Control and monitoring of two fans with air valve(s)

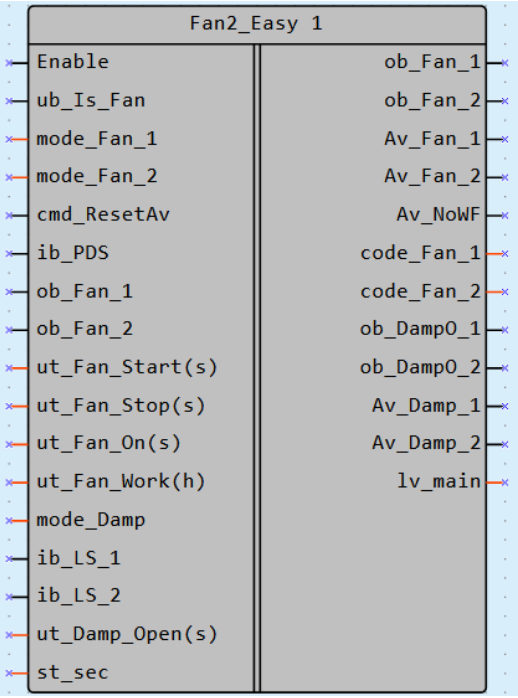

Figure 1 – Symbol

Inputs	Data type	Description	Range
Enable	Bool	Fan start command	0-Stop 1-Start
ub_Is_Fan	Bool	Allowing the node to operate	0-Prohibited 1-Allowed
mode_Fan_1	Int	Fan operating mode 1	0-Not used 1-Main 2-Reserve
mode_Fan_2	Int	Fan operating mode 2	0-Not used 1-Main 2-Reserve
cmd_ResetAv	Bool	Alarm reset	1-Reset
ib_PDS	Bool	Differential pressure sensor on a fan group	0-No difference 1-Difference
ob_Fan_1	Bool	Device output status “On Fan 1”	0-Stop 1-Start
ob_Fan_2	Bool	Device output status “On Fan 2”	0-Stop 1-Start
ut_Fan_Start(s)	Int	Permissible time of absence of signal from the differential pressure sensor after fan start in seconds	≥0

ut_Fan_Stop(s)	Int	Permissible time of presence of a signal from the differential pressure sensor after the fan has stopped in seconds	0-No control ≥0
ut_Fan_On(s)	Int	Fan start delay time	≥0
ut_Fan_Work(h)	Int	Leading fan change period based on operating hours	0-Shift disabled≥0
mode_Damp	Int	Type and method of connecting air valves on a group of fans	0…3 For more details see text below
ib_LS_1	Bool	Air valve limit switch	0-Closed 1-Open
ib_LS_2	Bool	Air valve limit switch	0-Closed 1-Open
ut_Damp_Open(s)	Int	Air valve opening time	0-Control disabled
st_sec	Int	System time	
Outputs	**Data type**	**Description**	**Range**
ob_Fan_1	Bool	Turn on the fan	0-Off 1-On
ob_Fan_2	Bool	Turn on the fan	0-Off 1-On
Av_Fan_1	Bool	Fan is faulty	0-Normal 1-Accident
Av_Fan_2	Bool	Fan is faulty	0-Normal 1-Accident
Av_NoWF	Bool	There are no working fans	0-Normal 1-Accident
code_Fan_1	Int	Fan status code	0-Not used 1-Off 2-Enabled 3-Accident 4-Reserve 5-Faulty 6-Turns On 7-Turns off
code_Fan_2	Int	Fan status code	0-Not used 1-Off 2-Enabled 3-Accident 4-Reserve 5-Faulty 6-Turns On 7-Turns off
ob_DampO_1	Bool	Open air valve	0-Closed 1-Open
ob_DampO_2	Bool	Open air valve	0-Closed 1-Open
Av_Damp_1	Bool	Air valve faulty	0-Normal 1-Accident
Av_Damp_2	Bool	Air valve faulty	0-Normal

			1-Accident
lv_main	Int	Lead fan nubmer	1...2

Explanation of how macro works

The macro is designed to control the operation of two fans, monitor their functionality, manage the air damper(s) ensuring airflow through a specific fan, and monitor its (their) status.

Type and method of connecting air dampers in the fan group. General sequence of operations.

There are 4 possible options for connecting an air damper and fans:

1- mode_Damp=0. One air damper with one limit switch is used. To start the fans, one output (ob_Fan_1) is used. To control the damper position, one output (ob_DampO_1) is used, which determines which specific fan will receive the control command (acting as a selector). The connection diagram is shown in Figure 2.

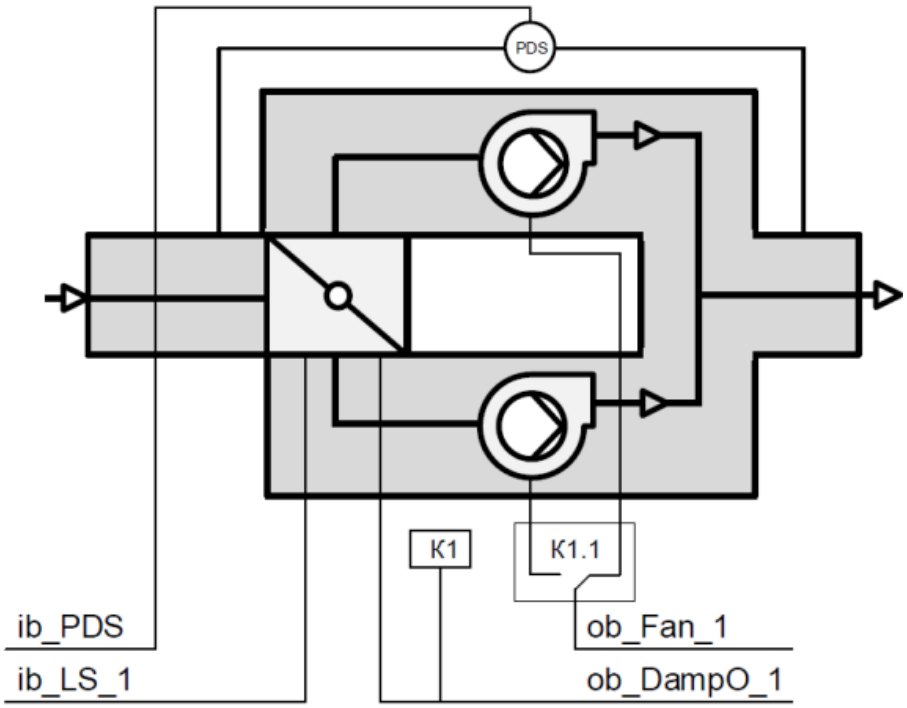

Figure 2 – Connection diagram for mode 0.

Labels in the diagram:

- ib_PDS – differential pressure sensor input
- ib_LS_1 – limit switch input
- K1, K1.1 – relay contacts
- ob_Fan_1 – fan output
- ob_DampO_1 – damper output

2- mode_Damp=1. Two air dampers are used (one for each fan), each with one limit switch. The signals from the limit switches are combined into one (ib_LS_1) via a selector. The commands for damper opening and fan startup are interlocked and combined into one signal (ob_Fan_1). The connection diagram is shown in Figure 3.

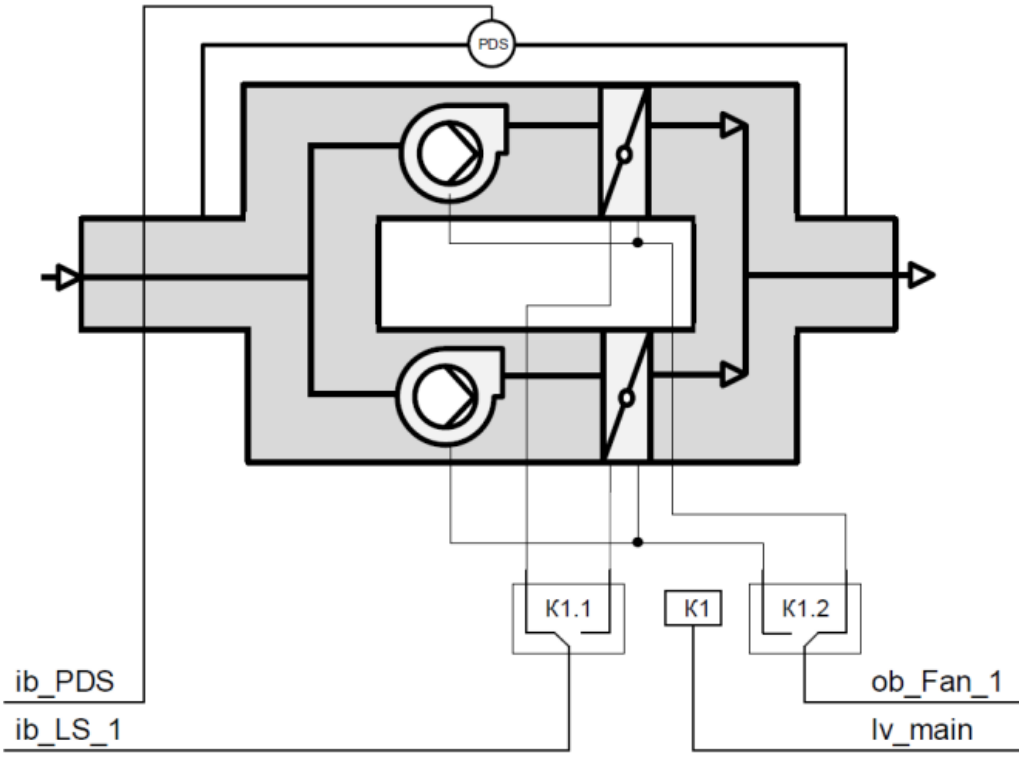

Figure 3 – Connection diagram for mode 1.

Labels in the diagram:

- ib_PDS – differential pressure sensor input
- ib_LS_1 – limit switch input
- K1, K1.1, K1.2 – relay contacts
- ob_Fan_1 – fan output
- lv_main – main power

3- mode_Damp=2. Two air dampers are used (one for each fan), each with one limit switch. The signals from the limit switches are combined into one (ib_LS_1) via a selector. The commands for damper opening are combined into one signal (ob_DampO_1). The commands for fan startup are combined into one signal (ob_Fan_1). The connection diagram is shown in Figure 4.

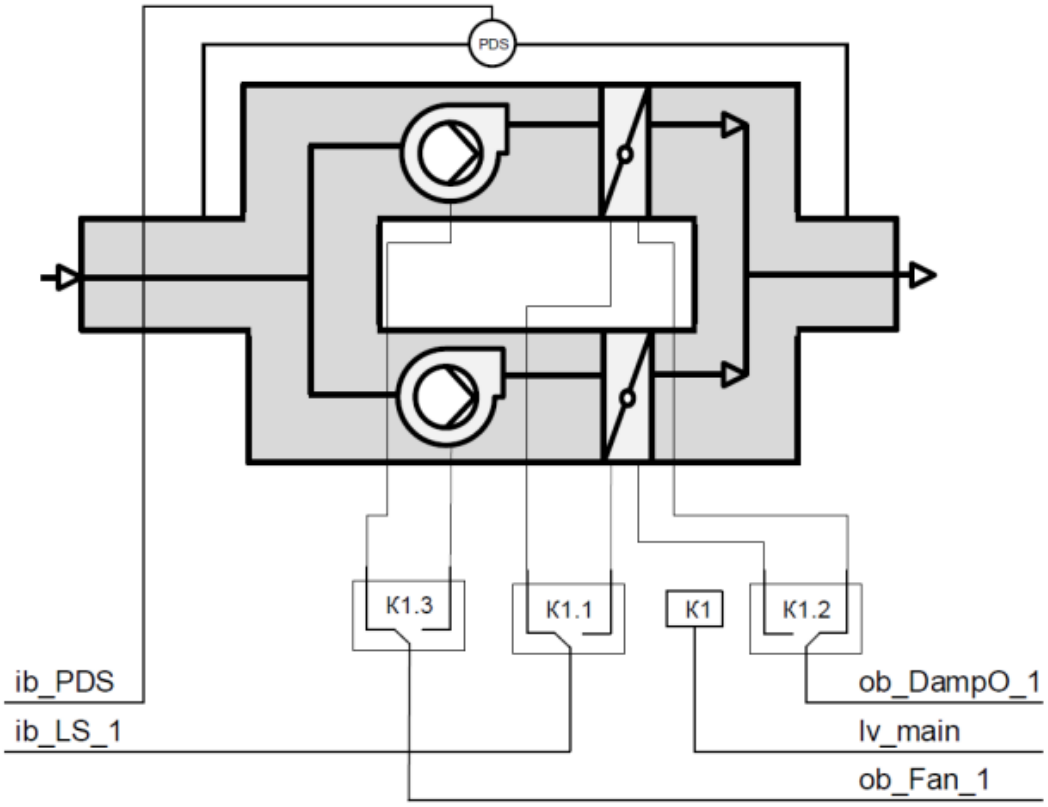

Figure 4 – Connection diagram for mode 2.

Labels in the diagram:

- ib_PDS – differential pressure sensor input
- ib_LS_1 – limit switch input
- K1, K1.1, K1.2, K1.3 – relay contacts
- ob_DampO_1 – damper output
- ob_Fan_1 – fan output
- lv_main – main power

4- mode_Damp=3. Two air dampers are used (one for each fan), each with one limit switch. The signals from the limit switches are individual (ib_LS_1 and ib_LS_2). The commands for damper opening are individual (ob_DampO_1 and ob_DampO_2). The commands for fan startup are also individual (ob_Fan_1 and ob_Fan_2). The connection diagram is shown in Figure 5.

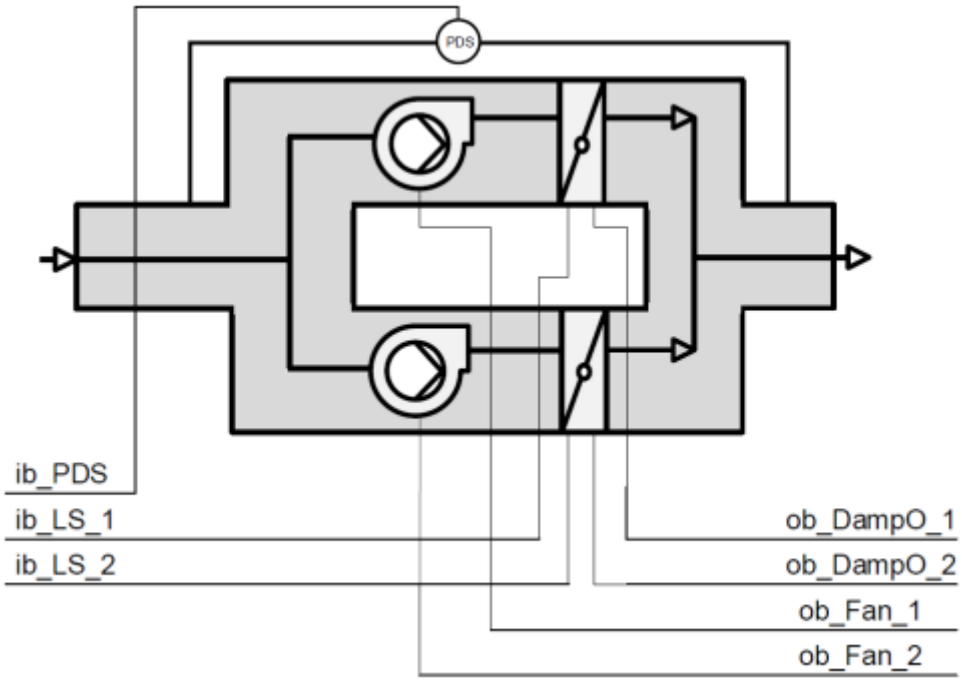

Figure 5 – Connection diagram for mode 3

Labels in the diagram:

ib_PDS – differential pressure sensor input

ib_LS_1 – limit switch input 1

ib_LS_2 – limit switch input 2

ob_DampO_1 – damper 1 output

ob_DampO_2 – damper 2 output

ob_Fan_1 – fan 1 output

ob_Fan_2 – fan 2 output

If the block is not used (ub_Is_Fan=0), then all outputs are inactive (equal to 0).

Operation in single-damper mode

If Fan №1 is leading (lv_main=1), then the damper is closed (ob_DampO_1=0).

If Fan №2 is leading (lv_main=2), then the damper is open (ob_DampO_1=1).

When a start command appears (cmd_Start), the fan starts with a delay (ut_Fan_On(s)). If during operation the leading fan changes, the state of the output controlling the damper (ob_DampO_1) changes immediately, and the following fan is switched off. The new leading fan starts with a delay (ut_Fan_On(s)). A timing diagram is shown in Figure 6.

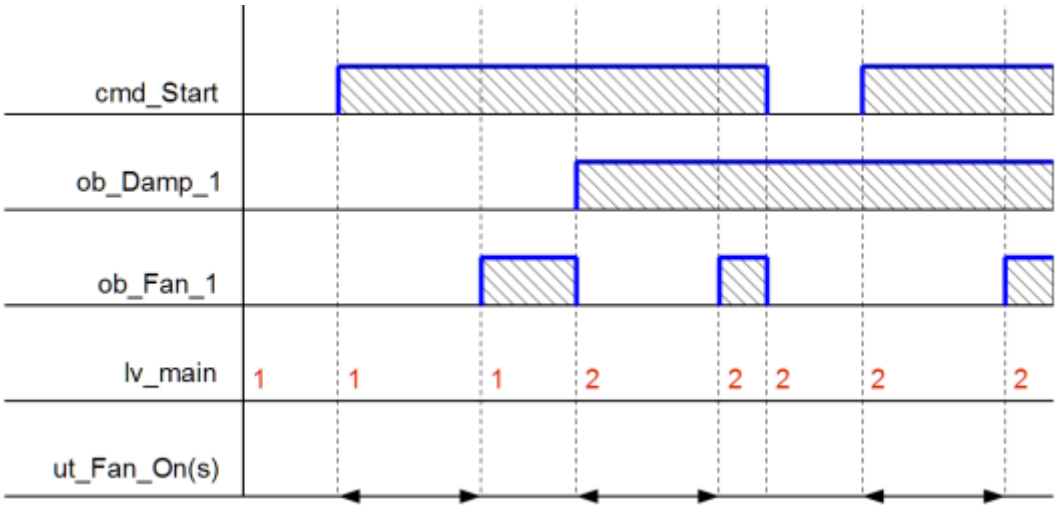

Figure 6 – Timing diagram of operation in single-damper mode

Operation in dual-damper mode

When a start command appears (cmd_Start), a command to open the damper (ob_DampO_x) is immediately issued. The fan starts with a delay (ut_Fan_On(s)). If, during operation, the leading fan changes, then the damper is immediately closed and the current fan is switched off. At the same time, a command is issued to open the damper of the new leading fan, and the new leading fan starts with a delay (ut_Fan_On(s)). The timing diagram is shown in Figure 7.

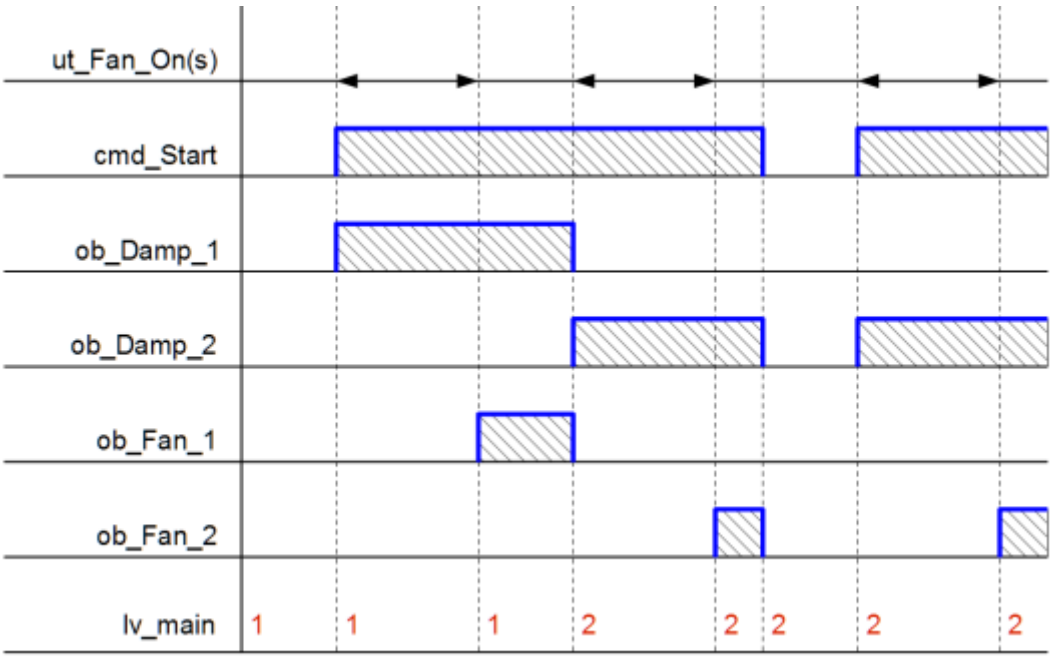

Figure 7 – Timing diagram of operation in dual-damper mode

Order of changing the role of the leading fan

If both fans are in the “Main” operating mode, then the change of the leading fan occurs either when the leading fan reaches the specified operating time (ut_Fan_Work(h)), or in case of a fault of the leading fan. For manual switching, it is necessary to change the operating mode of the leading fan for one cycle, and then return it to its initial value.

If one fan is in the “Main” mode and the other in “Reserve”, then the change of the leading fan occurs only in case of a fault of the leading one. The “Main” fan operates all the time, while the “Reserve” operates only in case of failure of the “Main”.

Fan operability control

When a fan start command is issued (ob_Fan_x=1), its status changes to “Starting” (code_Fan_x=6). After the fan reaches nominal speed, a signal from the differential pressure relay appears (ib_PDS=1) and the status changes to “Running” (code_Fan_x=2). If no signal is received within the fan startup timeout (ut_Fan_Start(s)), a fan malfunction will be recorded (Av_Fan_x=1, code_Fan_x=3).

When the fan start command is removed (ob_Fan_x=0), its status changes to “Stopping” (code_Fan_x=7). After the fan stops, the differential pressure relay signal disappears (ib_PDS=0) and the status changes to “Stopped” (code_Fan_x=1). If the signal does not disappear within the stop timeout (ut_Fan_Stop(s)), a fan malfunction will be recorded (Av_Fan_x=1, code_Fan_x=3).

If no stop timeout is set (ut_FB_Stop(s)=0), then the signal from the differential pressure relay must disappear immediately.

In simple cases, one input signal can be used both for feedback and, if necessary, for emergency diagnostics.

A timing diagram of the process is shown in Figure 8.

Failure of a damper leads to blocking of the operation of the corresponding fan, and the status changes to “Damper Fault” (code_Fan_x=5).

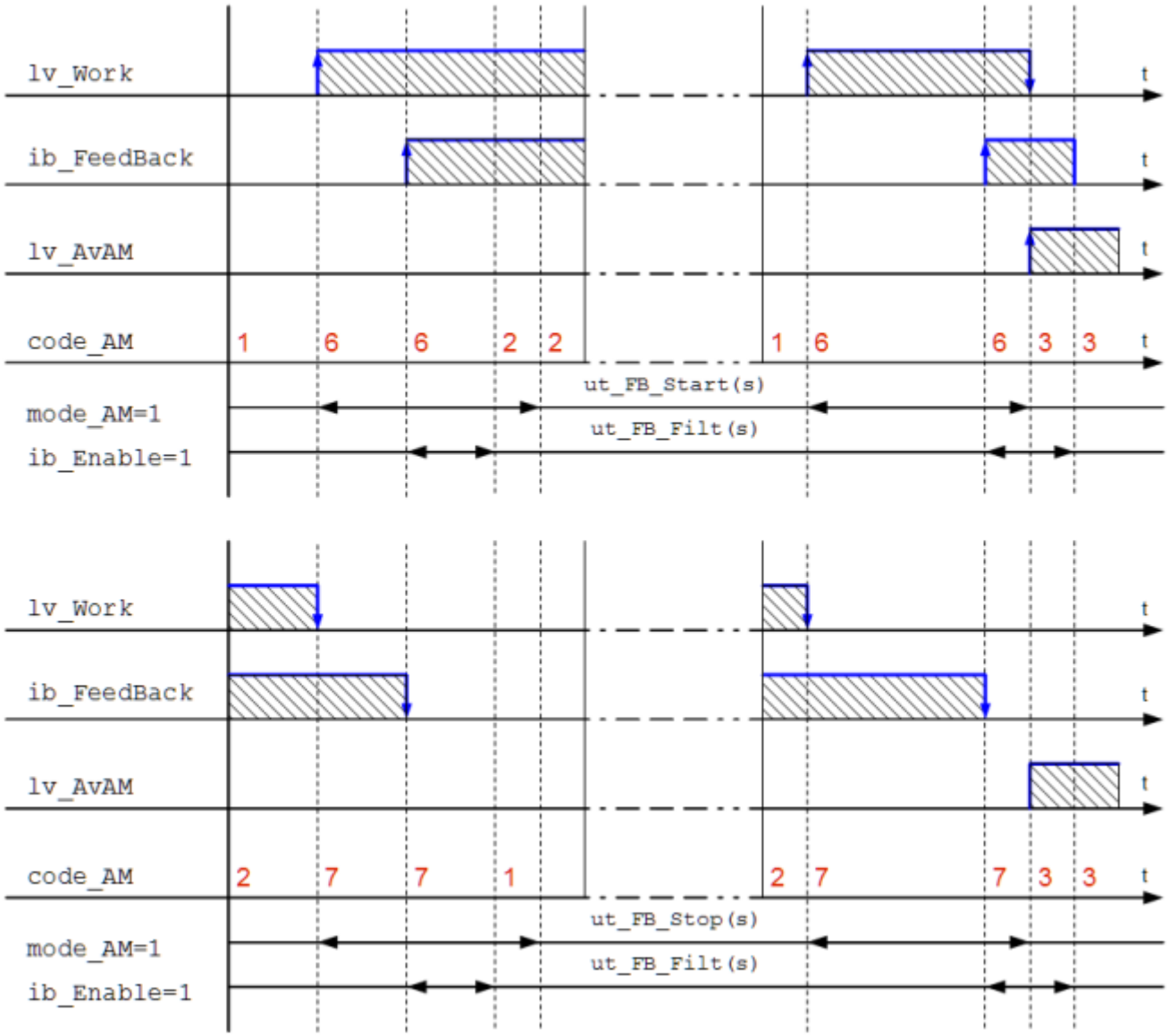

Figure 8 – Timing diagram

Air damper (VD) position control

After the damper is fully opened (ob_DampO_x=1), a signal from the limit switch will appear (ib_LS_x=1). If no signal appears within the damper opening timeout (ut_Damp_Open(s)), a damper fault will be recorded (Av_Damp_x=1).

After the damper is fully closed (ob_DampO_x=0), the signal from the limit switch disappears (ib_LS_x=0). If the signal does not disappear within the damper closing timeout (ut_Damp_Open(s)), a damper fault will be recorded (Av_Damp_x=1).

If the opening timeout is not set (ut_Damp_Open(s)=0), then no control of the limit switch signal is performed.

A timing diagram is shown in Figure 9.

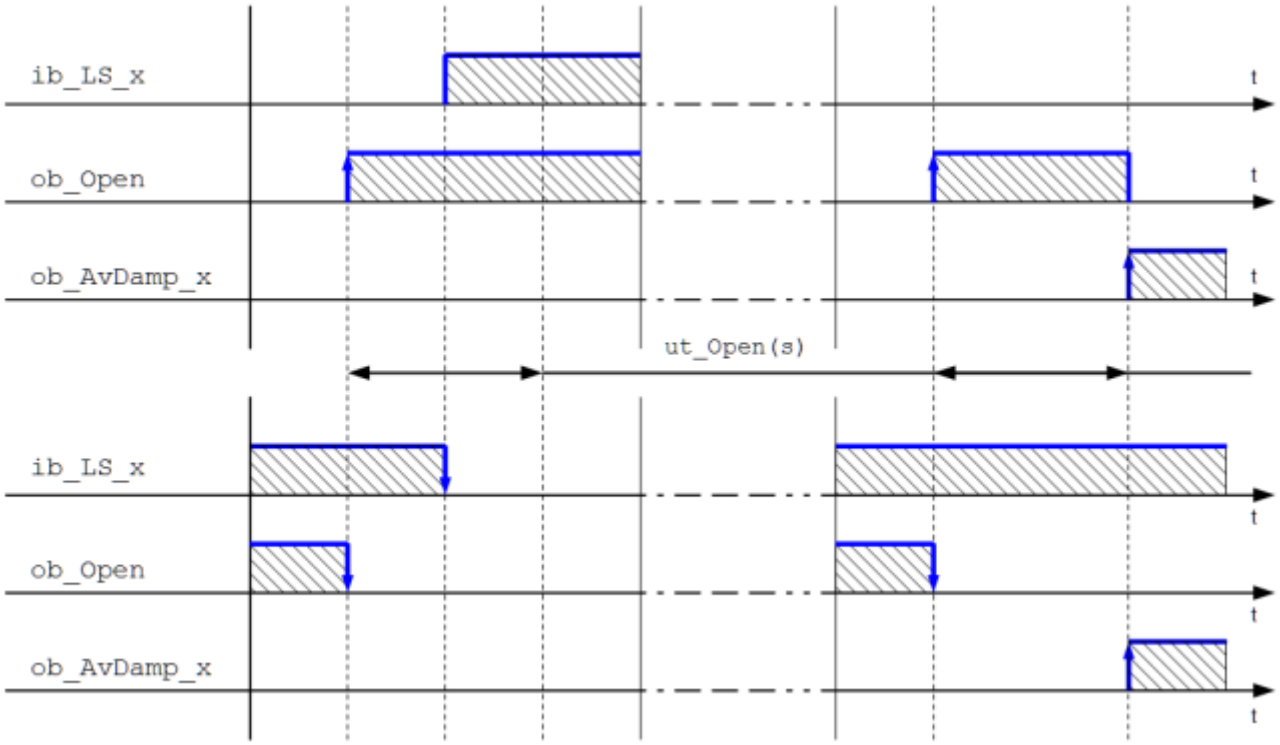

Figure 9 – Timing diagram

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