Series 420
Additional Modules Type 3424
Bumpless manual/automatic transfer
Control mode changeover · Signal limitation

Application

Additional module for Type 3423–... Controller Module for bumpless manual/automatic transfer, control mode changeover and signal limitation.

The additional modules can be combined with certain controller modules (see Data Sheet T 7521 EN) as well as to upgrade control equipment for special process engineering requirements. They are connected between the controller module and the connector strip assigned to the controller module (see Fig. 3). The units are designed for input and output signals of 0.2 to 1 bar (3 to 15 psi). The required supply pressure is 1.4 bar (20 psi).

Versions

Type 3424-4 (Fig. 1) · Additional module for bumpless manual/automatic transfer that can be combined with Type 3423-2 or Type 3423-3 Controller Modules.

Optionally with output pressure limiter[1)] which limits the controller output pressure y_A to the maximum pressure adjusted.

Type 3424-5 (Figs. 2 and 3) · Additional module for control mode changeover of the connected controller that can be combined with Type 3423-2 or Type 3423-3 Controller Modules.

Optionally with output pressure limiter[1)] (for y_A) and/or set point dependent operating point adjuster.

The control mode changeover switches the connected controller from PI or PID action to P action when the system deviation exceeds the adjusted limit value. The module is particularly suitable for batch processes where the set point must be quickly reached without overshooting.

Type 3424-6 (Fig. 4) · Additional module for maximum and minimum limit[1)] of the controller output signal y_A, the feedback signal (port R) or the reference variable w. It can be combined with Type 3423-1 to -7 Controller Modules.

The signal limiters are particularly suitable for discontinuous processes, for safety limitations, for controllers connected in series to safeguard signal coupling and/or to limit the reference variable w.

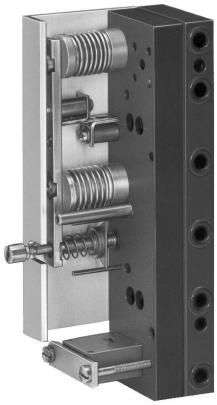


Fig. 1 · Type 3424-4 Bumpless Manual/Auto Transfer

Fig. 2 · Type 3424-5 Control Mode Switchover

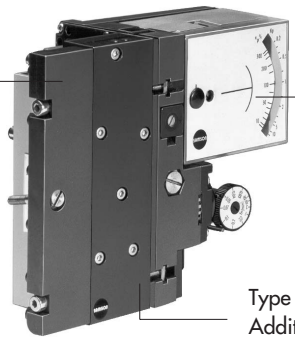


Fig. 3 · Type 3424-5 Control Mode Switchover with Type 3423-2 Controller Module

Fig. 4 · Type 3424-6 Signal Limiter

[1)] This version is **not** suitable for the combination with controller modules with feedback limitation (see Data Sheet T 7521 EN).

Principle of operation

Type 3424-4 · Bumpless Manual/Auto Transfer (see Fig. 5)

A bumpless transfer from manual to automatic mode is only possible when the controller output pressure y_A and the manual signal pressure y_H are the same. The tuning from y_A to y_H is performed manually in most instruments. The Type 3424-4 Additional Module connected between controller and manual control station performs the tuning from the automatic output y_A to the manual output y_H. The switchover from automatic to manual mode is not bumpless. In this case, the tuning must still be performed manually.

The module contains a comparator U1 operating according to the force-balance principle and a selector switch U2 connected to the feedback channel. In manual mode, the manual signal pressure y_H is at port R. The switching pressure S at switch U2 and the output pressure of the comparator U1 at the feedback bellows R1. The turnboard B must be positioned as in Fig. 5. When a deviation between y_A and y_H occurs, the comparator changes the pressure at R1 until both pressures are the same again.

The Type 3424-46 module can be equipped optionally with a pressure limiter U3. This limits the controller output pressure y_A to the maximum pressure adjusted. This version is not suitable for the combination with controller modules with feedback limitation.

Type 3424-5 · Control Mode Changeover (see Fig. 6)

On starting up a plant, the set point should be reached as quickly as possible and without overshooting. This requirement applies especially to the fixed set point control in discontinuous processes, e.g. batch operation of autoclave controls, vulcanizers, and industrial furnaces. Curve 1 in the graph (Fig. 7) shows the start-up and running-in behavior of a temperature controller with PI or PID controller module. In contrast, a corresponding controller with control mode changeover leads to the much better start-up behavior illustrated by Curve 2.

Fig. 6 shows the functional diagram of the Type 3424-5 Additional Module for control mode changeover of the connected PI or PID controller module. The control structure is determined by the error $x_d = w - x$ and the output switching pressure S_{St} of comparator S1 depending on the x_{ds} value adjusted. S_{St} can adopt the binary signal "0" or "1". The following conditions then apply:

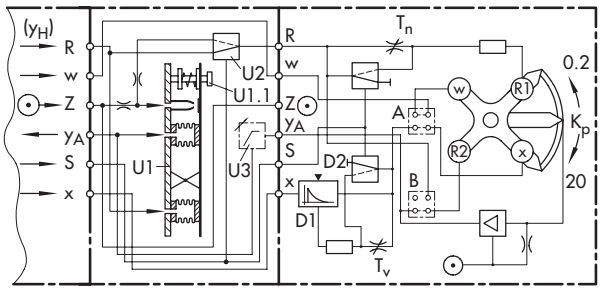
PI/PID structure	when $x_d \leq x_{ds}$ and S_{St} = "0"
P structure	when $x_d > x_{ds}$ and S_{St} = "1"

For example, $x_d > x_{ds}$ at the beginning of the start-up process (see Fig. 7). The controller module operates like a P controller with the operating point adjusted at adjuster S3. This structure favors the undelayed start-up of the set point. If x exceeds the switching point, $x_d \leq x_{ds}$ and S_{St} = "0". In this switching position, the control equipment has a PI or PID structure. This guarantees a start-up of the set point without hunting and a control loop without remaining system deviation when x_{ds} is set to match the plant conditions.

The operating direction can be selected at the turnboard A and S4: Increasing or decreasing output pressure as the reference variable increases.

Note: Control mode changeover by signal limitation (see Type 3424-6).

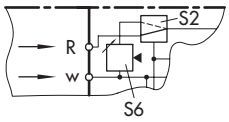
The module can be equipped optionally with set point dependent operating point adjuster (Type 3426-57). The operating point shifts proportional to the set point w, adjustable at adjuster S6:w ± 0 … 20 % (see Fig. 6.1).



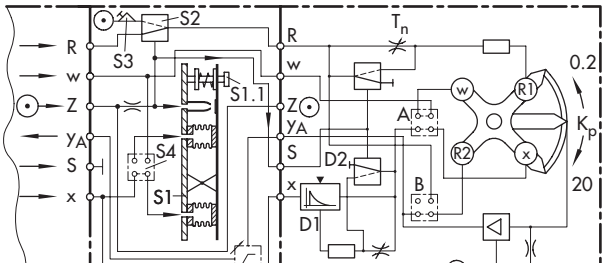
Controller and control station | Type 3424-45 Manual/Auto Transfer | Type 3423-3 PID Controller Module

U1	Comparator	U2	Selector switch
U1.1	Zero adjuster	U3	Pressure limiter

Fig. 5 · Type 3424-45 Bumpless Manual/Automatic Transfer
Typical application with Type 3423-3 PID Controller Module, turnboard B is in a fixed position



6.1 · Arrangement with version with set point dependent operating point adjuster S6



Controller and control station | Type 3424-5 Control Mode Changeover | Type 3423-3 PID Controller Module

S1	Comparator	S4	Selector switch
S1.1	x_{ds} adjuster	S5	Pressure limiter
S2	Selector switch	S6	Adjuster (optional)
S3	Adjuster		

Fig. 6 · Type 3424-5 Control Mode Changeover
Typical application with Type 3423-3 PID Controller Module

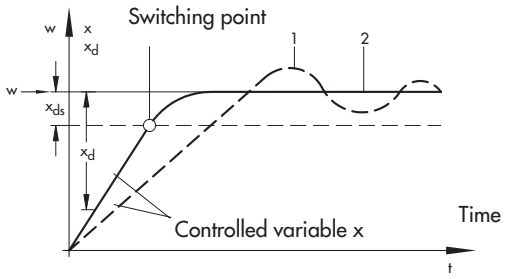


Fig. 7 · Start-up graphs of temperature controllers
Curve 1: With PI or PID controller **without** control mode changeover
Curve 2: With PI or PID controller **with** control mode changeover

The module can optionally be equipped with a pressure limiter S5 (Type 3426-56) which limits the controller output pressure yA to the maximum pressure adjusted. The module can be equipped with max. output limitation and set point dependent operating point (Type 3426-58). This version is not suitable for the combination with controller modules with feedback limitation.

Type 3424-6 · Signal Limiter (Fig. 8)

The additional module can be used in various applications. Depending on the version, the controller output signal y_A, the feedback signal (port R) or the reference variable w are monitored to a maximum and minimum value.

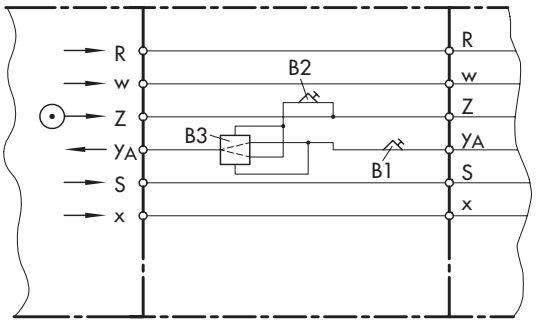
The unit uses a constant signal for the control when the maximum value is exceeded or the value falls below the minimum limit. Each additional module contains two adjusters B1 and B2 and a springless selector switch B3. They are connected to the signal channels to match the version. In non-limited operating range, the signal is controlled without any changes. When the maximum limit is reached, the adjuster B1 limits the output pressure and supplies a constant pressure p_{max} according to the maximum value. The lower limit p_{min} is set at the adjuster B2 which is supplied with supply air. The selector switch B3 compares this value with the output pressure. If the output pressure falls below the limit, the selector switch B3 is switched and the adjuster B2 is connected to the output. As a result, the controlled pressure always remains in the adjusted range between p_{min} and p_{max}.

On activating the signal limitation in the feedback R (see Fig. 8.2), a control device with PI or PID controller module , for example, operates as P or PD controller when y_A exceeds or falls below the limits (p_{min} or p_{max}). Therefore, the device combination can also be used for control loops with a control mode changeover derived from the controller output signal (y or y_A). Unlike the instrumentation with Type 3424-5 Control Mode Changeover (see Fig. 6), this control equipment functions with the operating point p_{min} or p_{max} following a maximum or minimum limit violation. The device arrangement and port are shown in Fig. 6. Instead of Type 3424-5, the Type 3424-6 Module is used.

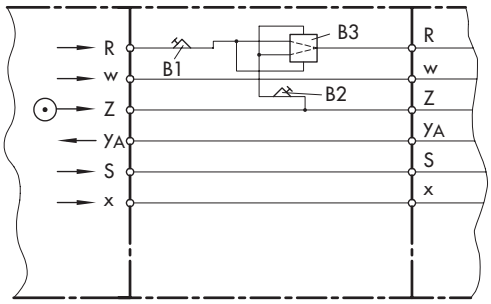
On activating the signal limitation in the signal branch y_A (Fig. 8.1), the device controls the output pressure p_{min} or p_{max} when y_A exceeds or falls below the limit. At the same time, the T_n influence is ineffective in PI and PID control loops since y_A is fed back to the port R. This output signal limitation can be useful, for example, in the following applications:

- In non-linear control processes
- In safety limitations or on connecting large pneumatic actuators to avoid an unfavorable dynamic behavior caused by unnecessary filling the actuator with air or venting it
- In series-connected controllers to safeguard the signal coupling to the next controller and/or to limit the reference variable w_2
- In ratio controls to maintain a minimum flow rate and/or to limit a maximum flow rate.

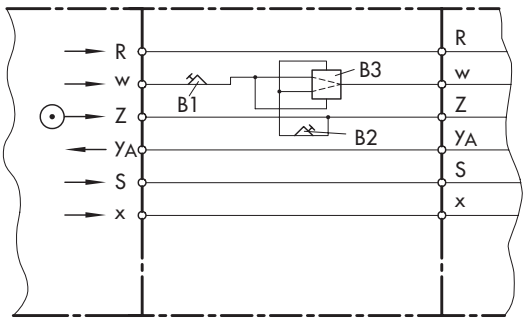
On activating the signal limitation in the signal channel w, further special solutions are possible.



8.1 Limitation for y_A



8.2 Limitation for R



8.3 Limitation for w

Fig. 8 · Type 3424-6 Signal Limiter

8.1 Adjuster for p_{max}
8.2 Adjuster for p_{min}
B3 Springless selector switch

Table 1 · Technical data · All pressure specified in bar (gauge)

Type 3424-4 Bumpless Manual/automatic Transfer	
Input	0.2 to 1.0 bar (3 to 15 psi)
Output	0.2 to 1.0 bar (3 to 15 psi) · Max. 0.02 to 1.35 bar (0.3 to 19 psi) Air supply and load characteristic same as connected controller module (see T 7521 EN)
Max. air supply for version with output pressure limitation	> 0.5 m_n^3/h
Air supply	1.4 bar (20 psi)
Permissible ambient temperature range	–20 to +60 °C
Weight, approx.	0.4 kg
Type 3424-5 Control Mode Changeover	
Switching point	Error x_{ds} adjustable: 0 to 50 %
Operating point for P action, adjustable	0.2 to 1.0 bar (3 to 15 psi)
Input	0.2 to 1.0 bar (3 to 15 psi)
Output	0.2 to 1.0 bar (3 to 15 psi) · Max. 0.02 to 1.35 bar (0.3 to 19 psi) Air supply and load characteristic same as connected controller module (see T 7521 EN)
Max. air supply for version with output pressure limitation	> 0.5 m_n^3/h
Air supply	1.4 bar (20 psi)
Perm. ambient temperature range	–20 to +60 °C
Weight, approx.	0.4 kg
Type 3424-6 Signal Limiter	
Versions	0.2 to 1.0 bar (3 to 15 psi)
Input	0.2 to 1.0 bar (3 to 15 psi)
Output	0.2 to 1.0 bar (3 to 15 psi) · Max. 0.02 to 1.35 bar (0.3 to 19 psi) Air supply and load characteristic same as connected controller module (see T 7521 EN)
Max. air supply for version with output pressure limitation	> 0.5 m_n^3/h
Air supply	1.4 bar (20 psi)
Perm. ambient temperature	–20 °C to +60 °C
Weight, approx.	0.4 kg

Ordering text

Type 3424-4 · Additional module for bumpless manual/automatic transfer, with/without output pressure limitation

Type 3424-5 · Additional module for control mode changeover, with/without output pressure limitation

Type 3424-6 · Additional module for maximum and minimum limitation of output signal y_A/feedback signal R/reference variable w

Specifications subject to change without notice.

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