A-2 Ratio

A-2-1 Description

The following paragraphs are provided to help the user to better understand all the information concerning the specific control strategy and, in particular:

- Project Tasks (POU) Organization and Order;
- Block diagram representation;
- Set of display panels used within the application;
- Application examples;
- I/O table related to the signals managed from/to the field.

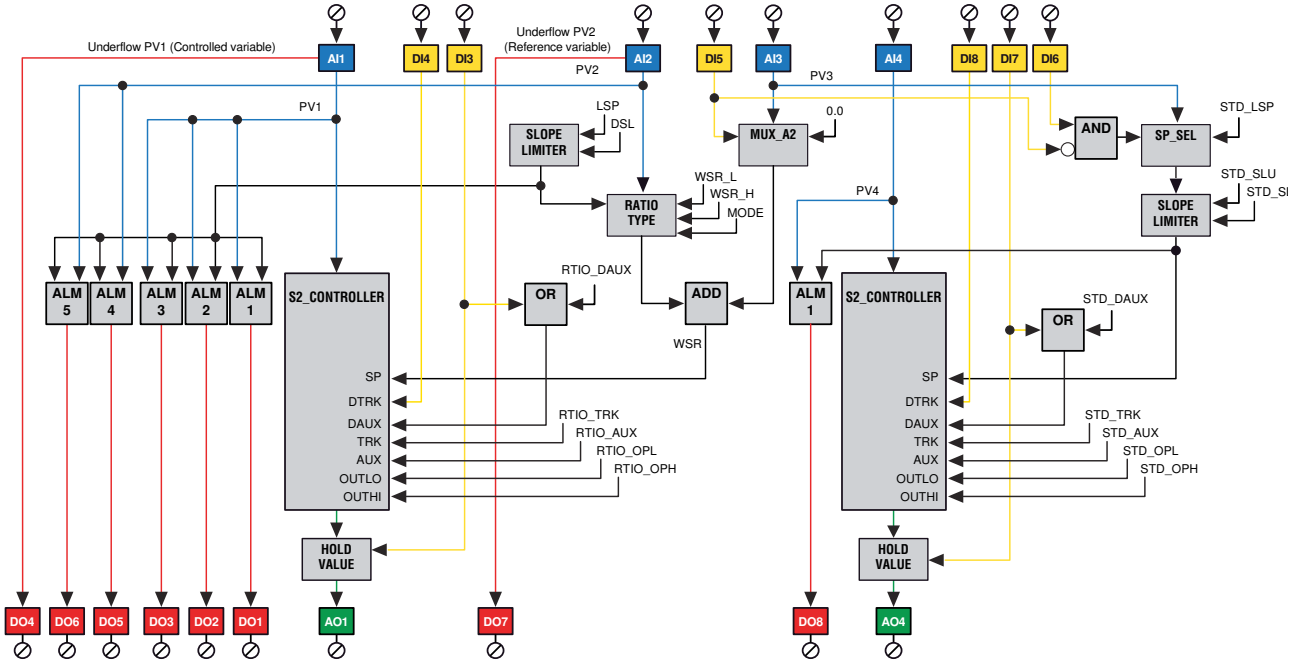
A-2-2 Project Tasks (POU) Organization and Order

In order to obtain the proper operations coming with the functions of the strategy, it is necessary to link the tasks that have been developed as follows:

1. **Ratio_Vars.STD.POE** Global Variables declaration file;
2. **Ratio_Vars.DIR.POE** Direct Variables declaration file;
3. **Ratio_Values_Mngt.ST** Variables application pre-set operations;
4. **Ratio_IO_Mngt.CFC** I/O conditioning operations;
5. **Ratio_Common_Oprs.ST** Application overhall general operations;
6. **Ratio_Loop_Mngt.CFC** Specific Ratio process control operations;
7. **Ratio_Loop_Std_Mngt.CFC** Generic Standard process control operations;
8. **Ratio_Pages.CFC** Overhall display Pages management;
9. **Ratio_Tags.CSV** Display pages specific tags excel CSV file.

A-2-3 Block Diagram

The following diagram provides an overall understanding of the process control and logic that have been arranged for the specific purpose. For this reasons the function block representation has been simplified to enhance readability and the specific functionalities meaning.



This configuration consists of:

- An advanced Ratio Loop;
- A Standard single action loop.

The first loop is the main one and implements a full ratio control algorithm, which calculates the SP correlating the Reference analogue input signal (AI2) and the Controlled one.

Additionally have been implemented the following important functionalities:

- BIAS on the Local SP (WSR);
- Control Output forcing modes;
- Up to 3 Alarms on AI1;
- Up to 2 Alarms on AI2.

The second loop is a Standard PID loop having the following functionalities:

- Remote SP (through AI3 if this signal is not used for the Ratio BIAS);
- Control Output forcing modes;
- Alarm on the controlled variable AI4.

Control

Ratio Loop

Both the AI1 Controlled and AI2 Reference variables are acquired, filtered, corrected and converted into the desired engineering unit by the specific and dedicated MP_AIMNGT_ADV function blocks with out of range detection. These two variables are managed by the RATIO_TYPE function block which computes the Working SP Ratio for the loop accordingly to the selected type of ratio (direct or reverse), as in the following formulas:

Direct ratio = AI2 x Ratio SP = WSR

Inverse ratio = AI2/Ratio SP = WSR

The Working SP Ratio (WSR) becomes then the working SP used by the S2_CONTROLLER to control the AI1 variable. The loop control output is then used to drive the actuator which has to be connected to the AO1 analogue output.

Standard Loop

The AI4 Controlled variable is acquired, filtered, corrected and converted into the desired engineering unit by the specific and dedicated MP_AI_MNGT_ADV function blocks with out of range detection. Then, it is managed by the dedicated S2_CONTROLLER function block which performs the PID calculation accordingly to the desired SP. It generates the control output value to drive the actuator which has to be connected to the AO4 analogue output.

BIAS

The BIAS feature consists in a simple math sum of a quantity to the Ratio SP (WSR), before to be used as SP of the Controlled variable by the S2_CONTROLLER, provided by the analogue BIAS input (AI3). This feature can be enabled or disabled by using the digital input DI5.

Remote SP

This feature is supported only on the Standard Loop and can be enabled or disabled by using the DI6 digital input and in combination with the DI5. The Remote SP can be selected, by using the dedicated SP_SEL function block, between the standard Local SP, coming from the front panel pages or the analogue input AI3. The choice is univocally alternative to using AI3 as BIAS input for the Ratio loop.

Forcing Modes

These operations are alternative to the S2_CONTROLLER PID output calculation. The functionalities provided by the two loops are slight different, as described below.

Ratio Loop

The control output forcing mode available within this configuration, selectable through the DI3 and DI4 are:

- **Tracking:** It can be enabled by the activation of the DI4 digital input and it produces as result the control output forcing to the constant value editable from the specific Configuration page.
- **Hold:** It can be enabled by the activation of the DI3 digital input or the DAUX command coming from the dedicated front panel page, and it produces as

result the freezing of the control output at the last value calculated at the time before the transition.

DI3	DI4	Selected Value
OFF	OFF	No forcing
OFF	ON	Output Tracking
ON	OFF	Output Hold
ON	ON	Output Tracking

An important point to keep in mind is that the Output Tracking is handled directly by the S2_CONTROLLER function block whilst the Output Hold is managed by a dedicated external HOLD_VALUE one.

Standard Loop

Both the previous described functions have been available also on the additional Standard Loop.

The Tracking mode sets the control output to the constant value, editable from the specific Configuration page, until the DI8 is activated or the DTRK command coming from the dedicated front panel page whilst the Hold function freezes the loop control output while the DI7 digital input is activated.

DI7	DI8	Selected Value
OFF	OFF	No forcing
OFF	ON	Output Tracking
ON	OFF	Output Hold
ON	ON	Output Tracking

Alarms **Ratio Loop**

There are three alarms either on the AI1 Controlled variable, according to the working mode desired for each of the ALARM_ADV function blocks that have been used. The status of each alarm is then reported as digital output through DO1, DO2 and DO3.

Two alarms are implemented by the additional ALARM_ADV function blocks on the AI2 Reference variable. Also in this case, the status is reported as digital output through DO5 and DO6.

Both the AI1 Controlled variable and AI2 Reference variable Out of Range status is detected and applied as digital output through DO4 and DO7.

Standard Loop

This loop is provided with a unique alarm either on the controlled variable AI3, according to the working mode desired on the ALARM_ADV function block. The status of the alarm is applied as digital output through DO8.

A-2-4 Graphic Display

The pictures above show the different types of display panels, providing the most effective interface for this strategy configuration. After the Custom page, three more panel pages consisting in a 3 bargraph display, the alarm list and the Forcing mode list are intended to provide a quite complete interface for this configuration.

Referring to the 3 bargraph display, the two bargraph from the left are used for the AI1 Controlled and AI2 Reference variables whilst the third one belongs to the additional Standard Loop.

If you want to operate on a loop, first you have to select it, by pressing the  button. The loop selected is highlighted by the fact that the background colour of the specific Tag changes from dark grey to light blue. Once the loop has been selected, it is possible to change either the SP or the A/M station operating mode. Furthermore, the parameters shown in the upper part of the panel relates to the selected loop.

The alarms status is displayed by the scrolling bar present on top of all the available pages within an application. When an alarm becomes active, the related alarm description scrolls continuously, to alert the operator. Anyway, the operator can get a more detailed view of the alarms, by looking at the specific "Alarms & Events" panel pages.

Furthermore, this configuration provides four more additional panel pages, 2 for each loop, with the well know bargraph and trend displays, as shown in the pictures above.

A-2-5 Applications

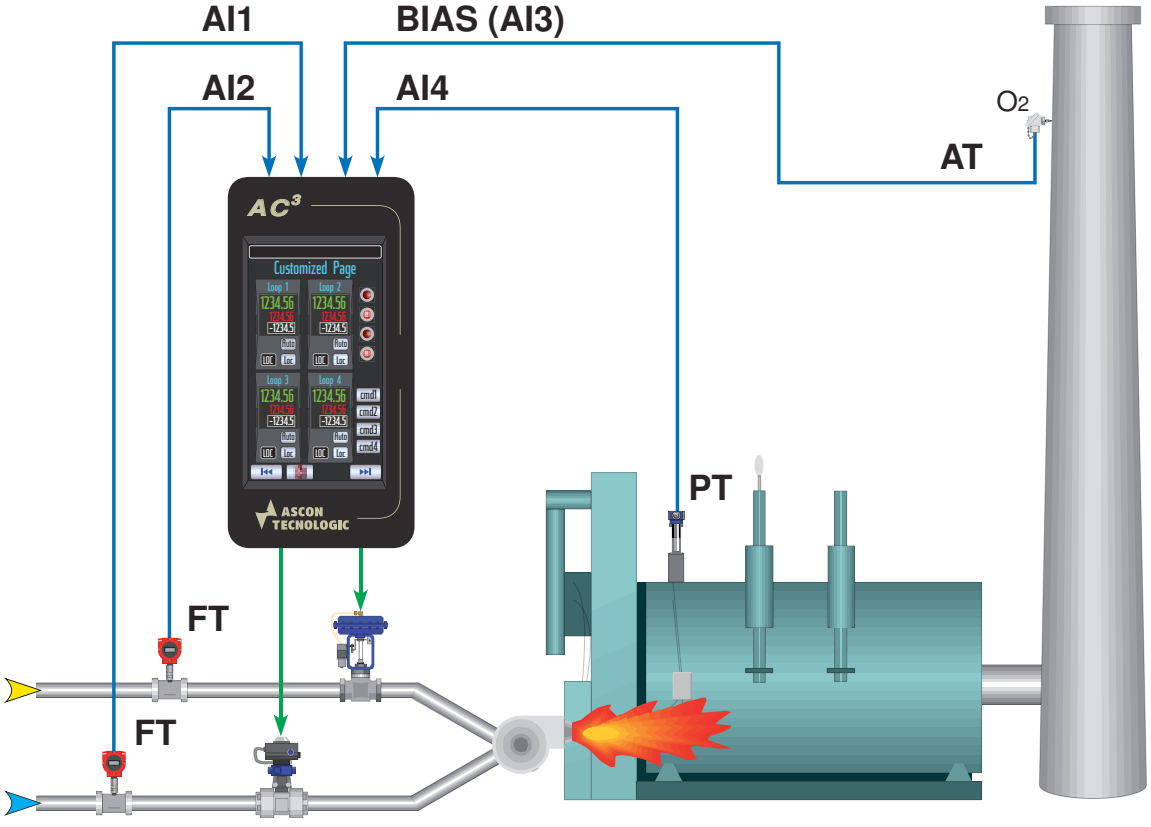
The purpose of the ratio loop is to control those processes where it is required to keep, at a predefined set, the ratio between two controlled variables. There are plenty of examples of processes of this type: for instance, the control of the blending between two fluids and the control of the combustion (air and gas mix).

The second basic PID loop can be used to control an independent variable of the process, where the ratio control is required.

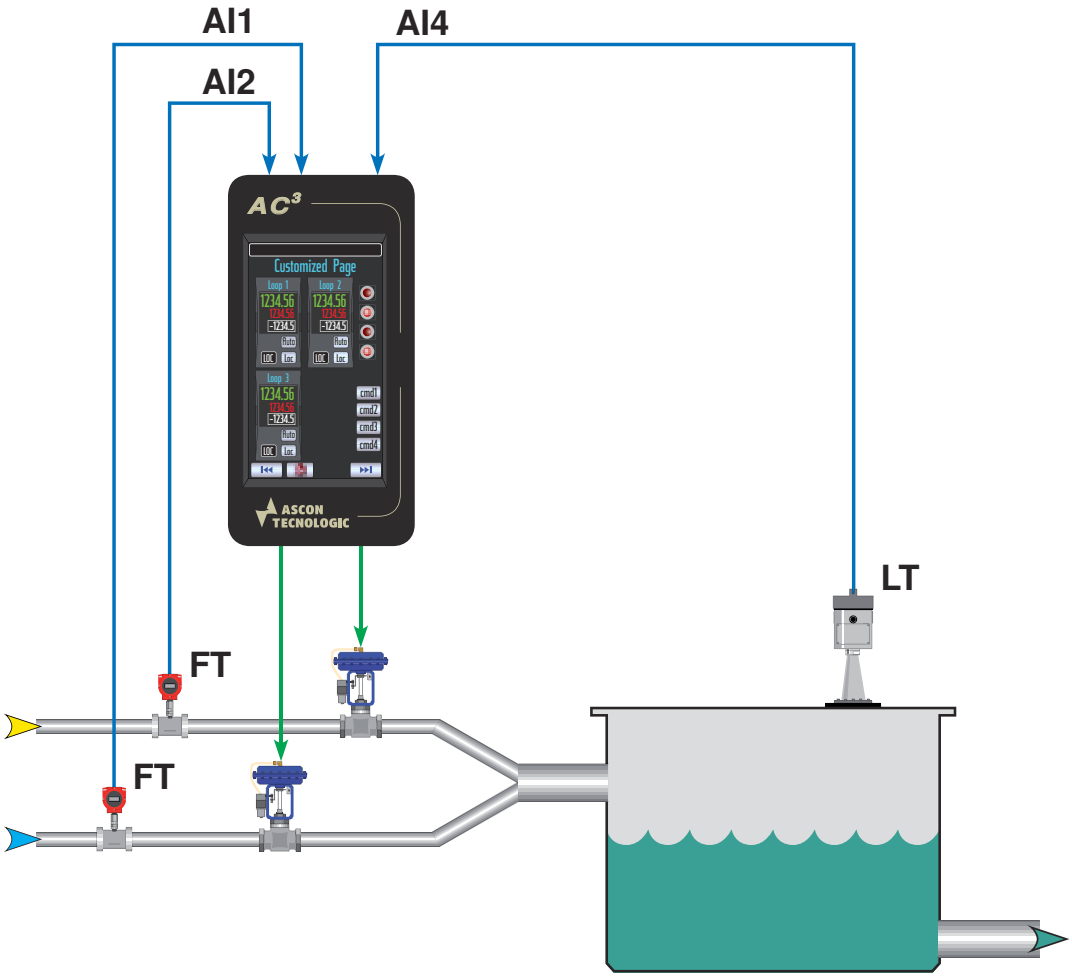
An example is shown in the picture below, related to the combustion control of a steam generator. The steam pressure is controlled by the Std Loop, whose output defines the energy (heat amount) to supply to the boiler, driving the gas valve.

The ratio loop controls the air flow rate, that, in order to optimise the combustion, must be kept to a predefined ratio with the instantaneous gas flow rate. The ratio loop receives the gas flow rate, as PV2, and its output drives the air door. The control of combustion can be, further, improved by measuring the oxygen in the fumes and correcting, according to the measure, the air/gas ratio SP, by mean of the Bias input.

Furthermore, using the digital inputs, some additional functionalities can be implemented, like forcing the closure of the gas valve, tracking the valve at the start up, and disabling the oxygen bias when the production is at the minimum level.



Another application of the ratio loop is in controlling the dosing of an additive to a fluid with variable flow. In this application, Std Loop can be used for the control of the level of the tank where the fluid enters.



A-2-6 Signals I/O Table

I/O	Terminals	Type	Meaning
AI1	E1 +/F1 -	4... 20 mA	Controlled Variable
AI2	E2 +/F2 -	4... 20 mA	Reference Variable
AI3	E3 +/F3 -	4... 20 mA	Bias WSR Ratio/SP Remote Std Loop
AI4	E4 +/F4 -	4... 20 mA	Std. Loop Variable
AI5	E5 +/F5 -	4... 20 mA	Not Used - Available
AI6	E6 +/F6 -	4... 20 mA	Not Used - Available
AI7	E8 +/F8 -	4... 20 mA	Not Used - Available
AI8	E10 +/F10 -	4... 20 mA	Not Used - Available
AO1	E11 +/F11 -	4... 20 mA	Ratio Control Output
AO2	E12 +/F12 -	4... 20 mA	Not Used - Available
AO3	E13 +/F13 -	4... 20 mA	Not Used - Available
AO4	E14 +/F14 -	4... 20 mA	Std. Loop Control Output
DI1	A2	NO Digital Input	Not Used - Available
DI2	A3	NO Digital Input	Not Used - Available
DI3	A4	NO Digital Input	Hold OP Ratio
DI4	A5	NO Digital Input	Tracking OP Ratio
DI5	B2	NO Digital Input	Bias WSR Ratio/SP Remote Std Loop
DI6	B3	NO Digital Input	SP Remote Std Loop
DI7	B4	NO Digital Input	Hold control output Std. Loop
DI8	B5	NO Digital Input	Tracking control output Std Loop
DO1	A6	NO Digital Output	Ratio Alarm_1 Status
DO2	A7	NO Digital Output	Ratio Alarm_2 Status
DO3	A8	NO Digital Output	Ratio Alarm_3 Status
DO4	A9	NO Digital Output	Out of Range Controlled Variable
DO5	B6	NO Digital Output	Ratio Alarm_4 Status
DO6	B7	NO Digital Output	Ratio Alarm_5 Status
DO7	B8	NO Digital Output	Out of Range Reference Variable
DO8	B9	NO Digital Output	Std. Loop Alarm_1 Status

A-3 Cascade

A-3-1 Description

The following drawings below are provided to help the user to better understand all the information concerning the specific control strategy and, in particular:

- Project Tasks (POU) Organization and Order;
- Block diagram representation;
- Set of display panels used within the application;
- Application examples;
- I/O table related to the signals managed from/to the field.

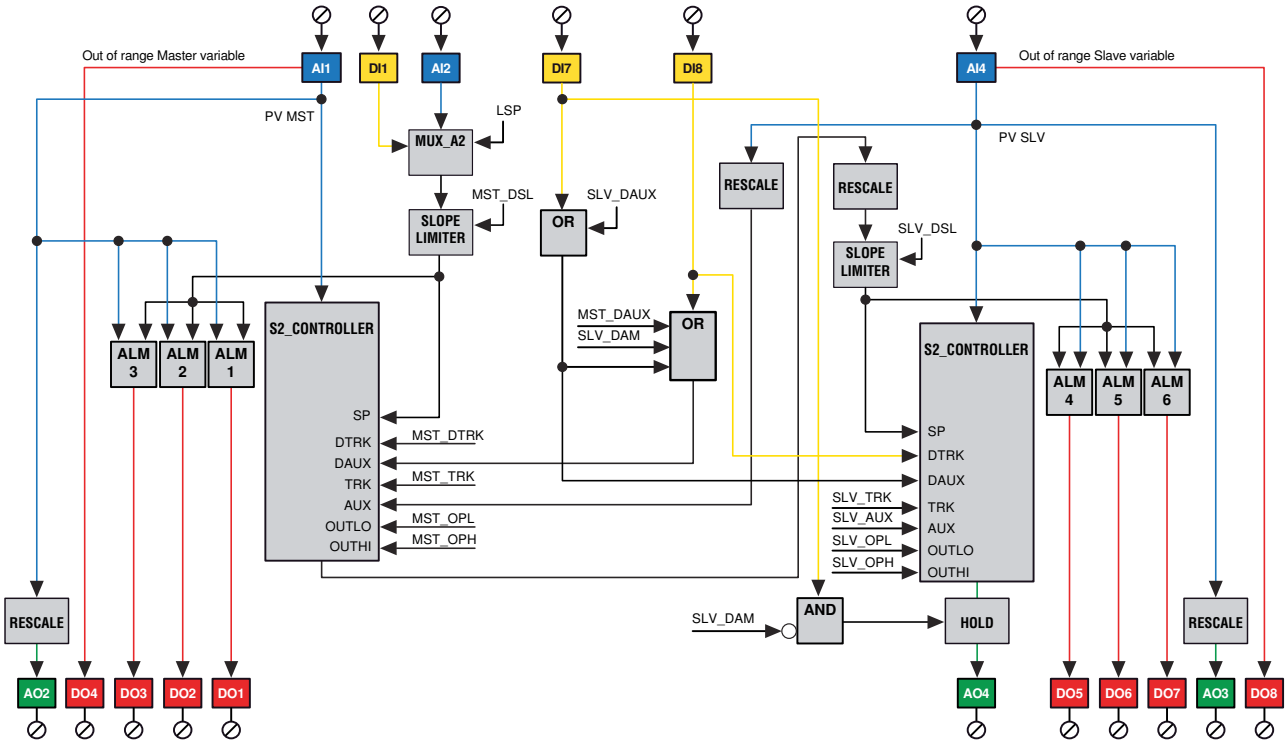
A-3-2 Project Tasks (POU) Organization and Order

In order to obtain the proper operations coming with the functions of the strategy, it is necessary to link the tasks that have been developed as follows:

1. **Cascade_Vars.STD.POE** Global Variables declaration file;
2. **Cascade_Vars.DIR.POE** Direct Variables declaration file;
3. **Cascade_Values_Mngt.ST** Variables application pre-set operations;
4. **Cascade_IO_Mngt.CFC** I/O conditioning operations;
5. **Cascade_Common_Oprs.ST** Application overhall general operations;
6. **Cascade_Loop_Mngt.CFC** Specific Cascade process control operations;
7. **Cascade_Pages.CFC** Overhall display Pages management
8. **Cascade_Tags.CSV** Display pages specific tags excel CSV file.

A-3-3 Block Diagram

The following diagram provides an overall understanding of the process control and logic that have been arranged for the specific purpose. For this reasons the function block representation has been simplified to enhance readability and the specific functionalities meaning.



This configuration consists of 2 loops interconnected in a Cascade configuration and, in particular:

- The Master control loop;