicated in the individual product data sheet, the fluid viscosity should remain within the range 10 to 500 cSt.
The performance curves and specifications data shown in **Valvole Italia** catalog are obtained using mineral based fluid ISO VG 46, i.e. 46 cSt at 40°C (104°F), with an oil temperature of 30-40°C (86-104°F). More detailed technical characteristics are available upon request at **Valvole Italia**.

Fluid temperature recommendation

Valvole Italia products are generally equipped with BUNA-N seals and, for this reason, the fluid temperature should remain within the -30°C and +100°C range (-22°F and +212°F).In case of temperatures outside this range, consult **Valvole Italia**.

Fluid cleanliness requirements

Excessive contamination is often the cause of malfunctions in hydraulic systems.
Hard contamination particles present in the fluid, can cause premature wear and leakages in hydraulic components. For the correct operation of **Valvole Italia** products, it is necessary to put in place filtration methods which guarantee for life the specified fluid cleanliness level. Fluid filtration must comply with the specifications given by following guideline.

* ***Absolute filtration:*** *characteristic of each type of filter; it refers approximately to the size (in micron) of the largest spherical particle that can get through the openings in the filter element*

System / Valve type	Recommendations		
	Cleanliness class recommended		Absolute filtration (micron rating)*
	ISO 4406:1999	NAS 1638	
> System/Component operating at high pressure (>250 bar , 3000 psi) > High duty cycle applications > Systems/Components with LOW dirt tolerance	18 / 16 / 13	7 – 8	5
> System/Component operating at medium-high pressure > Systems/Components with moderate dirt tolerance	19 / 17 / 14	9	10
> System/Component operating at low pressure (100 bar< , 1500 psi) > low duty cycle applications > Systems/Components with good dirt tolerance	20 / 18 / 15	10- 11	20

Pressure setting

Valvole Italia products are supplied pre-set at the standard pressure setting indicated in the relevant catalog sheet. If the application requires a readjustment, please ensure that the limits of the indicated pressure range and maximum working pressure are never exceeded.

Storage of new valves

The valves shall not be exposed to direct sun light nor to sources of heat or ozone (like electric motors running), and should be stored in their original, protective packing at ambient temperature within the range -20°C and +50°C (-4°F and 122°F).

Seals

O-Rings: Buna N (acrylonitrile butadiene), also named NBR (according to ASTM), compatible with fluids having mineral oil base, water-in-oil emulsions, and water-glycol fluids. These seals are standard for temperatures within the range -30°C and +100°C (-22°F and +212°F).

Back-up rings and Slide rings: strengthened PTFE (Politetrafluoroetilene like Teflon®, Lubriflon®, Ecoflon®, or similar).

FPM (Viton®) seals are available on request.

Note: the seals materials are compatible with the fluids normally used in hydraulic systems; in case of special fluids, if you suspect incompatibility between the fluid used and the standard seals, contact **Valvole Italia**.

Seal kits

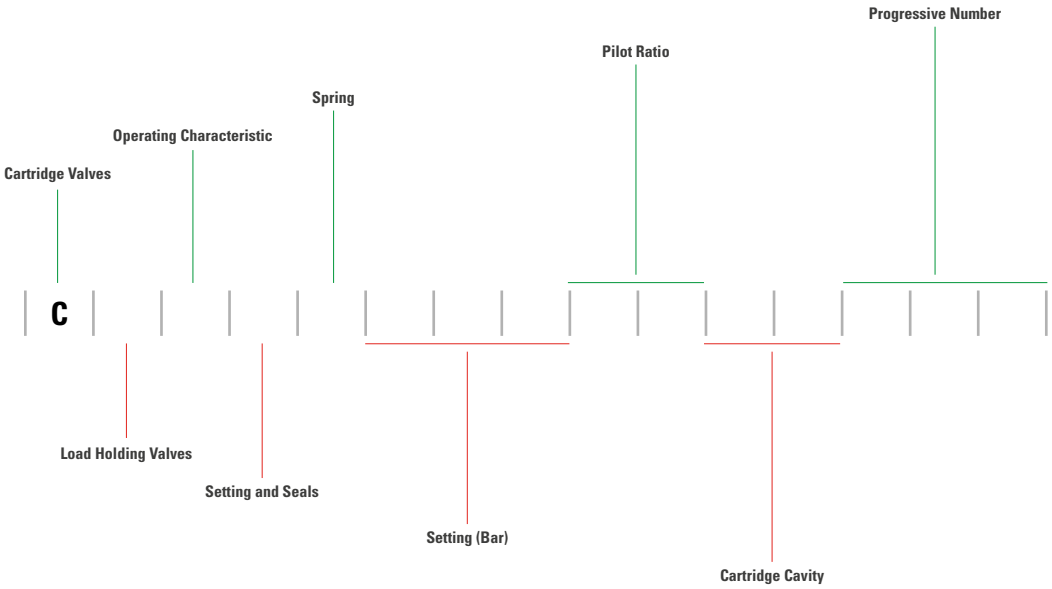
Cartridge valves: the kits include all the external seals

Parts-in-body valves: the kits normally include all external seals for flange fitting (please refer to each single datasheet)

Installation

- Ensure that all matching surfaces are clean, without contamination.
- Ensure that all seals and back-up rings for the matching surfaces are flawless and correctly placed.
- Do not put any sealing material other than the standard seals.
- Place the valve in position, then, by hand, insert the fittings and the locating screws.
- In case of cartridge valve, check that the cavity is clean, without sharp edges or chips. Dip the cartridge in clean oil, then insert it into the cavity and screw it in by hand, until you begin to compress the top O-Ring.
- Finally tighten with a calibrated torque wrench and torque up to the specifications shown in the catalog.

Cartridge Valves



Parts in body