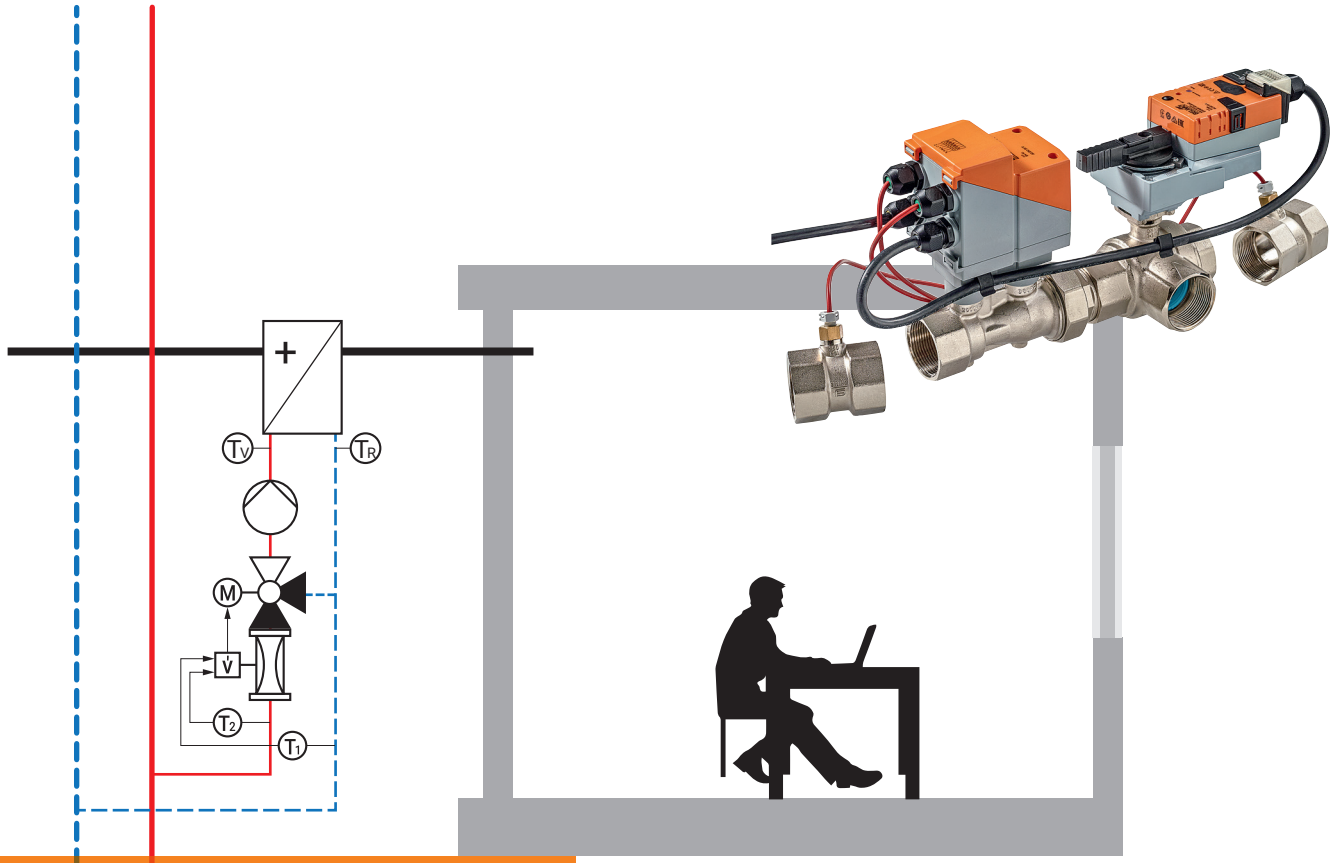


# Project planning notes

# Electronic pressure-independent 3-way characterised control valve with energy monitoring Belimo Energy Valve™

BELIMO

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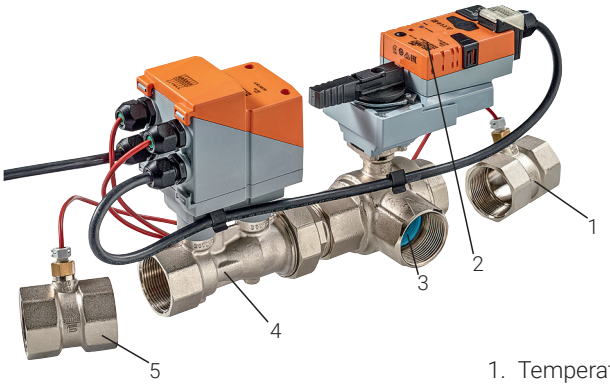
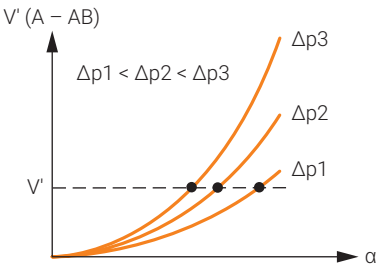
# The Belimo 3-way Energy Valve™

### Structure nominal diameter DN 15...50



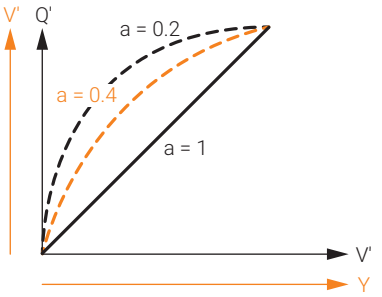

1. Temperature sensor T1
   – Cable length 3 m
2. Actuator with integrated web server
   Actuator with versatile functionality such as energy monitoring and data logging.
3. 3-way characterised control valve (control path A – AB leakage rate A according to EN 12266-1) Air-bubble tight closure of the control path increases energy efficiency.
4. Measuring pipe with volumetric flow sensor
   Ultrasonic flow measurement optimally adapted to the requirements of the application.
5. Temperature sensor T2
   – Cable length 0.8 m

### Mode of operation



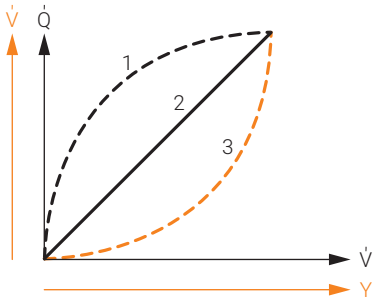

The HVAC performance device is comprised of four components: 3-way characterised control valve, measuring pipe with volumetric flow sensor, temperature sensors and the actuator. The set maximum flow $V'_{max}$ via the control path A – AB is assigned to the maximum positioning signal (typically 10 V / 100%). Alternatively, the positioning signal of the valve position (A – AB) or the power required at the heat exchanger can be allocated. The fluid is recorded by the sensor in the measuring pipe and is measured as the flow rate value. The measured value is compared with the setpoint (analogous to actuation signal or requirement via bus communication) . The actuator corrects the deviation by changing the valve position. The angle of rotation α varies according to the differential pressure through the actuation element.

### Heat transfer characteristic



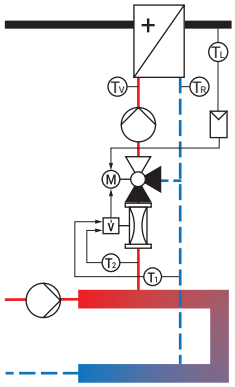
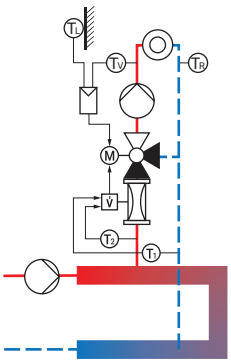

The heat transfer characteristic depends on the hydronic circuit and the control strategy applied, among other things. The form of the heat transfer characteristic is described by the a value:
– a value < 1: "quick open"- characteristic
– a value ~1: linear characteristic

Example:




The goal is to always achieve linear power output (route characteristic curve). Correspondingly, the characteristic curve of the flow rate must be adjusted to the heat transfer characteristic. The heat transfer characteristic with an a-value <1 (1) is linearised by using an equal-percentage characteristic curve at the valve (3). The resulting power output at the heat exchanger is therefore linear (2).
The 3-way Belimo Energy Valve™ offers the possibility to set the desired flow characteristics:
– Factory setting: equal percentage
– Adjustable: linear
There are two resulting possibilities for the main application purpose of the 3-way Belimo Energy Valve™:

**Mixing circuit on low-pressure distributors**

| | Supply air temperature control: | Supply temperature control: (weather-compensated) |
|---|---|---|
| |  |  |
| | $a = \frac{T_V - T_R}{T_V - T_L} = <1$ | a = 1 |
| 3-way-Belimo Energy Valve™ setting: | Positioning signal characteristic = equal percentage | Positioning signal characteristic = linear |

**Control functions**

With the 3-way Belimo Energy Valve™, various actuation variables can be allocated to the positioning signal depending on the respective requirements.

1. Position control
   In this setting, the positioning signal is assigned to the opening angle of the valve control path A – AB (e.g. Y = 10 V <-> α= 90°). This results in pressure-dependent operation similar to that of a conventional valve. However, this is combined with a unique monitoring function.
2. Flow control
   The positioning signal directly requires a defined water quantity (e.g. Y = 10 V <–> V‘ = 80 l/min). The valve unit selects the opening angle automatically so that the requested water quantity is available. Differential pressure fluctuations are automatically compensated for by the 3-way Belimo Energy Valve™ –> pressure-independent operation.
3. Power control
   In this setting, the power output at the heat exchanger is used as an actuation variable (e.g. Y = 10 V‘ <–> Q‘ = 20 kW). The valve unit selects the opening angle and therefore the water quantity automatically so that the requested power is provided to the heat exchanger. Influences of differential pressure and temperature fluctuations are automatically compensated for –> pressure and temperature-independent operation.

Take note that during flow and power control, the opening angle of the control path A – AB depends on the differential pressure and the supply temperature. For example, if the differential pressure increases across the valve in the operating mode "flow control", then it automatically reduces the opening angle in the control path A – AB. This inevitably opens the bypass path. Under certain circumstances, this can mean that the partial opening of the bypass in the supply temperature control leads to the desired flow temperature not being reached, even at 100% demand. If a 100% opening of the control path A – AB is absolutely required at 100% positioning signal request, then this can be guaranteed using position control.

# Project planning

**Relevant information**

The data, information and limit values on the data sheets of the 3-way Belimo Energy Valve™ must be observed and complied with.
– EV..R3+BAC (DN 15...50 with standard actuator)

**Dimensions**

The dimensions of the actuator combination used depend on the design and nominal diameter used. The dimensions are listed on the data sheets.

**Pipeline clearances**

The minimum clearances between the pipelines and the walls and ceilings required for project planning depend not only on the valve dimensions but also on the design. The dimensions can be found on the corresponding data sheet.

**3-way characterised control valves**

3-way control ball valves are mixing devices. Installation in the supply or return is dependent on the selected hydronic circuit.
The 3-way characterised control valve must not be used as a diverting valve.

**Flow direction**

The specified flow direction must be observed.

**Water quality**

The water quality requirements specified in VDI 2035 must be adhered to.

**Strainer**

The 3-way Belimo Energy Valve™ is a regulating device. So that the control task can be taken on in the long term, central strainers are recommended in the system.

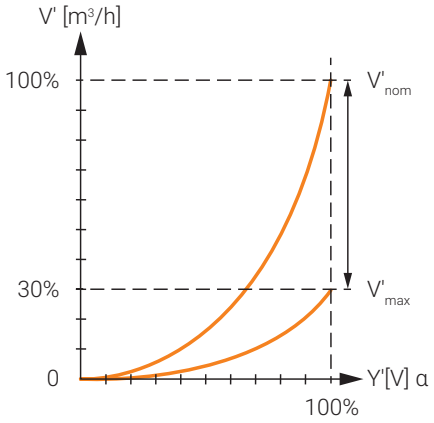
**Design water system**

Application is permitted only in closed water circuits.

**Isolation valves**

Care must be taken to ensure that sufficient numbers of isolation valves are installed.

## Definitions



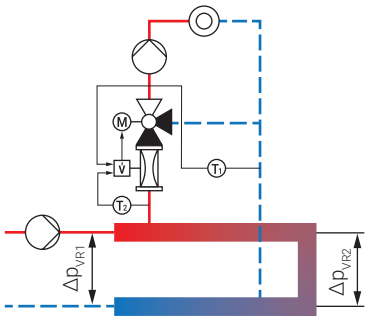

$V'_{nom}$ is the maximum possible flow.
$V'_{max}$ is the maximum flow which has been set with the greatest positioning signal, e.g. 10 V.
$V'_{max}$ can be set between 30% and 100% of $V'_{nom}$ (DN 15...50).
$V'_{min}$ 0% is not variable.

## Hydronic

The main application area of the 3-way Belimo Energy Valve™ is in mixing circuits with low-pressure distributors. For a pressured distributor, the use of an injection circuit with a 2-way Belimo Energy Valve™ is recommended.

This design results in approximately the same pressures in the supply distributor and return collector ($\Delta p_{VR}1 \approx \Delta p_{VR}2$).


The constant flow that flows through the consumer is determined by the internal pump. The 3-way-Belimo Energy Valve™ only influences the mixing behaviour of the flow/bypass. The valve position is used to influence the quantity of return water that is added to the supply via the bypass.

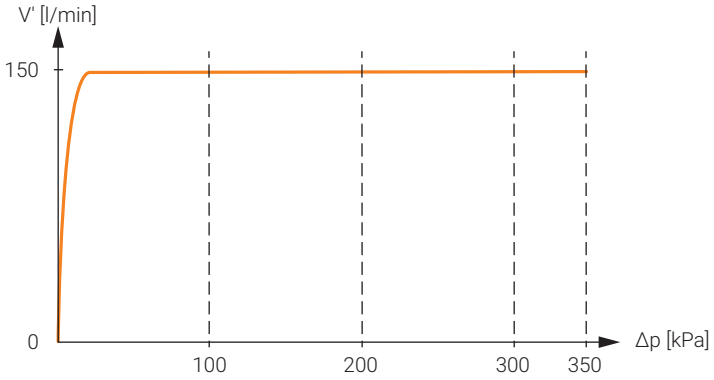


# Design and dimensioning

**Constant flow volume V'**
**(control function flow control)**

Permanent balancing of the measured flow value with the setpoint and the corresponding automatic readjustment of the valve opening position ensure a constant pressure-independent water quantity over a large differential pressure range.

Pressure-independent flow over a large differential pressure range due to dynamic balancing (example EV040R3+BAC)

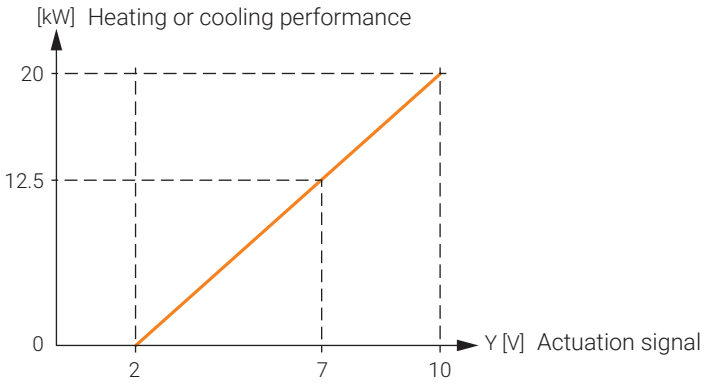



**Constant power output Q'**
**(control function power control)**

The power output at the heat exchanger is influenced not only by the flow volume but also by the water temperature. A changed flow temperature, for example, can adversely affect the power output and thus the comfort. In the "power control" control function, in addition to the influence of the differential pressure, the influence of the temperature is also automatically compensated for by the 3-way Belimo Energy Valve™. The pressure and temperature-independent operating mode always ensures optimum comfort.

The actuation signal requires directly a power output at the heat exchanger.

Example: power control with set $Q'_{max}$ = 20 kW

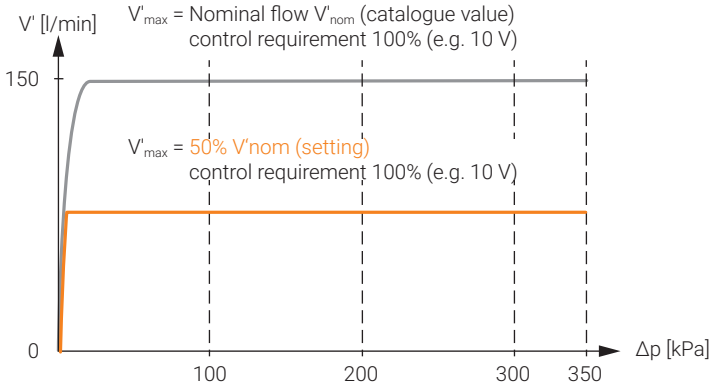



**Valve design**

The valve is determined using the maximum flow required $V'_{max}$. A calculation of the kvs value is not required. The required system-specific maximum flow $V'_{max}$ must lie within the permissible setting range.
DN 15...50: $V'_{max}$ = 30...100% of $V'_{nom}$ (data sheet value)
If the 3-way Belimo Energy Valve™ is to be operated in the "power control" operating mode, the maximum controllable power according to the data sheet must be observed.

During commissioning, the desired system-specific flow value $V'_{max}$ is set on the valve using the ZTH EU setting tool, integrated web server or via bus.

System-specific setting of the maximum flow $V'_{max}$ (example EV040R3+BAC)




**Verification of the differential pressure**

For proper operation, the differential pressure across the valve must lie within a defined range.

**Minimum differential pressure (minimum pressure drop)**

The minimum required differential pressure (pressure drop across the valve) to reach the desired volumetric flow $V'_{max}$ can be calculated using the theoretical kvs value (see data sheet) and the formula below. The calculated value depends on the required maximum volumetric flow $V'_{max}$. Higher differential pressures are compensated for automatically by the valve.

Formula:

$$\Delta p_{min} = 100 \times \left(\frac{V'_{max}}{k_{vs\ theor.}}\right)^2$$

| | |
|---|---|
| $\Delta p_{min}$: | kPa |
| $V'_{max}$: | $m^3/h$ |
| $k_{vs\ theor.}$: | $m^3/h$ |

Example:
DN 25 with the desired maximum flow = 58% $V'_{nom}$
EV025R3+BAC
kvs theor. = 8.6 $m^3/h$
$V'_{nom}$ = 69 l/min
58% x 69 l/min = 40 l/min = 2.4 $m^3/h$

$$\Delta p_{min} = 100 \times \left(\frac{V'_{max}}{k_{vs\ theor.}}\right)^2 = 100 \times \left(\frac{2.4\ m^3/h}{8.6\ m^3/h}\right)^2 = 8\ kPa$$

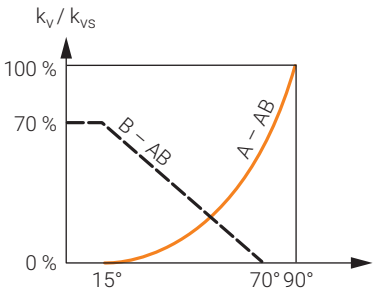
**Maximum differential pressure**

Higher differential pressures across the valve are compensated for automatically by this. Motion of the closing element in the direction of the closing point causes an increase in the pressure drop across the valve. This ensures a constant water quantity. The permitted maximum differential pressure is specified on the data sheet.

**Design for missing hydronic data**

If no hydronic data are available, then the same valve DN can be selected as the heat exchanger nominal diameter.

**Flow characteristics**

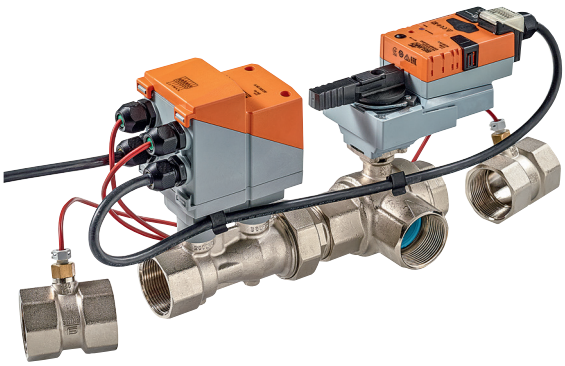



Control path A – AB: the characteristic curve is equal percentage with a characteristic curve factor n(gl) = 3.2. This guarantees stable control behaviour in the upper partial load range. The curve is linear in the lower opening range between 0…30% operating range. This ensures outstanding control characteristics, also in the lower partial load range. The operating range 0…100% corresponds to an angle of rotation of 15…90°.
The flow in the bypass B – AB is designed to be 70% of the $k_{vs}$ value of the control path (A – AB). The characteristic curve in the bypass is linear. Note that the bypass B – AB is already closed at 70° due to its ball design. This must be taken into account in the supply temperature control. Therefore, check whether the use of a double mixing circuit is necessary.

**Settings**

The 3-way Belimo Energy Valve™ offers diverse setting possibilities. The detailed description can be found in the separate document –> Instructions web server Belimo Energy Valve™.

# Dimensional diagram for EV DN 15...50



**Application**

This HVAC performance device is used in closed cold and warm water systems for modulating water-side control of air handling units and heating systems.

**Media**

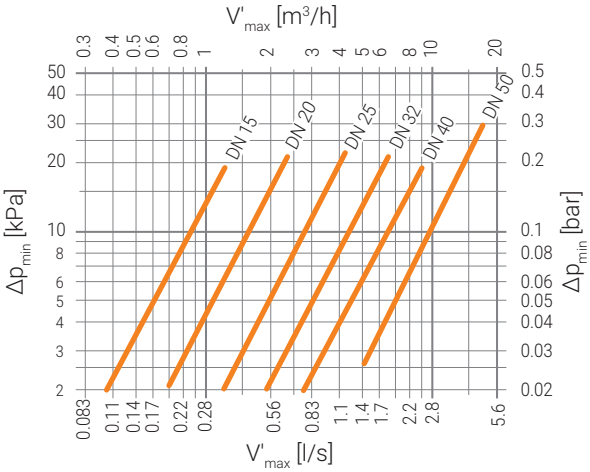
Cold and hot water, water with glycol up to max. 50% vol.

**Medium temperatures**

The permissible medium temperatures can be found in the corresponding data sheets.

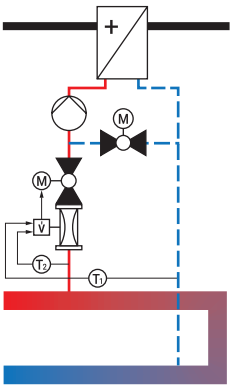
**$\Delta p_{min}$**
Minimum required differential pressure (pressure drop across the valve) to reach the desired volumetric flow $V'_{max}$

**$V'_{max}$**
Desired volumetric flow that should be achieved at full load. Flow at greatest positioning signal, e.g. 10 V



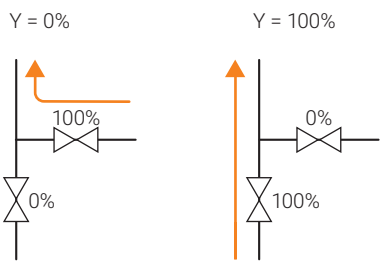

**Design for DN 65...150**

The 3-way Belimo Energy Valve is available in the nominal diameters DN 15...50. If a larger nominal diameter DN 65...150 is required, the following alternative can be considered.




In general, one 3-way valve can be replaced by two 2-way valves. A DN 65...150 mixing circuit can thereby be realised with the products listed below.
– 2-way Belimo Energy Valve [EV..F+BAC] in the supply
– 2-way characterised control valve [R6..W..-S8] or EPIV (EP..F+MP) in the bypass
Note for R6..W..-S8: the $k_{vs}$ value must be chosen so that it is equal to or greater than the $k_{vs}$ value of the Energy Valve.

Control: both valves are operated with the same positioning signal. In order to represent the functionality of a 3-way valve, however, the actuator of the valve in the bypass is operated in an inverted manner.



# All inclusive.

As the global market leader, Belimo develops innovative solutions for the regulation and control of heating, ventilation and air-conditioning systems. In doing so, actuators, valves, and sensors make up the core business.

With a consistent focus on customer value, we deliver more than just products. We offer you a complete product range of actuator and sensor solutions for the regulation and control of HVAC systems from a single source. At the same time, we rely on tested Swiss quality with a 5-year guarantee. Our worldwide representatives in over 80 countries guarantee short delivery times and comprehensive support through the entire product life. Belimo does indeed include everything.

"Small" Belimo products have a major impact on comfort, energy efficiency, safety, installation, and maintenance. In short: Small devices, big impact.

- 5-year guarantee
- On site around the globe
- Complete product range
- Tested quality
- Short delivery times
- Comprehensive support

EN – 08-2020 – Subject to technical modifications

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