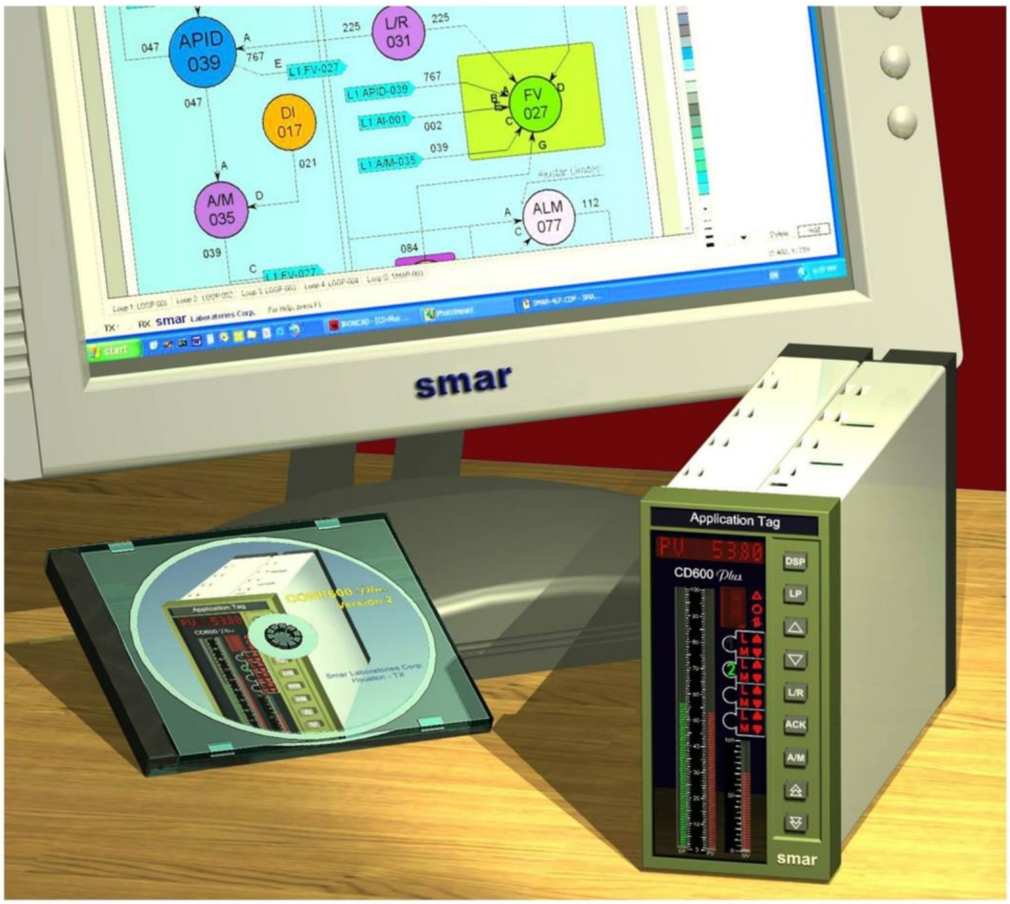
smar - CD600 PLUS

USER'S MANUAL

MULTI-LOOP CONTROLLER
CD600 Plus



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CD600 PLUS

VERSION 4

CD600PLUME

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INTRODUCTION

The **CD600 Plus Universal Multi-Loop Controller** is the next generation of a successful and very reliable Smar Multi-Loop Controller, the CD600. Now using modern electronics and new technologies, it is smaller, lighter, and even more powerful than its predecessor.

The **CD600 Plus** is a powerful stand-alone single station controller capable of simultaneously controlling up to 4 loops (single or cascade) with up to 8 PIDs (four of them with advanced adaptive control) and more than 120 advanced control blocks. To program it, the user can execute the **CONF600 Plus** application.

For the operating personnel, the **CD600 Plus** offers a user-friendly control panel with individual push buttons, an eight-digit alphanumeric display and a reliable hardware.

And for the plant management, the **CD600 Plus** offers cost-effective modularity, management information through digital communication and plant integration through CRT based operator station.

Main Features

- The bar graphs, alphanumeric display status (monitoring, alarm, parameters, etc.) and dedicated keyboard make the **CD600 Plus** a complete stand-alone device for operation and fine-tuning.
- 4 independent control loops with up to eight PID functions (single or cascade).
- 8 analog and 8 digital inputs, 8 analog and 8 digital outputs.
- Built-in 24 Vdc, 200 mA power supply for up to eight field transmitters.
- Flexible and powerful function block library that deals with most every-day situations in process control.
- Several pre-programmed control configurations including cascade, ratio, feed forward, split range, 3-element boiler feed water control, distillation column control and much more.
- Configurator with an easy-to-use graphic interface for Windows XP SP3, Windows 7 SP1 Professional 64-bit, Windows 10 Professional, Windows Server 2008 R2 64-bit, Windows Server 2012 R2, and Windows Server 2016 Standard.
- Time proven dependability and availability - one of the best in the market.

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OPERATION

CD600 Plus Front Panel

The **CD600 Plus** front panel has 3 bargraphs, an alphanumeric display, a group of keys for adjustment and control and LEDs for signaling.

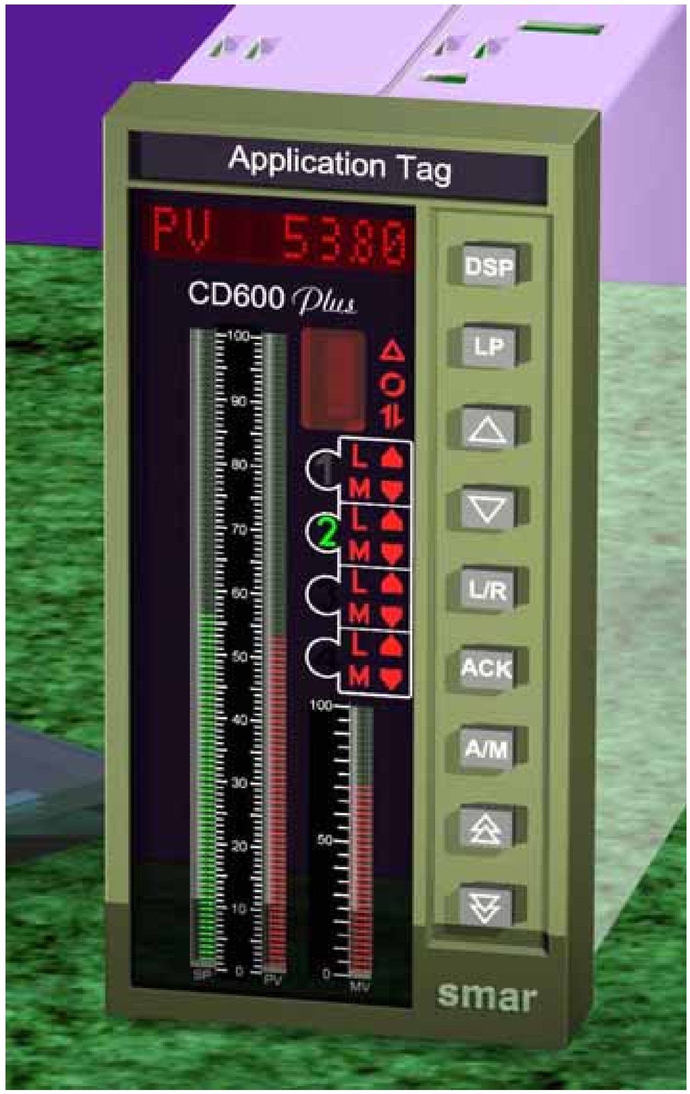


Fig 1.1 - Front Panel

Bargraph	*Description*
SP	Indication of monitored loop's Setpoint it is indicated on the green 101 LEDs bargraph.
PV	Indication of the monitored loop's Process Variable. It is indicated on the red 101 LED's bargraph.
MV	Indication of the monitored loop's Manipulated Variable. It is indicated on the red 41 LEDs bargraph.

Since the visualization of each loop can be freely configured by the user. The 3 bargraphs may also be used for other purposes.

Keys	Description
DSP	Selects the variable to be shown in the alphanumeric display.
LP	Selects the loop to be monitored on the front panel.
△	Increases the value of the variable shown on the display.
▽	Decreases the value of the variable shown on the display.
L/R	Selects the Local Setpoint or the Remote Setpoint of the monitored loop.
ACK	Alarm Acknowledgement
A/M	Selects the Automatic or Manual mode of the monitored loop.
⩓	Increases the MV value, when the control is in Manual. When touched shows the output value on the display.
⩔	Decreases the MV value, when the control is in Manual. When touched shows the output value on the display.
	**Fail:** When lit, indicates that the controller is in fault condition.
	**Cycle:** Blinks every 10 cycles, during cycle time adjustment (refer to section 8 communication).
	**Adjust:** When lit, indicates that the variable, which is being shown on the display, can have its value changed by the keys <△> and <▽>.
	**1, 2, 3** or **4 –** When lit, indicates that the variables, shown on the front panel refer, to the respective loop. **L** – - When lit, indicates that the respective loop is working with Local Setpoint. Unlit **L** means Remote Setpoint. **M** – When lit, indicates that the respective loop is working in the Manual mode. Unlit **M** means Automatic Operation. ▼ or ▲ - When lit, indicates an alarm situation – High (▲) or Low (▼).

Loop Selection

A short touch on the <LP> key lets the display shows the Tag (see below) of the loop being monitored. A longer touch transfers the monitoring to the next Loop. Initially, the new Loop's Tag is shown and, after a few seconds, the monitored information.

Alarm Acknowledgment

Regardless of the selected Loop and of the variable shown on the display, if any alarm, which has been programmed to be indicated on the front panel occurs, the display goes on to show the information of the variable and the **"*ALARM"** information alternately. Furthermore, one of the LED's < ▲ > or < ▼ > from the respective loop, blinks.

As soon as the operator presses the <ACK> key for the first time, the Tag that identifies the configuration, appears on the display, followed by the mnemonic message of the alarm. The message will blink until the operator presses the <ACK> key again, acknowledging the alarm. After the acknowledgement, the message stops blinking and remains displayed if the alarm condition persists. Otherwise, the next alarm will be displayed on the stack, or the "NO ALARM" message, if no alarm exists.

The alarm acknowledgement can also be made automatically. It means that when an alarm condition disappears, the message also disappears, without the acknowledgment by the <ACK> key.

While the alarm is present, the alarm message remains stored in memory stack with capacity for up to 36 alarm messages.

With the keys <Δ> and <∇>, the operator can scroll the stack, checking if there is any other alarms.

Among the alarm messages, which can be visualized on the display, the user can write 8, and the remainders are fixed messages. The blocks that can provide these alarms, and its characteristics, are listed in table 1.1.

BLOCK	TYPE	DEFAULT MNEMONIC	CONFIGURABLE MNEMONIC
001	BURNOUT	AI1 OUT	NO
002	BURNOUT	AI2 OUT	NO
003	BURNOUT	AI3 OUT	NO
004	BURNOUT	AI4 OUT	NO
005	BURNOUT	AI5 OUT	NO
006	BURNOUT	AI6 OUT	NO
007	BURNOUT	AI7 OUT	NO
008	BURNOUT	AI8 OUT	NO
009	DEV/BURNOUT	AO1 OUT	NO
010	DEV/BURNOUT	AO2 OUT	NO
011	DEV/BURNOUT	AO3 OUT	NO
012	DEV/BURNOUT	AO4 OUT	NO
039	DEVIATION	DEV - 1	NO
040	DEVIATION	DEV - 2	NO
041	DEVIATION	DEV - 3	NO
042	DEVIATION	DEV - 4	NO
077 (1º comp.)	LOW/EQUAL/HIGH	LOW COMP	YES
077 (2º omp.)	LOW/EQUAL/HIGH	HGH COMP	YES
078 (1º comp.)	LOW/EQUAL/HIGH	LOW COMP	YES
078 (2º comp.)	LOW/EQUAL/HIGH	HGH COMP	YES
079 (1º comp.)	LOW/EQUAL/HIGH	LOW COMP	YES
079 (2º comp.)	LOW/EQUAL/HIGH	HGH COMP	YES
080 (1º comp.)	LOW/EQUAL/HIGH	LOW COMP	YES
080 (1º comp.)	LOW/EQUAL/HIGH	HGH COMP	YES
081	UPPER LIMIT	LIM H 01	NO
081	LOWER LIMIT	LIM L 01	NO
081	VELOCIDADE	VELOC 01	NO
082	UPPER LIMIT	LIM H 02	NO
082	LOWER LIMIT	LIM L 02	NO
082	VELOCIDADE	VELOC 02	NO
083	UPPER LIMIT	LIM H 03	NO
083	LOWER LIMIT	LIM L 03	NO
084	VELOCIDADE	VELOC 03	NO
085	UPPER LIMIT	LIM H 04	NO
085	LOWER LIMIT	LIM L 04	NO
085	VELOCIDADE	VELOC 04	NO

Table 1.1 - Alarm Characteristics

Changing the Alphanumeric Display Bright

In order to change the alphanumeric display bright, follow the steps below:

1. Press the <ACK> key in the controller front panel and keep pressed for a few seconds until the display and frontal keyboard functions change to PID.
2. Press the <ACK> and <DSP> keys together until the ID of the controller appears.
3. Press the <DSP> key until the “Bright” function appears. Using the <Δ> and <∇> keys, select the desired bright for the alphanumeric display.

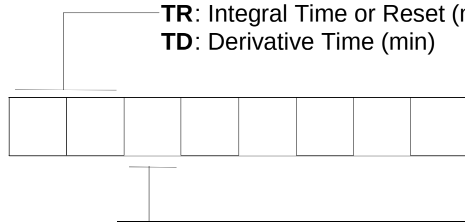
TUNING

Proportional gain, Integral time and Derivative time constants of any Proportional, Integral, Derivative *(PID)* block existing in the controller's configuration may be adjusted from the front panel without using the Programmer. To make it possible, it is necessary to set the **CACT** parameter, of the respective *PID* block, to "0" or "1".

Keep the <**ACK**> key pressed for a few seconds, until it changes the function of the display and the front keyboard. Regardless of the previously shown variable, the display shows the PID proportional gain, of the selected loop. In case there is more than one *PID* block on the loop (e.g. Cascade control), the proportional constant refers to the lowest number *PID* block. In this case, the user should know the blocks in the loop, in order to identify the “**MASTER**” and “**SLAVE**” *PID*.

The mnemonic of each constant is composed of two letters that identify the action type, and a number, that identifies the *PID* block that it belongs to.

KP: Proportional Gain
TR: Integral Time or Reset (min/rep.)
TD: Derivative Time (min)



1	**BLK039**	**1º**	PID Advanced
2	**BLK040**	**2º**	
3	**BLK041**	**3º**	
4	**BLK042**	**4º**	
5	**BLK043**	**1º**	PID Simple
6	**BLK044**	**2º**	
7	**BLK045**	**3º**	
8	**BLK046**	**4º**	

Table 2.1 – Number of the PID block related to the front panel tuning

When there is more than one loop in the controller, use the <**LP**> key in order to change the *PID* parameters. Use the <Δ> and <∇> keys to change the values of the *PID* constants.

The scroll of all tuning parameters of all the *PID* blocks of a Loop is made by the <DSP> key.
The front panel keys (DSP, Δ, ∇, ACK) return to their normal functions by pressing the key <**LP**> or in 20 seconds, if any key frontal panel is not actuated.

NOTE
a-) Tuning by the front panel can be disabled through the configuration. b-) Tuning can be done by a PC connected to the communication port.

PROGRAMMING

Operation

The programming of the **SMAR CD600 Digital Controller** is based on the concept of ***freely interconnectable Function Blocks***. The interconnection is done in accordance to the control strategy defined by the user.

All the function blocks already exist in a part of the memory not accessible by the user. Programming the controller means to configure it by calling the necessary blocks into the user memory, NVRAM, link them together, set their **Characterization** and **Adjustment** parameters to fit a specific application.

Exchange of information between the used control algorithm and the process is done by means of the input and output Function Blocks (both analog and digital). By these blocks the programmed configuration is "physically" connected to the controller terminal block. Therefore, for example, the **Analog Input** block **No.1** can only be used for reading and processing the signal which is connected to the terminal **001** (first analog input).

TYPICAL DESCRIPTION OF A BLOCK

The blocks described in Section 4 have a **Control Function**, consisting of one or more mathematical and/ or logical operations. The function will relate block inputs with block outputs. The inputs are designated by letters (A, B, C...), and outputs are designated by numbers. Exceptions are the Analog and Digital input and output blocks, whose inputs, respectively outputs, are related to hardwired terminals.

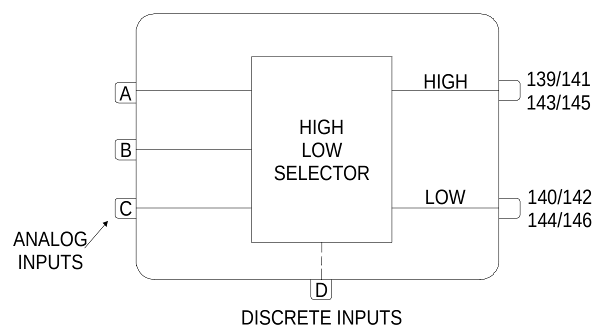


Fig 3A - Typical Block

The numbers related to the block outputs are addresses. Each number refers exclusively to a certain output of a certain block and vice versa.
Each block has one **Linking Parameter (L)** for each input. A block with 3 inputs has the **Linking Parameters LIA**, **LIB**, and **LIC** (Link Input **A**, **B** and **C**). If the HIGH-LOW selector block shown in Figure 3A has **LIA**=2, that means that the input **A** of that block is on.
As a block can perform several operations, the activations of these operations are defined by the **Characterization Parameters**. For example, the **Analog Input** block offers a choice of implementing **SQ**uare **R**oot extraction (**CSQR**=1) or not (**CSQR=0**). It offers also a choice to use **LIN**earization (**CLIN**=1) or not (**CLIN**=0) - (See Figure 3B).

Constants in the Function Blocks that require frequent changes during process operation are called **Adjustment Parameters** (**ADJ** Parameters). The same **Analog Input** block has an adjustable filter, which has a time constant adjustable by **ATIM**.

There are two types of signals between blocks: scalar and discrete. Scalar are continuous signals while discrete are on-off type of signals.

The signal transfer through block link is always made in the form of percentage, even if the signal is discrete (0% for low logical level 0 and 100% for high logic level 1). A scalar signal, connected to an input prepared to receive discrete signals, will be interpreted as follows:

- less than 70%: level 0
- more than 80%: level 1
- between 70% and 80%: previous state

The output signal of a block can be received by as many inputs of blocks as desired.

THE LOOPS

A Loop is a set of interconnected blocks with a certain purpose. It has a single man-machine interface for the manipulation and visualization of data by the front panel of the controller. The maximum number of loops per **CD600** is 4.

The **CD600**'s program also offers a configuration workspace named **General Loop**, "**LOOP G**" which contains only blocks that may be simultaneously used by more than one loop. An example of information maintained in the General Loop are the coordinates of the points used by a linearization curve that may be used by several Analog Inputs simultaneously.

Tags

The Tag (Loop identification, see below) of the General Loop will always be the Tag of the whole configuration. All configurations **must have a General Loop**, even if the program contains only one control Loop. If no blocks are configured for the General Loop, at least a Tag must be given.

How to Program the CD600 Plus

When the **CD600 Plus** leaves the factory, with a default configuration named "4 LOOPS" (see Section 5). This configuration can be changed to fit a particular application, or can be replaced by a new one.

A program can be created, can be changed, or have its parameters modified through a PC. The PC will need an appropriate interface, the **CONF600 Plus**. The **CONF600 Plus** is a powerful user interface; it can be installed in a laptop or PDA and can be executed in the field as far as the hardware allows. The configuration is drawn with control blocks and links, in part, as a control diagram or a wiring diagram in a CAD system. In the Help windows, parameter information, options and limits can be found.

The **CONF600 Plus** allows continuous access to all parameters and input/output monitoring parameters of the blocks, becoming easier to troubleshoot configuration failures. The **CONF600 Plus** also supplies user documentation with configuration hardcopies, and disk storage. Please refer to the **CONF600 Plus** section in this manual for further details.

Example of a Configuration

The following control strategy can be implemented on the **CD600 Plus**:

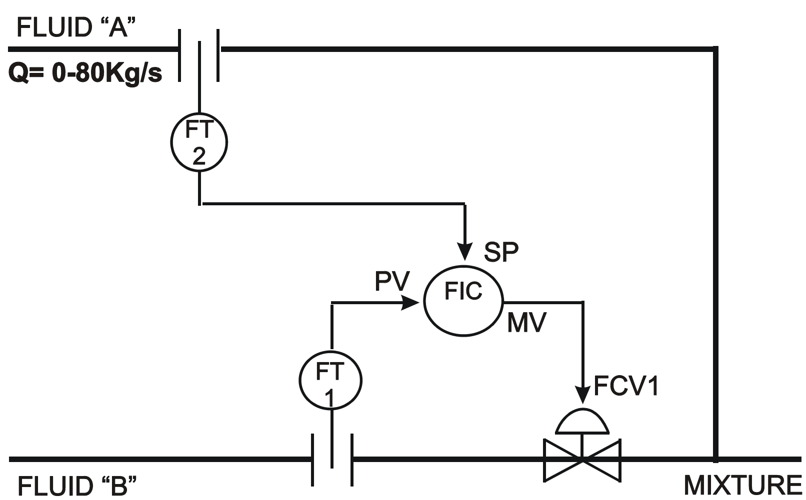


Figure 3.1. Designed Control Loop

The Fluid B flow should be controlled to be the same as Fluid A. There is an example in section 4, **Function 12 - ARTH**, where Fluids A and B are constantly controlled.

It is recommended to draw the configuration control using the block library as a reference. The drawing should have block and terminal numbers, as indicate in the following figure:

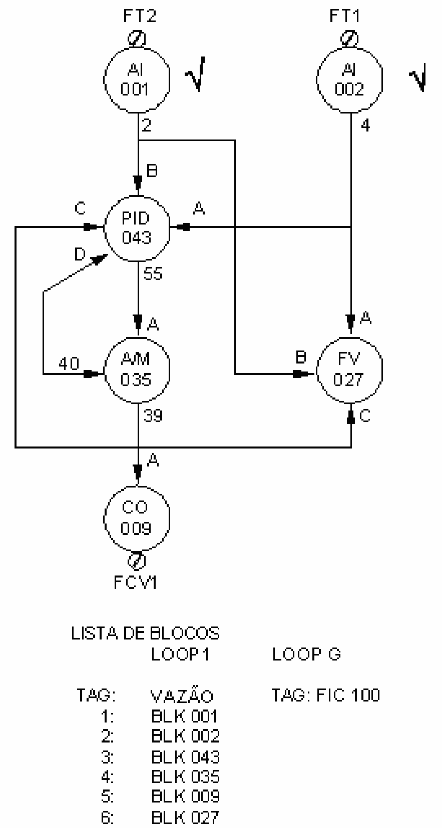


Figure 3.2. Configuration of a Control Loop

The procedures above described are used to configure the controller through the **CONF600 Plus**.

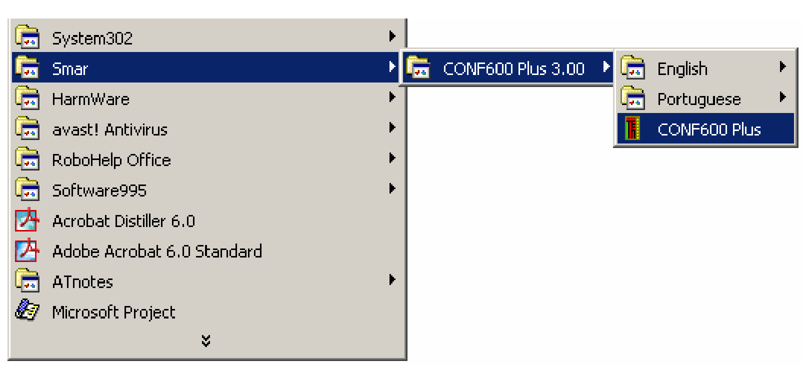
There will be only one loop in the new configuration. It is necessary to adjust the identification address of the **CD600 Plus**.

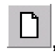
A) Adjusting the identification address of the **CD600 Plus**:

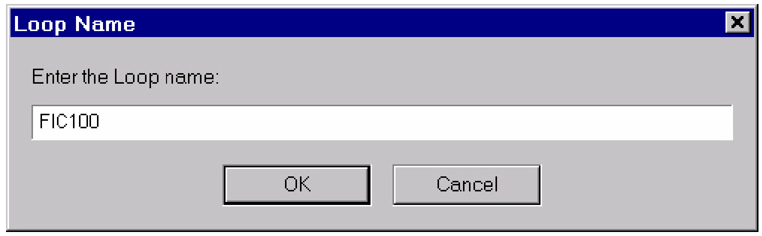
- Press the **<ACK>** key in the front panel of the **CD600 Plus** and keep it pressed for a few seconds until the display changes its message.
- Then, press the **<ACK>** and **<DSP>** keys together, the panel will show the controller's ID address.
- Adjust the numeric values on the display using the keys <Δ> or <∇>. When the address is "1", it means the controller only accepts communication from the Hand-Held Terminal. Addresses from "2" to "30" are the addresses programmed for the controller on the serial communication network.
- Click on the **<LP>** key to return to normal operation.

B) Starting up the CONF600 Plus:

- From the Start menu, open Programs > Smar > CONF600 Plus > CONF600 Plus.



- Start a project file clicking in *New*, , on the toolbar.
- Right click on Loop G on the palette and type “FIC100” as project name.



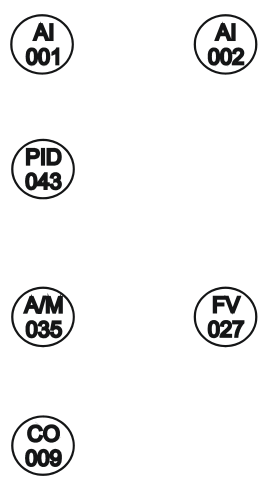
- With another right click on Loop 1, “Flow” can be the name of the other loop.

C) Adding blocks in the configuration:

- Click on the *Loop 1* palette. Select the *Node* tool, , and click on the drawing area to add the indicated blocks in the table below. Locate the blocks in the drawing area as indicated in figure 3.3.

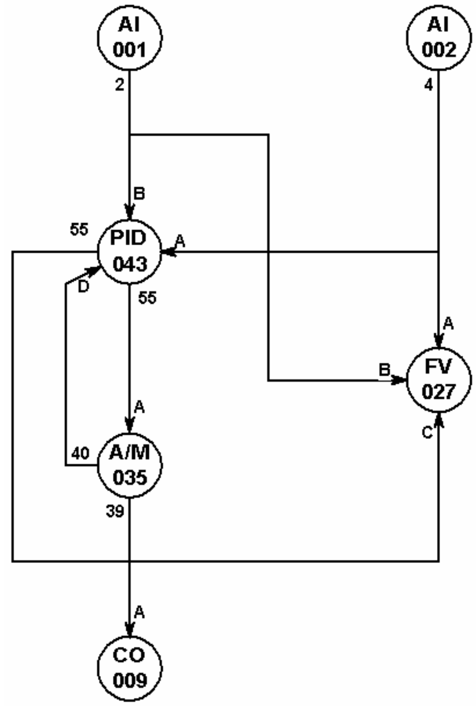
Function Block	Block ID
AI (Analog Input)	001
AI (Analog Input)	002
Simple PID	043
A/M (Auto/Manual Station)	035
CO (Current Output)	009
FV (Front View)	027

- The drawing area should look like this:



D) Connecting the blocks:

- Select the Node tool, , and click on the AI Block (001) to open the Link menu. Click in output 2.
- Place the cursor on the PID block (043), and click on the Link menu to open it. Click in output B.
- Repeat these steps to connect the other blocks in this configuration, as indicated in the following figure:

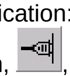


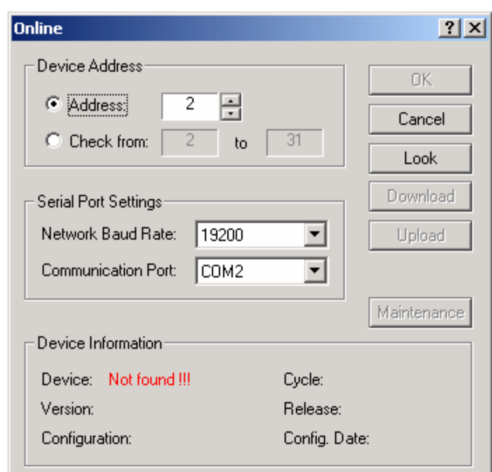
E) Editing the parameters:

- Click on the Select tool, , and right click on the block for the popup menu to appear. Select the option Edit Parameters to open the dialog box of each block and adjust the parameter values as indicated in the following table:

Function Block	Parameters	Description	Default Value	New Value
PID (043)	AKp	Proportional Gain	0.30	1.20
PID (043)	ATr	Reset Time (min/cycle)	10.00	2.00
AI (001)	CSQR	Square Root	0.00	1.00

F) Initializing the communication:

- Click the Online button, , to open the Online dialog box .



- Select the identification address number in the Address box and click in Look. The CONF600 Plus will search for devices connected to the PC.

G) Downloading the configuration:

- Once the controller is selected, click on Download to download the block configuration for the controller.

H) Monitoring the blocks: The block outputs can be monitored while the controller is operating, thus not disturbing the process. The user can monitor the block output, by selecting the block and pressing the <M> key.

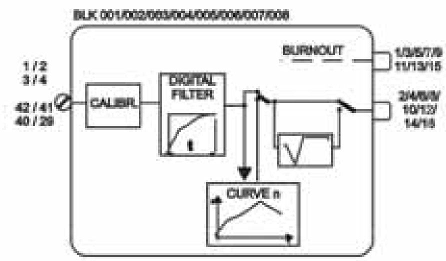
- On the Online dialog box, click in the Go Online button for the values to be shown.

FUNCTION BLOCKS LIBRARY

FUNCTION NAME AND MNEMONIC

Function 01 - Analog Input (AI)

SCHEMATIC DIAGRAM



OPERATIONAL DESCRIPTION

Operation

All the analog inputs have a corresponding **Analog Input** block. The *analog input 2*, for example, which is connected to terminal **2**, corresponds to *block BLK002*. The input to the circuit is always a voltage signal (0-5 V or 1-5 V). If a current signal (0-20 mA or 4-20 mA) be used, a Shunt resistor shall be placed in the corresponding terminal block position.

The input signal passes through an analog second order BESSEL filter with cutoff frequency at 15 Hz.

The result is converted into a digital number and in this form, it passes through a four point calibration process in which 0V, 1V, 3V and 5V are made to correspond respectively to 0, 20, 60 and 100% for 0-20 mA/0-5 V input and -25, 0, 50 and 100% for 4-20 mA/1-5 V input. See the CALIBRATION section for further details.

After conditioning, the signal is digitally filtered with an adjustable time constant. It can be linearized in accordance with a curve established in the **Function 31 - Linearization Curve (Blocks 109 to 116)**, configured in Loop G. This curve is selected by **CLIN** and may be used with 13 or 26 pairs of points x, y, interconnected by straigh line segments. The curves that may be performed are show on table 4.31.1 page 4.59.

The signal can also have square root extraction, selectable by **CSQR**. The square root has an adjustable cutoff point (**ACUT**) for low signals. All values below **ACUT** will be considered 0%.

Parameter **CSQR** permits input signal selection (4-20 mA/1-5 V or 0-20 mA/0-5 V) and to decide whether square root will be extracted.

In **Burnout** (signal after calibration smaller than -2% or greater than +102%), an Alarm can be indicated on the front panel (if **CFRT**=1) and a **Burnout** alarm signal can be activated. This signal can be used, for example, to switch the process variable to another input through a block of the **Function 29 - Input Selector** or to force the controller's output to an emergency position.

PARAMETER LIST

TYPE	MNEN	DESCRIPTION	RANGE	DEFAULT
I	CFRT	"Burnout" indication on the front panel	0-No 1-Yes 2-Yes with Auto Ack	0
I	CLIN	Linearization (See Table 4.31.1 on Function 31 - Linearization Curve)	0-No 1 to 8 /Curves 1 to 8 9-Curves 1 e 2 10-Curves 3 e 4 11-Curves 5 e 6 12-Curves 7 e 8	0
I	CSQR	Signal Selection and Square root extraction	0-No (1 to 5 V or 4 to 20 mA) 1-Yes (1 to 5 V or 4 to 20 mA) 2-No (0 to 5 V or 0 to 20 mA) 3-Yes (0 to 5 V or 0 to 20 mA)	0
P	ACUT	Cutoff level for square root extraction	0,00 - 100,00%	1,00%
P	ATIM	Filter time constant	0,00 - 30,00s	0,20s

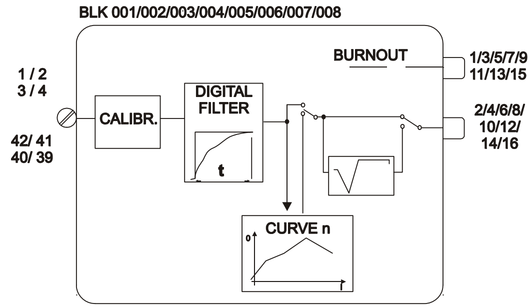
USED FOR COMMUNICATION

Number of Bytes per Type of Parameter: A = 4 C = 6 L = 0

Function Table

FUNCTION	MNEM	BLOCK NUMBER	DESCRIPTION	PAGE Nº
01	AI	001/002/003/004/005/006/007/008	ANALOG INPUT	4.3
02	CO	009/010/011/012	CURRENT OUTPUT	4.4
03	VO	013/014/015/016	VOLTAGE OUTPUT	4.5
04	DI	017/018	DIGITAL INPUT	4.6
05	DO	019/020/021/022/023/024/025/026	DIGITAL OUTPUT	4.7
06	FV	027/028/029/030	FRONT VIEW	4.8
07	L/R	031/032/033/034	LOCAL/REMOTE SP SELECTOR	4.10
08	A/M	035/036/037/038	AUTOMATIC/MANUAL STATION	4.13
09	APID	039/040/041/042	ADVANCED PID	4.17
10	PID	043/044/045/046	SIMPLE PID	4.26
11	STEP	047/048/049/050	STEP CONTROLLER	4.30
12	ARTH	051/052/053/054/055/056	MULTIPLIER-DIVIDER-ADDER-SUBTRACTOR	4.33
13	SQR	057/058	SQUARE ROOT	4.37
14	LIN	059/060	LINEARIZATION	4.38
15	LL	061/062	DERIVATIVE/LEAD-LAG	4.40
16	PTC	063/064	PRESSURE AND TEMPERATURE COMPENSATION	4.43
17	POL	065/066	POLYNOMIAL	4.47
18	TOT	067/068/069/070	TOTALIZATION	4.49
19	P/DI	071/072	PULSE TOTALIZATION INPUT	4.51
20	BAT	073/074	BATCH COMPARATOR	4.55
21	SPG	075/076	SETPOINT GENERATOR	4.56
22	ALM	077/078/079/080	DOUBLE ALARM	4.58
23	LIMT	081/082/083/084	LIMITER WITH ALARM	4.60
24	LOG	085/086/087/088/089/090	LOGIC	4.63
25	TMR	091/092	TIMER	4.65
26	H/L	093/094/095/096	HIGH/LOW SELECTOR	4.67
27	SSEL	097/098	INTERNAL/EXTERNAL SELECTOR	4.68
28	ADJ	099/100/101/102	CONSTANT ADJUSTER	4.69
29	ISEL	103/104/105/106	INPUT SELECTOR	4.70
30	OSEL	107/108	OUTPUT SELECTOR	4.71
31	PNT	109/110/111/112/113/114/115/116	LINEARIZATION CURVE	4.72
32	GV	117	GENERAL VISUALIZATION	4.75
33	K	118	CONSTANTS	4.76
34	SCN	119	SCAN	4.77
35	PRM	120	SCAN/ACTUATION OF THE PARAMETERS PID	4.79
36	ATU	121	ACTUATION	4.80
37	DIT	122/123/124/125	DIGITAL INPUT WITH TIMER CONTROL	4.83

Function 01 - Analog Input (AI)



Operation

All the analog inputs have a corresponding **Analog Input** block. The *analog input 2*, for example, which is connected to terminal **2**, corresponds to *block BLK002*. The input to the circuit is always a voltage signal (0-5 V or 1-5 V). If a current signal (0-20 mA or 4-20 mA) be used, a Shunt resistor shall be placed in the corresponding terminal block position.

The input signal passes through an analog second order BESSEL filter with cutoff frequency at 15 Hz.

The result is converted into a digital number and in this form, it passes through a four point calibration process in which 0V, 1V, 3V and 5V are made to correspond respectively to 0, 20, 60 and 100% for 0-20 mA/0-5 V input and -25, 0, 50 and 100% for 4-20 mA/1-5 V input. See the CALIBRATION section for further details.

After conditioning, the signal is digitally filtered with an adjustable time constant. It can be linearized in accordance with a curve established in the **Function 31 - Linearization Curve (Blocks 109 to 116)**, configured in Loop G. This curve is selected by **CLIN** and may be used with 13 or 26 pairs of points x, y, interconnected by straigh line segments. The curves that may be performed are show on table 4.31.1 page 4.59.

The signal can also have square root extraction, selectable by **CSQR**. The square root has an adjustable cutoff point (**ACUT**) for low signals. All values below **ACUT** will be considered 0%.

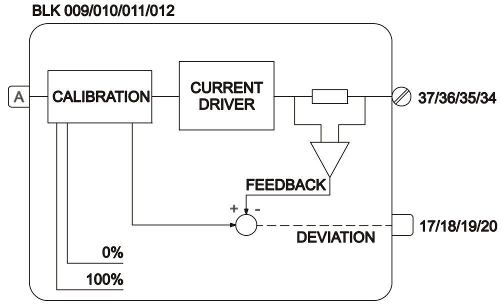
Parameter **CSQR** permits input signal selection (4-20 mA/1-5 V or 0-20 mA/0-5 V) and to decide whether square root will be extracted.

In **Burnout** (signal after calibration smaller than -2% or greater than +102%), an Alarm can be indicated on the front panel (if **CFRT**=1) and a **Burnout** alarm signal can be activated. This signal can be used, for example, to switch the process variable to another input through a block of the **Function 29 - Input Selector** or to force the controller's output to an emergency position.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	CFRT	"Burnout" indication on the front panel	0-No/1-Yes 2-Yes with Auto Ack	0
I	CLIN	Linearization (See Table 4.31.1 on Function 31 – Linearization Curve)	0-No 1?8/Curves 1?8 9-Curves 1 and 2 10-Curves 3 and 4 11-Curves 5 and 6 12-Curves 7 and 8	0
I	CSQR	Signal Selection and Square Root extraction	0-No (1 to 5V or 4 to 20mA) 1-Yes (1 to 5V or 4 to 20mA) 2-No (0 to 5V or 0 to 20mA) 3-Yes (0 to 5V or 0 to 20mA)	0
P	ACUT	Cutoff level for square root extraction	0.00 - 100.00%	1.00%
P	ATIM	Filter time constant	0.00 - 30.00s	0.20s

Number of Bytes per Type of Parameter: A = 4 C = 6 L = 0

Function 02 - Current Output (CO)



Operation

The block input, in percentage, is calibrated and converted into an analog current signal. A **feedback** of this current is sent to a comparator, which also receives the input signal. If there is a deviation greater than the **ADEV** (allowable deviation) parameter, the discrete output **Deviation** will be activated. This signal may, for example, be connected to the input **H** of a block of **Function 06 - Front View**, in order to make the **MV** bargraph blink, warning the operator that something is wrong or to activate any other type of alarm.

This alarm indicates, for example, that the current loop has an interruption. There is a parameter in the block, which allows the output type to change according to the type of actuator used.

Actuator type:

- "Air to Open" - **CVTP** = 0 or 2 / output 0-100% corresponds to 4-20 mA

- "Air to Close" - **CVTP** = 1 or 3 / output 0-100% corresponds to 20-4 mA

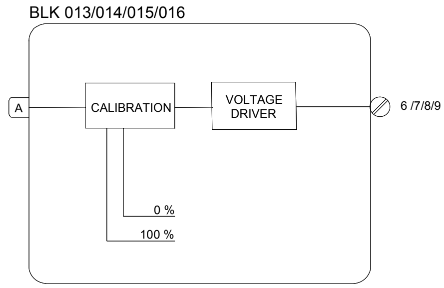
This enables the operator to have always 0% corresponding to a closed valve and 100% to an open valve.

It is essential to calibrate the output according to the specifications. For example, for a 0-20 mA signal in block 011, the output current at terminal 35 shall be calibrated with 0-20 mA and **CVTP** shall have the code 2.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - Output Signal	Address 0 to 170/225 to 240	0
I	CVTP	Type of Output	0-Direct (4 to 20 mA) 1-Reverse (20 to 4 mA) 2-Direct (0 to 20 mA) 3-Reverse (20 to 0 mA)	0
I	CFRT	Front Panel Indication of deviation between the desired and actual current	0-No/1-Yes/2-Yes with Auto Ack.	0
P	ADEV	Maximum allowable deviation	0.00 - 100.00%	5.00%

Number of Bytes per Type of Parameter: A = 2 C = 4 L = 2

Function 03 - Voltage Output (VO)



Operation

The block input in percentage is calibrated and converted into an analog voltage signal sent to the terminal block.

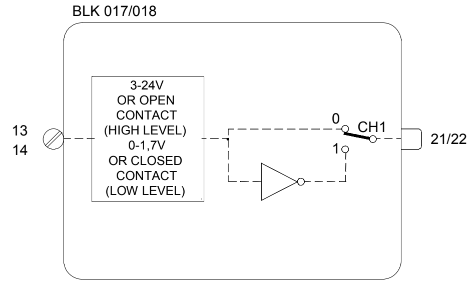
This block includes a parameter, which allows signal type selection, i.e., it makes 0-100% correspond to 1-5 Vdc/0-5 Vdc (direct type) or to 5-1 Vdc/ 5-0 vdc (reverse type).

The corresponding output shall be calibrated as per the specifications to 1-5 Vdc or to 0-5 Vdc (see Calibration Section for further details).

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - output signal	Address 0 to 170/225 to 240	0
I	CVTP	Type of output	0 - Direct (1 to 5V) 1 - Reverse (5 to 1V) 2 - Direct (0 to 5V) 3 - Reverse (5 to 0V)	0

Number of Bytes per Type of Parameter: A = 0 C = 2 L = 2

Function 04 - Digital Input (DI)



Operation

If the input block terminal is open (impedance > 50 KΩ) in relation to the Digital Ground terminal or with a voltage between 3 and 24 Vdc, the signal will be considered as high logic level and the value 100% (high logic level) will be available in the block output.

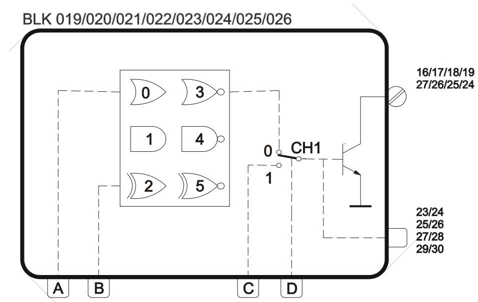
If, on the other hand, the input is short-circuited (impedance < 200Ω) or with a voltage between 0 and 1.7 Vdc, the signal will be considered as low logic level and the value 0% (low logic level) will be at the block output.

This condition can be inverted by the parameter **CNOT**.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	CNOT	Inverts Interpretation	0 - No/1 – Yes	0

Number of Bytes per Type of Parameter: A = 0 C = 2 L = 0

Function 05 - Digital Output (DO)



Operation

This block can perform a logic operation with inputs **A** and **B**. The output is sent to a two-position selector switch. The other position is connected to input **C**. A high logic level at **D**, switches CH1 to position "1", making the output equal to safety input **C**.

The logic operation to be performed by the block is defined by the parameter **CLOG** according to the table 4.5.1:

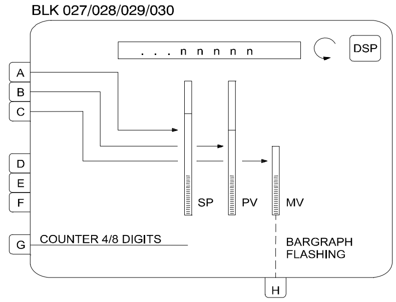
INPUT		OUTPUT					
A	**B**	**OR**	**AND**	**XOR**	**NOR**	**NAND**	**NXOR**
0	0	0	0	0	1	1	1
0	1	1	0	1	0	1	0
1	0	1	0	1	0	1	0
1	1	1	1	0	0	0	1

Table 4.5.1 - Truth table for digital

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170/225 to 240	0
I	LIB	Input B		0
I	LIC	Safety input C		0
I	LID	Input D to activate safety input		0
I	CLOG	Logic function	0 - OR/1 - AND/2 - XOR 3 - NOR/4 - NAND/5 - NXOR	0

Number of Bytes per Type of Parameter: A = 0 C = 2 L = 8

Function 06 - Front View (FV)



Operation

This block leads inputs **A**, **B**, **C** to bargraphs **SP**, **PV** and **MV** respectively, and in the default condition, associates these inputs to the mnemonics **SP**, **PV** and **MV** on the display.

Thus, the use of this block is limited to one per loop.

Inputs **A**, **B**, **D**, **E**, **F** and **G** can be visualized on the alphanumeric display and scrolled by key <DSP>. Input **C** will be visualized only by pressing key <△> or key <▽>.

Blocks that have manual adjustment registers, operated by keys <Δ> or <∇> must be connected to the Loop Visualization block. An adjustment can be performed only while the variable is being visualized; the LED "Adjust" indicates that adjustment can be done.

The blocks with the manual adjustment feature are *Local/Remote Selector, Setpoint Generator, Internal/ External Selector and Constant Adjuster.*

The blocks with adjustment capability have the outputs identified by numbers equal or greater than 225. The Input Selector block also allows manual adjustment of blocks with this feature whose output is connected to the Input of the Input Selector block. Notice that its output numbering is greater than 225.

VISUALIZATION

All inputs, except **C** and **G**, may have the three-character mnemonics changed and the indication configured in engineering units.

Input **C** appears on the display when <△> or <▽> is pressed.

Input **G**, if connected to a block of the **Function 18 - Totalization or Function 19 - Pulse Totalization Input**, will show an eight-digit number. Connecting it to any other block, it will operate as a 4 digit display.

Input **H** - **Bargraph Flashing** - can be used to blink the **MV** bar. It is activated with a high logic level signal. This input can be used, for example, to show a deviation or break in the current output from a block of **Function 02 - Current Output.**

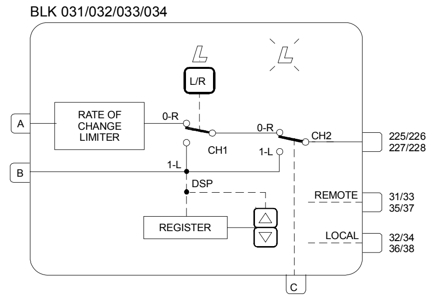
If one of the inputs **A**, **B**, **D**, **E** or **F** be shown in the Alphanumeric Display and its indication in engineering units exceeds 10000, the display will show the message "++++" instead of the input value. If this indication be lower than -10000, the message displayed will be " - - - -".

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input **A** - SP	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input **B** - PV		0
I	LIC	Input **C** – MV		0
I	LID	Input **D**		0
I	LIE	Input **E**		0
I	LIF	Input **F**		0
I	LIG	Input **G** - Counter type Input		0
I	LIH	Input **H** - blink MV bargraph		0

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
M	AMSP	Three-character mnemonic for SP	***	SP
R	ASPZ	0% for SP in engineering units	-10000 to 10000	0
R	ASPM	100% for SP in engineering units	-10000 to 10000	100.00
M	AMPV	Three-character mnemonic for PV	***	PV
R	APVZ	0% for PV in engineering units	-10000 to 10000	0
R	APVM	100% for PV in engineering units	-10000 to 10000	100.00
M	AMND	Three-character mnemonic for D	***	MND
R	A-DZ	0% for D in engineering units	-10000 to 10000	0
R	A-DM	100% for D in engineering units	-10000 to 10000	100.00
M	AMNE	Three-character mnemonic for E	***	MNE
R	A-EZ	0% for E in engineering units	-10000 to 10000	0
R	A-EM	100% for E in engineering units	-10000 to 10000	100.00
M	AMNF	Three-character mnemonic for F	***	MNF
R	A-FZ	0% for F in engineering units	-10000 to 10000	0
R	A-FM	100% for F in engineering units	-10000 to 10000	100.00

Number of Bytes per Type of Parameter: A = 60 C = 0 L = 16

Function 07 - Local/Remote SP Selector (L/R)



Operation

This block allows Setpoint selection by pressing the key <L/R> (Local/Remote), Setpoint adjustment by pressing keys <∆> and <∇> and the selection and adjustment of several Setpoints related functions.

Actuation in Local mode is possible in two ways:

a) By the internal Register of the block, which is actuated by the <∆> and <∇> keys of the front panel, when the Set Point is selected on the display. The output of the block must be connected to a block of **Function 06 - Front View or Function 32 - General Visualization**.

b) By input **B**, that can be connected to the output of another block. The use of **B** automatically cancels the internal register action. The block becomes an input selector.

Transfer from Local to Remote and vice versa is possible in two ways:

a) By using the <L/R> key of the front panel, that actuates the switch **CH1**. In this case, the LED "L" of the corresponding loop will light up when Local mode is selected.

b) By a high logic level at input **C**, that actuates the switch CH2 and "forces" Local mode. In this case, the LED "L" of the corresponding loop will remain blinking while input **C** is with high level.

The following tables summarize the block status for the different combinations of CH1, CH2 and input B.

INPUT B CONNECTED

CH1	INPUT C	LED L	OUTPUT
R	0	-	INPUT A
R	1	FLASHING	INPUT B
L	0	LIT	INPUT B
L	1	LIT	INPUT B

Table 4.7.1 - Block output and LED action according CH1 (R/L key) and CH2 ("C" input) position, with input "B" connected.

INPUT B NOT CONNECTED

CH1	INPUT C	LED L	OUTPUT
R	0	-	INPUT A
R	1	FLASHING	INTERNAL REGISTER
L	0	LIT	INTERNAL REGISTER
L	1	LIT	INTERNAL REGISTER

Table 4.7.2 - Block output and LED action according CH1 (R/L key) and CH2 ("C" input) position, with input "B" not connected.

The controller can also be locked in Local or in Remote by the parameter **CLKR**.

After a power interruption, the controller will return to operation in the mode (Local or Remote) selected by the parameter **CTON**.

The block features bumpless Local-Remote transfer, with adjustable changing rate (Slew Rate, **ASLW**). This feature avoids abrupt changes in the Setpoint, and, consequently, in the process, when the Setpoint is switched from Local to Remote.

Remote to Local transfer is balanced, that is, the Local register tracks the Remote Setpoint, when operating in Remote mode. This can be used to implement Setpoint tracking when the loop is in manual.

In a Setpoint tracking configuration the SP=PV in manual mode. The PV is manually adjusted to the desired Setpoint by using the MV <△> and <▽>. Then he can switch back to automatic mode and the Setpoint will remain.

The LOG block inverts the MANUAL status signal to a AUTOMATIC, since Local Setpoint is desired in automatic mode.

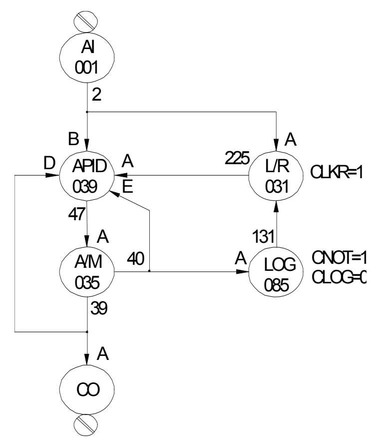


Fig 4.7.1 L/R Selector Configuration for Setpoint Tracking

The maximum and minimum limits for the Local Setpoint actuator are established in the parameters **ALOW** and **AUPP**.

If it is necessary to have limits on the Remote Setpoint, this shall be done by means of **Function 23 - Limiter with Alarm**.

In addition to the analog signal generated internally (in Local mode) or externally (in Remote Mode), the block has two discrete outputs; the first is at high logic level when the block is in Remote mode and the second is at high logic level when the operating mode is Local.

When one of the outputs 225/226/227 or 228 is visualized on the Alphanumeric Display and the block is in Local mode, the register may be actuated by the Front Panel (Local Setpoint). Besides, should this output signal be from inputs **A** or **B** (Remote Setpoint), and this input is linked to the output of an adjustment block, this adjustment block will also be actuated by the Front Panel. This feature is used in the following configuration.

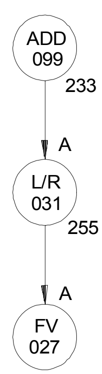


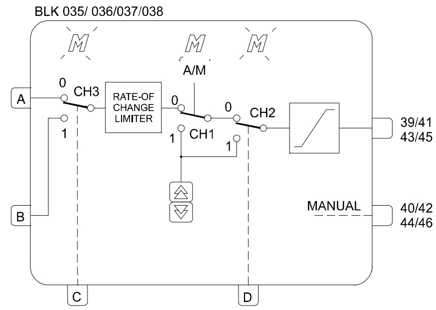
Fig 4.7.2 - L/R Selector Configuration for Internal or External Register Actuation

In the above configuration, when in Local mode, actuation is performed in the register of *Block 031* and, in Remote mode, in *Block 099*, although the visualized output is that of *Block 031*.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - Variable to Remote Mode	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B - Variable to Local Mode		0
I	LIC	Input C - Forces Local Mode		0
I	CLKR	Locks switch CH1 in:	0-No Lock/1-Remote/2-Local	2
I	CTON	Starting condition after power failure	0 - Last mode 1 – Local 2 – Remote	0
P	ASLW	Maximum rate-of-change in Remote mode	1.00 - 200.00%/s	200.00%/s
P	ASPD	Register actuation speed	0.00 - 200.00%/s	10.00%/s
P	ALOW	Register lower limit	-102.00 to +102.00%	0.00%
P	AUPP	Register upper limit	-102.00 to +102.00%	100.00%

Number of Bytes per Type of Parameter: A = 8 C = 4 L = 6

Function 08 - Automatic/Manual Station (A/M)



Operation

This block allows the operator to actuate the controller output directly, whenever necessary.

In the most common application, the output signal of one of the *PID* blocks is linked to the input **A** of the **A/M** block, its output being linked to a current output block.

If the other inputs of this block are not used, switches CH3 and CH2 are permanently in position "0".

Switch CH1 may then be actuated by pressing the key <A/M> on the front panel, thus altering the operation mode:

a) AUTOMATIC (CH1 in position "0"): letter **M** is unlit in the corresponding loop. Input **A** signal goes to the block output after passing by a rate-of-change limiter (parameter **ASLW**) and by an output signal limiter (parameters **ALOW** and **AUPP**).

b) MANUAL (CH1 in position "1"): letter **M** is lit in the corresponding loop. Output signal may then be adjusted by the keys <△> and <▽>, its speed being determined by parameter **ASPD**, with the limits set by parameters **ALOW** and **AUPP**.

Manual to Automatic transfer may be bumpless or hard. Both modes are described in the PID block functions.

Automatic to Manual transfer is always balanceless. The register, actuated by the keys <△> and <▽>, always tracks the value available at the output of the **Rate-of-Change** limiter while in automatic operation.

After a power failure or a manual reset of the controller, switch CH1 returns to operation according to parameter **CHST**; it may return in Manual, Automatic or in the last position prior to the power failure or to the reset.

It is also possible to block the <A/M> key, locking the controller in Automatic or Manual, by means of the parameter **CCH1**.

FORCED MANUAL
Forced Manual mode is implemented by actuating switch CH2 by means of input **D**:

a) A low logic level in **D** keeps CH2 in position "0" (NORMAL OPERATION).

b) A high logic level in **D** switches CH2 to position "1" (FORCED MANUAL). In this situation, the register actuated by the keys <△> and <▽> takes the input value at position "0", just before the switching.

Other features may be added to this mode. For further information, see description of parameters **CCH1**, **CST1**, **CLAM** and **CLMV**.

SAFETY OUTPUT
The controller output may be driven to a safe value by switching CH3 to position "1", by means of input **C** of the block. The output signal will then be the input **B** signal. This may be a constant or a variable value, depending on which block it is originated.

If CH1 is in position "1" (equivalent to Manual), the letter **M** of the corresponding loop will be continuously lit and the output signal will be the signal of input **B** in the instant prior to CH3 switching.

If CH1 is in position "0" (equivalent to Automatic), the letter **M** will blink faster than when in Forced Manual and the signal at the output will be the same signal of input **B**.

The position of switch CH1 after input **C** returning to a low logic level is determined by parameter **CSA1**, with the following options: last position, position "1" and position "0". This may imply in Manual or Automatic operation if input **D** is with low logic level.

Other features may be added to this mode. For further information, see description of parameters **CCH1**, **CST1**, **CLAM** and **CLMV**.

INPUT B CONNECTED

INPUTS		SWITCHES			OUTPUT	LED M
C	D	CH3	CH1	CH2		
0	0	0	0	0	INPUT A	UNLIT
0	0	0	1	0	INTERNAL REGISTER	LIT
1	0	1	0	0	INPUT B	FAST FLASH
1	0	1	1	0	INTERNAL REGISTER	LIT
0	1	0	0	1	INTERNAL REGISTER	SLOW FLASH
0	1	0	1	1	INTERNAL REGISTER	LIT
1	1	1	0	1	INTERNAL REGISTER	SLOW FLASH
1	1	1	1	1	INTERNAL REGISTER	LIT

Table 4.8.1 - Truth table

Observe that the parameters CCHI, CST1 and CSA1 can affect the CH1 position in function of the input C and/or D status independent of the A/M key. Although, configuration of those parameters can automatically alter the table line, as it can suppress some lines.

CCH1 - ACTUATION OF CH1
This parameter determines if switch CH1 will be actuated only by the front panel or with CH2 and/or CH3, or if it will be locked in "0" (AUTO) or in "1" (MANUAL).

CH1 is actuated simultaneously with CH2 or CH3 when inputs **C** or **D**, have high logic level. CH1 position, when actuated by CH2 and/or CH3 is described in parameter **CST1**. The position of CH1, when CH3 returns to position "0", is defined in parameter **CSA1**.

CST1 - POSITION OF CH1 WITH CH2 AND CH3 ACTUATED
This parameter determines CH1 position when inputs **C** or **D** are with high logic level and parameter **CCH1** is programmed with 3, 4 or 5.

When input **C** returns to logic level "0", switch CH1 will take the position determined by parameter **CSA1**. After CH1 is actuated by input **D**, it may be free to be actuated by the <A/M> key since this is not locked (parameter **CLAM**=1 or 3). CH1 position when input **D** returns to a low logic level will be the position of CH1 just before CH2 switching.
Such position is indicated on the front panel as follows:
- "**M**" blinking: CH1 in position "0" (equivalent to automatic when CH2 returns to position "0").

- "**M**" continuously lit: CH1 in position "1" (equivalent to Manual).

CLAM - LOCKS A/M KEY
This parameter locks the front panel <A/M> key, thus preventing the actuation of switch CH1 when inputs **C** and/or **D** have high logic level.

This feature prevents the operator from actuating the <A/M> key during situations of "safety output" or "forced manual".

CLMV - LOCKS <△> AND <▽> KEYS
This parameter locks the front panel keys <△> and <▽>, thus preventing the alteration of the output value while in Manual mode, when inputs **C** and/or **D** have high logic level.

This prevents the operator from changing the output signal during situations of "safety output" or "forced manual".

CHST - RESTART CONDITION
CHST configure the operating mode of the respective loop after a power interruption.

CLIM-OUTPUT LIMITER ONLY ON AUTOMATIC
The output limiter actuates normally in both operating modes: manual and automatic. CLIM allows the limiter to actuate only on the automatic mode.

EXAMPLES:
1) As an emergency situation defined by a high logic level signal, the control output shall remain in the last value prior to the emergency, unless the operator decides to change it. If the emergency situation disappear, the control shall remain in manual mode.

Solution: This is a "Forced Manual" situation. The emergency signal shall be linked to input **D** and the following parameters shall be configured:

CST1 = 0 → CH1 goes to or remains in position "1" (Manual) whenever an emergency situation occurs.

CCH1 = 3 → Input **D** signal switches **CH1.**

CSA1 = → any value.

CLMV = 0 → The keys <△> and <▽> shall operate.

CLAM = 1→ Locks the <A/M> key, thus preventing CH1 to be switched to position "0", allowing return in Automatic mode.

In the same emergency situation described above, the output signal shall go to 2%, remaining in this value throughout the emergency situation. When the emergency signal disappear, the controller shall remain in manual mode.

Solution: This is a "Safety Output" situation. The emergency signal shall be linked to Input **C**, the value 2% (from an adjustment block or a constant value block) shall be linked to Input **B** and the following parameters shall be configured:

CST1 = 1 → CH1 goes to or remains in position "0" (Auto). The output will be the input **B** value in the instant of CH3 switching.

CCH1 = 4 → Input **C** signal switches CH1.

CSA1 = 1 → Controller shall remain in Manual after the emergency signal drops.

CLMV = 2 → The keys <△> and <▽> are locked as long as the emergency signal is present.

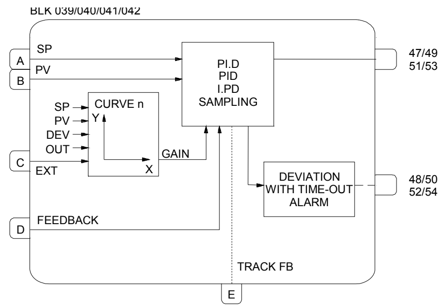
CLAM = 2 → CH1 is locked since the emergency signal is present.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (Automatic)	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B (Safety)		0
I	LIC	Input C (Safety Switch)		0
I	LID	Input D (Forced Manual)		0
I	CST1	CH1 position when inputs C or D have a high logic level and parameter CCH1 ? 0, 1 or 2	0 - Position 1 (Manual Position in normal operation) 1 - Position 0 (Automatic Position in normal operation)	0
I	CCH1	Actuation of CH1	0 - <A/M> Key 1 - Locks in Position 0 (AUTO) 2 - Locks in Position 1 (MANUAL) 3 - <A/M> Key or Input D 4 - <A/M> Key or Input C 5 - <A/M> Key or Inputs C or D	0
I	CSA1	CH1 position when input C returns to a low logic level	0 - Last Position 1 - Position 1 - (MANUAL) 2 - Position 0 - (AUTO)	0

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	CLMV	Locks <⇧> and <⇩> keys	0 - No Lock 1 - When Input D has a high logic level 2 - When Input C has a high logic level 3 - When Inputs C or D have a high logic level	0
I	CLAM	Locks <A/M> key	0 - No Lock 1 - When Input D has a high logic level 2 - When Input C has a high logic level 3 - When Inputs C or D have a high logic level	0
I	CHST	Restart condition - Operating mode after power interruption	0 – Last 1 – Manual 2 - Auto	0
I	CLIM	Output limiter only on Automatic	0 - Manual and Auto 1 - Auto	0
I	ASPD	Actuation Speed in Manual	0.00-200.00%/s	10.00%/s
I	ALOW	Lower Limit	-2.00 to +102.00%	-2.00%
I	AUPP	Upper Limit	-2.00 to +102.00%	+102.00%
I	ASLW	Slew Rate for the Automatic mode	1.00 to 200.00%/s	200.00%/s

Number of Bytes per Type of Parameter: A = 8 C = 14 L = 8

Function 09 - Advanced PID (PID)



Operation

This block offers a wide range of control algorithms, using the traditional Proportional *(P)*, Integral *(I)* and Derivative *(D)* modes in various arrangements.

There are two choices of *PID* algorithm: one is the parallel, ideal and the other is noninteractive, ISA algorithm. Calculation of the *PID* prevents the saturation of the output by the integral mode (anti-reset-windup). Saturation limits are adjustable by the user, a unique feature of the **SMAR CD600 Digital Controller**, that brings more flexibility to the control strategy.

Manual to Automatic transfer may be bumpless or hard. Bumpless transfer makes the automatic mode start from the last manual value prior to the switching. Hard transfer will add to this value the proportional action: (K_p.e). In both cases the output signal of the block of **Function 08 - Automatic/Manual Station**, must be connected to input **D** (**Feedback**) and the Status signal of the Auto/Manual block must be connected to input **E** (**track FB**).

This block allows selection of the following control types: *Sample and Hold, Quadratic Error, GAP and Adaptative Gain.*

TYPE OF PID (CTYP)

PI.D - The *P* and *I* act on the deviation, and *D* on the Process Variable. In this way, the output signal follows the changes of the Setpoint according to the Proportional and Integral actions, but does not give an undesirable impulse due to the Derivative action. This option is the most recommended for the majority of applications with Setpoint adjustable by the operator.

PID - The *P*,*I* and *D* actions act on the deviation. In this way, the output signal changes when there are changes on the Process Variable or on the Setpoint. This option is recommended for ratio control or for the slave controller of a cascade.

I.PD - In this type only the Integral mode acts on the deviation. Changes on the Setpoint cause variation of the output according to the Integral mode, which is a very smooth effect. It is recommended for processes that can be upset by abrupt changes of the Setpoint. This is the case of heating processes with high proportional gain.

PI-SAMPLING - In this option, when there is a deviation, the output signal changes according to the *PI* algorithm during a time t_0. Then, the output signal is kept constant during a time t_1. If the deviation persists, the signal will vary again during t_0, and will remain constant during t_1. The period is t_0+t_1, (adjusted by **CSAM**), and the actuation time is t_0 (adjusted by **CSON**). This type is recommended for processes with high dead time.

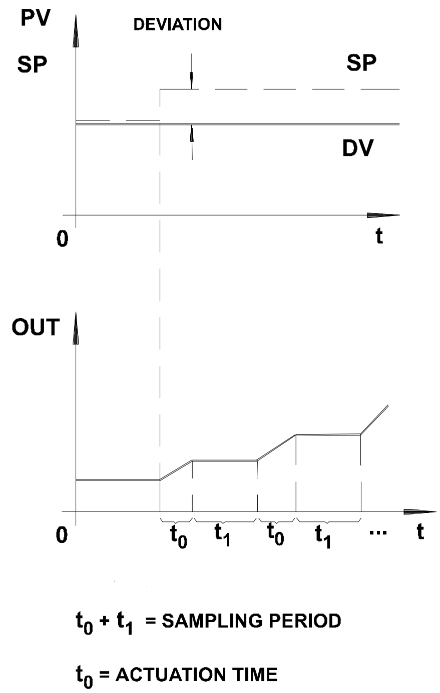


Fig 4.9.1 - PI Sampling

ACTION (CACT)
There are processes that require the output signal to increase when the Process Variable increases, while others require the other way around.

Parameter CACT selects the type of action:

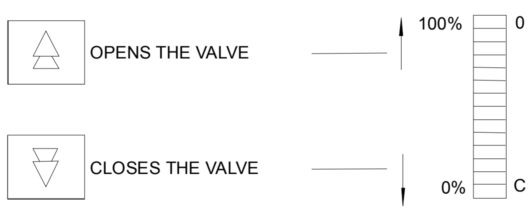
TYPE 0, 2, 4 or 6 - Output signal decreases when PV increases

$$e = (SP - PV)$$

TYPE 1, 3, 5 or 7 - Output signal ncreases when PV increases.

$$e = (PV - SP)$$

In order to standardize operation, it is recommended to consider that an output signal equal to 100% means valve open and that an output signal equal to 0% means valve closed. Operation of the front panel keys follows the same principle:



According to this procedure MV=100% means always valve open and MV=0% means always valve closed.

If the actuated valve is "Air-to-open", MV=100% must be equivalent to 20 mA. Valves type Air-to-close will require 100% being equivalent to 4 mA. This may be selected in Function 02 - Current Output.

Tuning by the Front Panel

Parameter CACT also defines if the block allows changes on the tuning parameters through the front panel push buttons or not (see *PID* constants ahead).

Front panel adjustment is selected when CACT=0, 1, 4 or 5.

Control Algorithm
The **CD600** offers two control algorithms:

Parallel or Ideal algorithm

$$MV(t) = K_P e(t) + \frac{1}{T_R} . \int e(t) dt + T_D \frac{de(t)}{dt}$$

Noninteractive or ISA algorithm

$$MV(t) = K_P [e(t) + \frac{1}{T_R} . \int e(t) dt + T_D \frac{de(t)}{dt}]$$

Parameters 0, 1, 2 or 3 select the parallel or ideal.
Parameters 4, 5, 6 or 7 select the noninteractive or ISA.

For the noninteractive option, when K_p=0 the controller is automatically set as ID.

QUADRATIC ERROR (CETY)
The control deviation (or error) normally used in the **CD600** controller calculations is given by:

e = SP - PV When "Output decreases when PV increases" is selected.

e = PV -SP When "Output increases when PV increases" is selected.

There are processes where the deviations in relation to the Setpoint are preferable to disturbances caused by the controller on downstream processes. Therefore, the control actuation should be small for small deviations and increase gradually with the size of the deviation. A typical example of this type of process is the level control of a tank where the Setpoint is not as important as the flow stability downstream the tank. This type of process can be controlled with the adaptative gain, the control with gap, or the quadratic error in-stead of the linear (normal) error.

In the quadratic error (**CETY=**1), the error to be considered in the PID calculations is given by:

$$\hat{e} = \frac{e \cdot /e/}{100}$$

ê = error to be considered in the *PID* calculation.

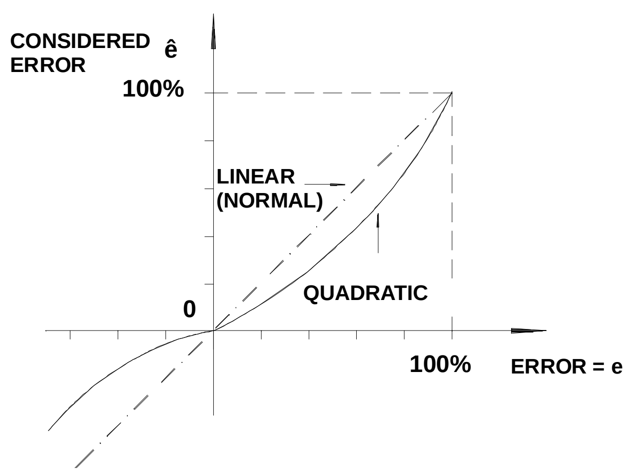


Fig 4.9.2 - Quadratic Error x Normal Error

GAP CONTROL (CBND AND CSGA)

There are applications where the control is unstable near the Setpoint due to actuator dead band, noise or other reasons. In this case, it is advisable to have a controller with a differentiated action around the Setpoint.

The gap control or gap with special gain can be used to solve this problem.

EXAMPLE:

Considered error *(ê)* for a gap control with a band equal to 10% (**CBND=**10) and special gain equal to zero (**CSGA=**0).

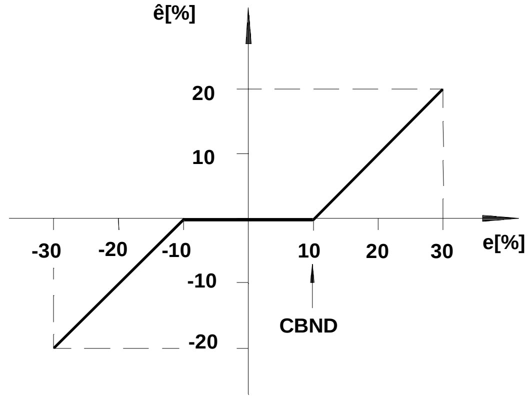


Fig 4.9.3 - Gap Control with Gain=0

Some processes may require a special gain within the band. In such cases, it is possible to select a factor at parameter **CSGA** which multiplies the error, thus making the error to be considered in the *PID* calculations to be:

ê=e.CSGA

Thus, the control action will be, within the Gap, faster when **CSGA**>1 and slower when **CSGA**<1. For **CBND**=0 (null band) the gap control is not activated.

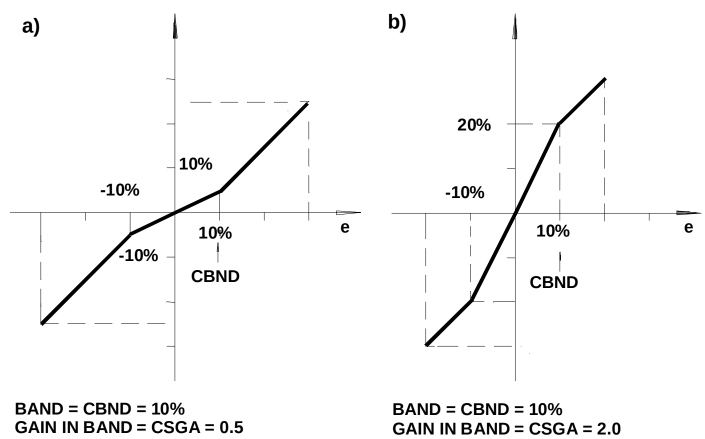


Fig 4.9.4 - Gap Control - (a) Gain < 1, (b) Gain > 1

CONTROL WITH ADAPTATIVE GAIN (CIAG, CLIN, CAAD)

The adaptative gain modifies the *PID* constants by a factor G. This factor G follows a curve of 13 or 26 points as a function of the Setpoint **SP**, of the Process Variable **PV**, of the deviation (error) **DEV**, of the output **OUT**, or of an external variable **EXT**. The type of signal that generates the gain curve is selected in parameter **CIAG**.

Curve selection is performed by **CLIN**. The points of the curve are specified in the General Loop, in blocks of the **Function 31 - Linearization Curve**. The curves that may be performed are shown on Table 4.31.1 (page 4.59).

The points of the adaptative gain curve are given as percentage of the selected variable on the axis of the abscissa **X** and by the gain **G** on the axis of ordinate **Y**. The gain modifies the tuned constants: K_P, T_R and T_D into K_P' , T_R' and T_D' as follows:

$$Kp' = G \cdot Kp$$

$$Tp' = \frac{T_R}{G}$$

$$T_D' = G \cdot T_D$$

Gain **G** may affect the *PID*, *PI*, *P*, *I* and *D* actions. Selection is performed by parameter **CAAD** which also inhibits Adaptative Gain action when **CAAD**=0. The adaptative gain is recommended for highly nonlinear controls. A classic example of adaptative gain is the drum level control of a boiler.

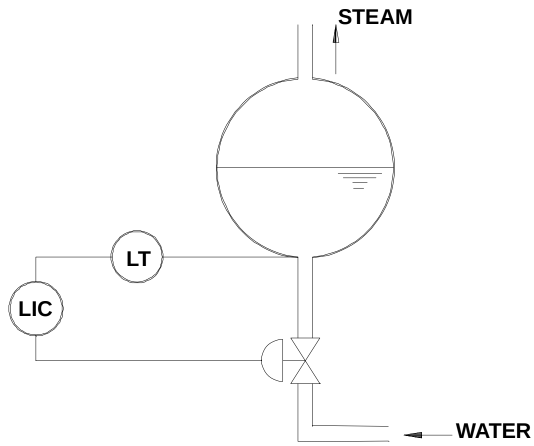


Fig 4.9.5 - Simple Drum Level Control of a Boiler

The volume variations are nonlinear with the level variations. The dotted line of Figure 4.9.6 show the volume gain with the level. Note that the volume varies slowly (low gain), around 50% level and varies very fast (high gain) around the level extremes. The control action must have a gain that is the inverse of the process gain. This is shown by the continuous line of Fig 4.9.6.

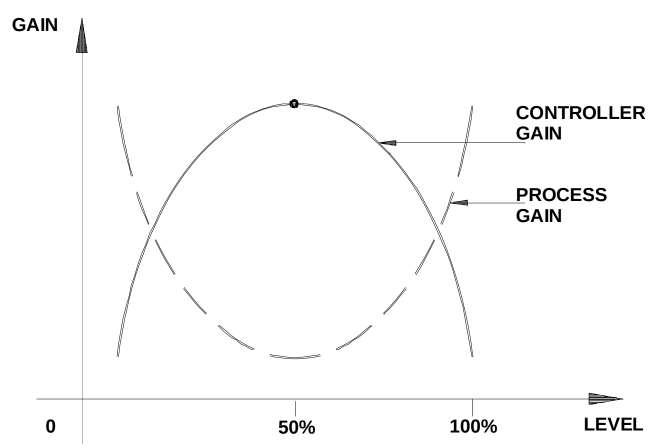


Fig 4.9.6 - Process and Controller Gain

The adaptative gain characteristic can be configured as shown in Fig 4.9.7. This curve can be represented by the following points of Curve 1: (X1 = 0; Y1 = 0.2; X2 = 20; Y2 = 0.8; X3 = 40; Y3 = 0.96; etc.).

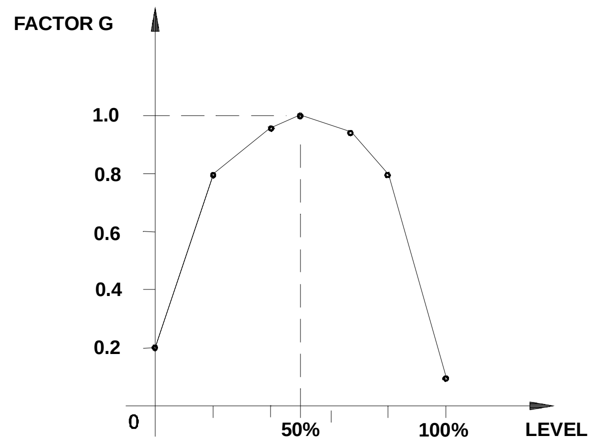


Fig 4.9.7 - Gain Curve as a Function of PV

While planning the configuration, observe the following:

It is not necessary to use all 13 points of the curve.

It is fundamental to use the 0% and the 100% of the determining variable (-100 and +100% for the Error).

It is recommendable to program the variable up to 102%, since the variable may be above 100%.

4. Tuning is normally done for G = 1. In the example, the control becomes slower above or below 50% of the level.

Adaptative Gain is also very useful for pH control.

ANTIRESET-WINDUP (CARL AND CARU)
The control algorithm automatically stops the contribution of the integral mode when the output signal reaches the limits of 0 or 100%. Contributions of the Proportional and Derivative modes are not affected.

The **CD600** has a unique feature: the adjustment of the limits for the integral mode saturation.

It is normally fixed at 0% (**CARL**) and 100% (**CARU**), but can be narrowed, allowing quicker responses and avoiding overshoot in heating processes, for example.

PID CONSTANTS (AKp, ATr, ATd)
The table is self-explanatory. *It is good to remember that the Proportional action is in terms of Gain and not of Proportional Band*. Bigger Kp means more action. The Integral action is in terms of minutes per repeats, not repeats per minute. Smaller T_R means more Integral action.

PID constants may be adjusted by the Hand Held Programmer or the controller's front panel (see tuning procedures). In order to inhibit tuning by the front panel, simply configure parameter **CACT** (action) with 2, 3, 6 or 7 instead of 0, 1, 4 or 5.

DEVIATION ALARM (AMXD, ATOD)
These parameters establish the alarm limit for the control deviation or error (**AMXD**) and for how long this deviation may be tolerated without alarm activation (**ATOD**).

If **AMXD=**5 and **ATOD=**0.5, the block will set the "**Dev-time-out**" output to high logic level if a 5% deviation or more persists for more than 0.5 minutes. Note that 0.00 for the time is here considered as infinite time or no alarm. The shortest time available is 0.01 minute.

CFRT specifies if the deviation alarm should appear on the front panel or not.

BIAS (ABIA)
In this parameter, it is possible to adjust an initial value for the output signal when the control is transferred from Manual to Automatic. This may be done only if the input **Feedback** is not connected (**LID**=0).

For bumpless Manual to Automatic transfer, the input **D** must be connected to the output of the A/M block and the **track FB** input **E** must be connected to the status indication of the A/M block. In this case, parameter **ABIA** is used to change the block output during automatic operation. The output signal is subjected to a step type variation whenever the **ABIA** value is modified. Amplitude and direction of this step are equivalent to the difference between the previous and the new **ABIA** value. The connection diagram for both cases are shown on the following figures:

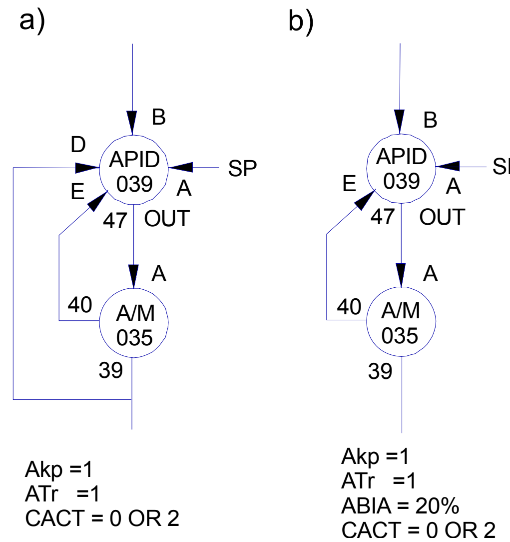


Fig 4.9.8 - Configuration for Manual to Auto Transfer. a) Bumpless b) The Automatic Output Starts with the Bias Value

During the Manual to Auto transfer, it is possible to add, to the initial output value (in both cases above), a value equal to the proportional gain (**AK$_P$**) multiplied by the error at that time. This is a transfer type HARD. It can be obtained with the parameter **CTYP** equal to 4, 5 or 6.

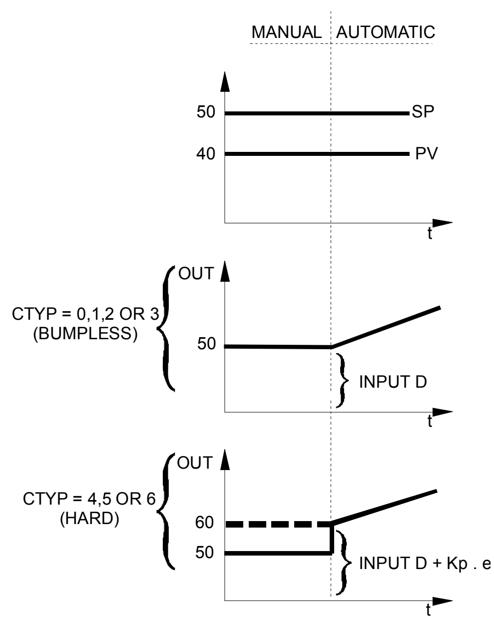


Fig. 4.9.9 - Manual to Auto Transfer. The Automatic Output starts with the Last Manual Output Value

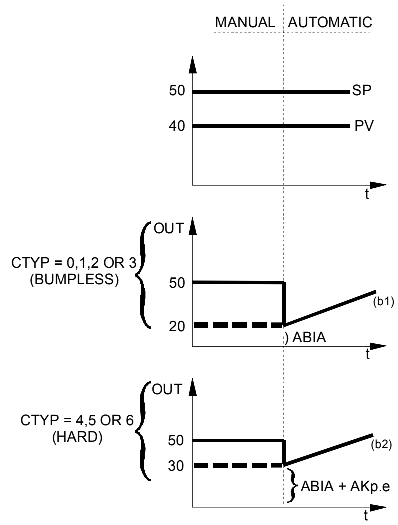


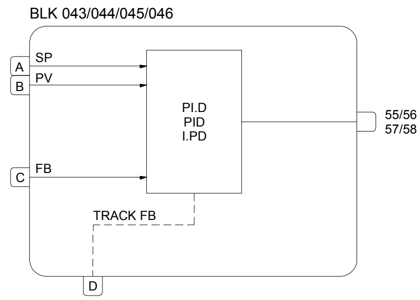
Fig 4.9.10 - Manual to Auto Transfer. The Automatic Output Starts with the Bias Value

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	SP (Setpoint) input	Addresses 0 to 170 / 225 to 240	0
I	LIB	PV (Process Variable) input		0
I	LIC	External Variable Input for Adaptative Gain		0
I	LID	Input for the control output (feedback), used for Bumpless transfer		0
I	LIE	Input for the Auto/Manual Status. Digital Interpretation		0
I	CACT	Control Action and Inhibition of tuning by the front panel and Control Algorithm REVERSE: Output decreases when PV increases DIRECT: Output increases when PV increases	Parallel or Ideal Algorithm: 0 – Reverse 1 – Direct 2 - Reverse with no tuning on front 3 - Direct with no tuning on front Noninteractive or ISA: 4 – Reverse 5 – Direct 6 - Reverse with no tuning on front 7 - Direct with no tuning on front	0
I	CTYP	PID Action on Error and Process Variable. Actions indicated before the point are on Error while the others are on the Process Variable Bumpless or Hard M $\rightarrow$ A transfer	0 - PI.D Bumpless 1 - PID Bumpless 2 - I.PD Bumpless 3 - PI Sampling Bumpless 4 - PI.D Hard 5 - PID Hard 6 - PI Sampling Hard	0
P	CETY	Type of Error to be considered	0 – Normal 1 – Quadratic	0
P	CBND	Special gain band	0.01 - 300.00% 0 - Not activated	0.00%
P	CSGA	Special Gain within the gap	0.00 - 10.00	0.00
P	CSAM	Period of PI - Sampling (t_0 + t_1)	0.00 - 180.00 min.	0.00 min
P	CSON	Time that the PI - Sampling is active (t_0) (CSON<CSAM)	0.00 - 180.00 min.	0.00 min
I	CIAG	Input variable for the Adaptative Gain	0-SP /1-PV/2-Error 3-Output/4-External	0

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
P	CLIN	Curve for the Adaptative Gain	0-X=Y 1→8/Curves 1 →8 9-Curves 1 and 2 10-Curves 3 and 4 11-Curves 5 and 6 12-Curves 7 and 8	0
I	CAAD	Adaptative Gain Action	0- Not Used/ 1-PID/ 2-PI/3-P/4-I/5-D	0
P	CARL	Antireset-Windup lower limit	-2.00 to +50.00%	0.00%
P	CARU	Antireset-Windup upper limit	+50.00 to +102.00%	100.00%
I	CFRT	Error alarm indication on front panel	0-No/1-Yes 2-Yes With Auto Ack.	0
P	Akp	Proportional Gain	0.00 - 100.00	0.30
R	Atr	Integral time (min./repetition)	0.01 - 1000.0	10.000
R	Atd	Derivative constant (min.)	0.00 - 100.00	0
P	ABIA	Bias	-100.00 - 100.00%	0.00
P	AMXD	Maximum deviation without alarm (%)	0.00 - 100.00%	0.00%
P	ATOD	Maximum time for deviation alarm (min.)	0.01 - 200.00 min. 0.00 - No Alarm	0.00 min

Number of Bytes per Type of Parameter: A = 16 C = 26 L = 10

Function 10 - Simple PID (PID)



Operation

This block offers a wide range of control algorithms, using the traditional Proportional *(P)*, Integral *(I)* and Derivative *(D)* modes in various arrangements.

There are two choices of *PID* algorithm: one is the parallel, ideal and the other is noninteractive, ISA algorithm. Calculation of the *PID* prevents the saturation of the output by the integral mode (anti-reset-windup). Saturation limits are adjustable by the user, a unique feature of the **SMAR CD600 Digital Controller**, that brings more flexibility to the control strategy.

Manual to Automatic transfer may be bumpless or hard. Bumpless transfer makes the automatic mode start from the last manual value prior to the switching. Hard transfer will add to this value the proportional action: (KP.e). In both cases, it is necessary to connect the output signal of the Auto/Manual block to input **C** (**Feedback**) and the status signal of the Auto/Manual block to input **D** (**track FB**).

TYPE OF PID (CTYP)
PI.D - The *P* and *I* act on the deviation, and *D* on the Process Variable. In this way, the output signal follows the changes of the Setpoint according to the Proportional and Integral actions, but does not give an undesirable impulse due to the Derivative action. This combination is the most recommended for the majority of applications with Setpoint adjustable by the operator.

PID - The *P*, *I* and *D* actions act on the deviation. In this way, the output signal changes when there are changes in the Process Variable or on the Setpoint. This option is recommended for ratio control or for the slave control of a cascade.

I.PD - In this type only the Integral mode acts on the deviation. Changes on the Setpoint cause variation of the output according to the Integral mode, which is a very smooth effect. This combination is recommended for processes that can be upset by abrupt changes of the Setpoint. This is the case of heating processes with high proportional gain.

ACTION (CACT)
There are processes that require the output signal to increase when the Process Variable increases, while others require the other way around.

Parameter **CACT** selects the type of action:

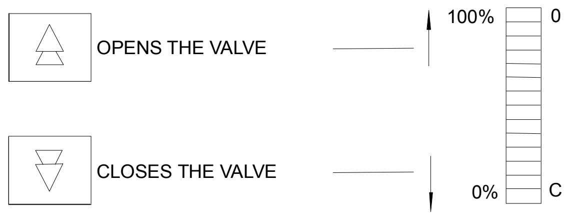
TYPE 0, 2,4 or 6 - output signal decreases when PV increases.

$$e = (SP - PV)$$

TYPE 1, 3, 5 or 7 - output signal increases when PV increases.

$$e = (PV - SP)$$

In order to standardize operation, it is recommended to consider that an output signal equal to 100% means valve open and that an output signal equal to 0% means valve closed. Operation of the front panel keys follows the same principle:



If the actuated valve is "Air-to-open", **MV=**100% must be equivalent to 20 mA. Valves type Air-to-close will require 100% being equivalent to 4 mA. This may be selected in **Function 02 - Current Output**.

Tuning by the Front Panel
Parameter **CACT** also defines if the block allows changes on the tuning parameters through the front panel push buttons or not (see "**PID Constants**" ahead).

Front panel adjustment is selected when **CACT**=0, 1, 4 or 5.

Control Algorithm
The **CD600** offers two control algorithms:

Parallel or Ideal algorithm

$$MV(t) = K_P e(t) + \frac{1}{T_R} . \int e(t)dt + T_D \frac{de(t)}{dt}$$

Noninteractive or ISA algorithm

$$MV(t) = K_P [e(t) + \frac{1}{T_R} . \int e(t)dt + T_D \frac{de(t)}{dt}]$$

Parameters 0, 1, 2 or 3 select the parallel or ideal.

Parameters 4, 5, 6 or 7 select the noninteractive or ISA.

For the noninteractive option, when K_P=0 the controller is automatically set as ID.

ANTIRESET-WINDUP (CARL AND CARU)
The control algorithm automatically stops the contribution of the integral mode when the output signal reaches the limits of 0 or 100%. Contributions of the Proportional and Derivative modes are not affected.

The **CD600** has a unique feature: the adjustment of the limits for the integral mode saturation.

It is normally fixed at 0% (**CARL**) and 100% (**CARU**), but can be narrowed, allowing quicker responses and avoiding overshoot in heating processes, for example.

PID CONSTANTS (AKp, ATr, ATd)
The table is self-explanatory. *It is good to remember that the Proportional action is in terms of Gain and not of Proportional Band*. Bigger gain means more action. *PID* constants may be adjusted by means of the Hand Held Programmer or the controller's front panel (see tuning procedures). In order to inhibit front panel tuning, simply configure parameter **CACT** with 2 or 3 instead of 0 or 1.

BIAS (ABIA)
With this parameter it is possible to assign an initial
bias value to the output signal when the control is transferred from Manual to Automatic. This may be done only if input **Feedback** is not connected (**LIC=**0).

For bumpless Manual to Automatic transfer, the input **C** must be connected to the output of the A/M block and the input **D** (**track FB**) must be connected to the status indication of the A/M block. In this case, parameter **ABIA** is used to change the block output during automatic operation. The output signal is subjected to a step type variation whenever the **ABIA** value is modified. Amplitude and direction of this step are equivalent to the difference between the previous and the new **ABIA** value. The connection diagram for both cases are shown on the following figures:

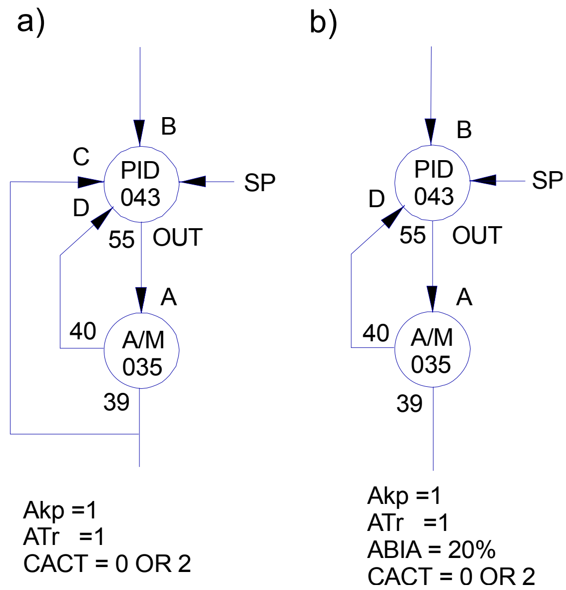


Fig. 4.10.1 - Configuration for Manual to Auto Transfer. a) Bumpless b) The Automatic Output Starts with the Bias Value.

During the Manual to Auto transfer, it is possible to add to the initial output value (in both cases above), a value equal to the proportional gain (**AKp**) multiplied by the error at that time. This is a transfer type HARD. It can be obtained with the parameter **CTYP** equal to 3 or 4.

The figures **4.9.9** and **4.9.10** (**Function 09**) show the output behavior for the Bumpless and Hard transfer.

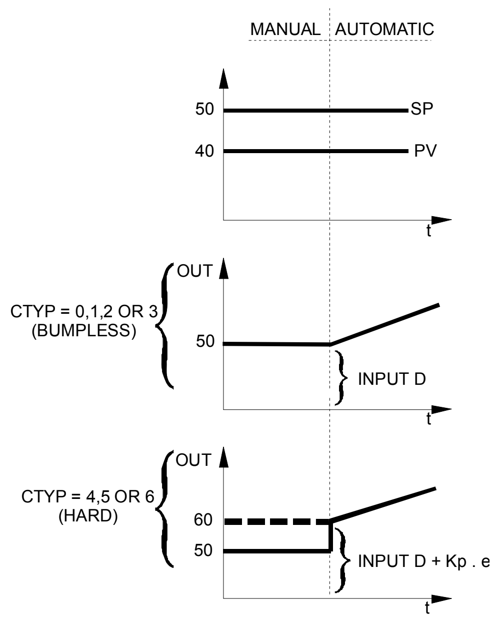


Fig. 4.9.9 - Manual to Auto Transfer. The Automatic Output starts with the Last Manual Output Value

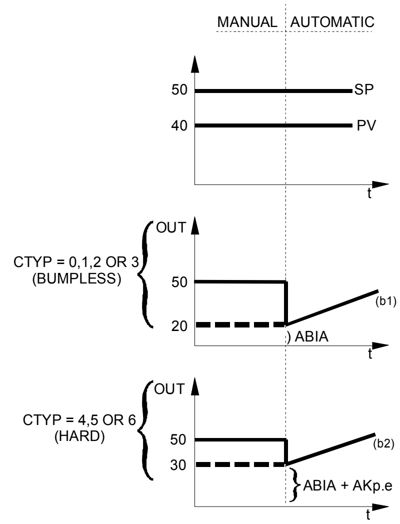
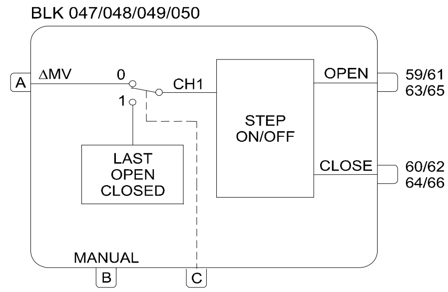


Fig 4.9.10 - Manual to Auto Transfer. The Automatic Output Starts with the Bias Value

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	SP (Setpoint) Input	Addresses 0 to 170 / 225 to 240	0
I	LIB	PV (Process Variable) Input		0
I	LIC	Input for the Control Output (Feedback), used for Bumpless transfer.		0
I	LID	Input for the Auto/Manual Status		0
I	CACT	Control Action and Inhibition of tuning by the front panel REVERSE: Output decreases when PV increases DIRECT: Output increases when PV increases	Parallel Ideal Algorithm 0 – Reverse 1 – Direct 2 - Reverse with no tuning on front 3 - Direct with no tuning on front Noninteractive or ISA 4 – Reverse 5 – Direct 6 - Reverse with no tuning on front 7 - Direct with no tuning on front	0
I	CTYP	Type of PID (see Advanced PID Controller)	0-PI.D/1-PID/2-I.PD(Bumpless) 3-PI.D/4-PID (Hard)	0
P	CARL	Antireset-Windup lower limit	-2.00 to 50.00%	0.00%
P	CARU	Antireset-Windup upper limit	50.00 to 102.00%	100.00%
P	AKp	Proportional Gain	0.00 - 100.00	0.30
R	ATr	Integral time (min./repetition)	0.01 - 1000.0	10.000
R	ATd	Derivative term constant (min.)	0.00 - 100.00	0
P	ABIA	Bias	-100.00 - 100.00%	0.00

Number of Bytes per Type of Parameter: A = 12 C = 8 L = 8

Function 11 - Step Controller (STEP)



Operation

This block is used in control loops with electrical final control element, such as rotating electric actuators.

This block always operates in conjunction with a block of the **Function 09 - Advanced PID** and one block from **Function 08 - Automatic/Manual Switch**. The PID and A/M blocks are connected as usual. The analog output of the A/M Station (39,41,43 or 45) is connected to the input **A** of the Step Control block and the status output (40, 42, 44 or 46) to the input **B**. The usual configuration is shown on the Figure 4.11.1.

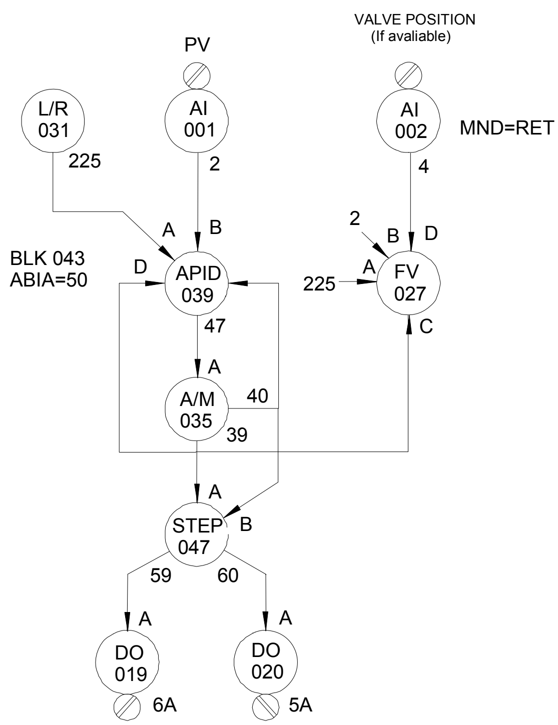


Fig 4.11.1 - Basic Configuration for a Step Control

It is recommended to use the advanced PID, because the gap control works as a dead band. This is required to avoid contact chattering, when the variable is close to the Setpoint.

When the control is in the automatic mode, the block is sensitive to incremental variations at input **A**. Output depends on this variation and on adjustments in parameter **AVOT** (Valve opening time) and **AWPL** (pulse width).

AVOT must be adjusted with the approximate time required for the valve to go from fully closed to fully open. The output characteristics also depend on **AWPL** - the minimum **pulse** width.

Proportional and Derivative actions of the PID are transformed into a pulse, whose duration depends on the P and D gains, on the error and on the time required by the valve for a complete excursion (**AVOT**).

Integral action is transformed into a series of pulses of minimum width **AWPL**, with a frequency determined by the integral time T_R and by the control deviation.

For example, consider a case where the *PID* is adjusted with proportional gain equal to 1, with no integral or derivative action; valve opening time = 1 minute and on instant *t*=0 there is a step error equal to 25% (Figure 4.11.2).

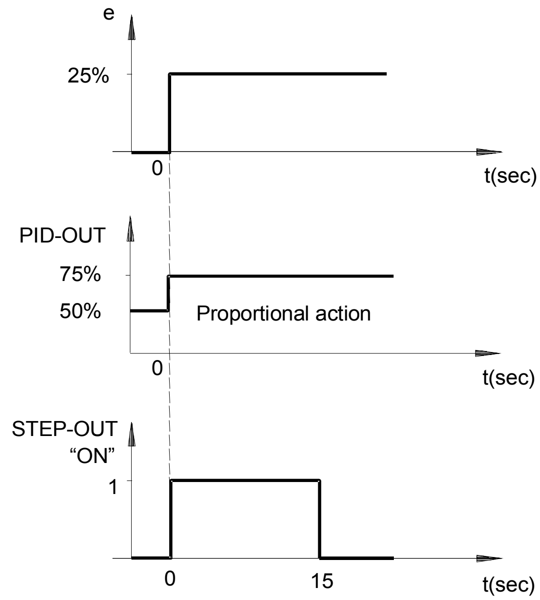


Fig 4.11.2 - Step Output for a 25% deviation with Proportional action only

In this example, 15 seconds of actuation are equivalent to 25% of the valve's excursion (0.25 min = 15 s).

The integral action works as a train of pulses with the same width. The total number of pulses in a given interval of time depends on the integral action adjustment in the *PID* and on the individual width of each pulse (**AWPL**).

Let's consider a case similar to the above example, where the *PID* has the integral action adjusted to 1 minute/repetition and each pulse has a width of 3 seconds. As **AWPL** is expressed in number of cycles and each cycle is 0.2 s, **AWPL**=3/0.2 = 15.

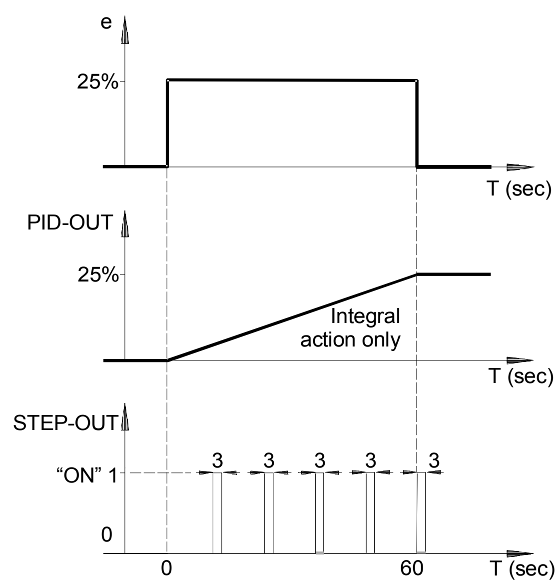


Fig 4.11.3 - Step Output for a 25% deviation with Integral action only

The error is 25%. A standard *I* controller would increase/decrease the output by 25% in 1 minute *(T_R)*.

In order to make a valve with excursion time = 1 minute open or close 25%, it is required a total time of 15 seconds (25% of 60 s).

As the minimum width (**AWPL**) was set to 3sec, the step control will give 5 pulses of 3 seconds equally distributed in a period of one minute. It will keep this rate while the PID output keeps the same rate of change. See Figure 4.11.3.

Increasing *PID* signal acts on output **OPEN** and decreasing *PID* signal acts on output **CLOSE**.

When the control is in Manual mode, the **MV** increase or decrease keys will change the block output status as follows:

Key <△ > Pressed → Output **OPEN** at high logic level

Key <▽> Pressed → Output **CLOSE** at high logic level

In order to have Manual operation, it is necessary to connect the status output of the A/M block to input **B** of the Step Control block.

When input **C** receives a high logic level signal, the block output is switched to the safety condition defined in parameter **CSAF**:

CSAF = 0 → Output **OPEN** and **CLOSE** at low logic level, the valve remains in the last position.

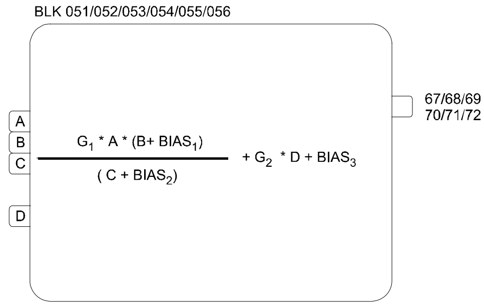
CSAF = 1 → Output **OPEN** at high logic level, the valve goes to the fully open position.

CSAF = 2 → Output **CLOSE** at high logic level, the valve goes to the fully closed position.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Incremental input (ΔMV)	Addresses 0 to 170 / 225 to 240	0
I	LIB	MANUAL MODE indicative input		0
I	LIC	Input for safety position switching		0
I	CSAF	Safety Position	0 - Last value 1 - Open 2 - Closed	0
I	CTYP	Type of control	0-Open/None/Close 1-On/Off	0
I	AWPL	Minimum pulse width (in number of cycles)	1 - 1000	2
I	AVOT	Valve opening time	0 - 3200s	60s

Number of Bytes per Type of Parameter: A = 4 C = 4 L = 6

Function 12 - Multiplier-Divider-Adder-Subtractor (Arth)



Operation

This block performs the four arithmetic operations with the inputs, as shown by the formula below:

$$Output = \frac{G_1 \cdot A \cdot (B + Bias_1)}{(C + Bias_2)} + G_2 \cdot D + Bias_3$$

Where,

A, B, C and D = inputs (in %)
$Bias_1$, $Bias_2$ and $Bias_3$ = constants (in %)
G_1 and G_2 = gain (in real numbers)
Output = Result (in %)

Multiplication between a percentage and a real number always results in a percentage. Sum is always in percentage.

The inputs and the output of this block may range from -102 to +102%. Out of these limits, the extreme value is taken.

If the input **A** is not used, the block will assume
A= 100%.

If the inputs **B** or **C** are not used, the Bias parameters (**ABS1** and **ABS2**) shall be adjusted to 100% in order to avoid that $G_1.A(B + Bias_1)/(C + Bias_2)$ be equal to zero in the first case (multiplication by zero) or always "saturated in 100%" in the second case (division by zero).

EXAMPLE 1: Calculation

$G_1 = 2;\ A = 20\%;\ B = 30\%;\ Bias_1 = 10\%;\ Bias_2 = 100\%$

According to the formula the output should be:

$$2 \,.\, 20\,\frac{(30+10)}{100} = \frac{40\%\ x\ 40\%}{100} = 16\%$$

EXAMPLE 2: Ratio control with fixed ratio constant.

A very important application of **Function 12** is the ratio control. See example of configuration Section 3.

The purpose of this control is to maintain the ratio of flows Q_A and Q_B constant:

$$\frac{Q_A}{Q_B} = K$$

The best way to achieve this, is to control one of them, for example Q_B, with a Setpoint corresponding to Q_A/K. Q_B is called controlled flow and Q_A wild flow. Figure 4.12.1 shows configuration to be used.

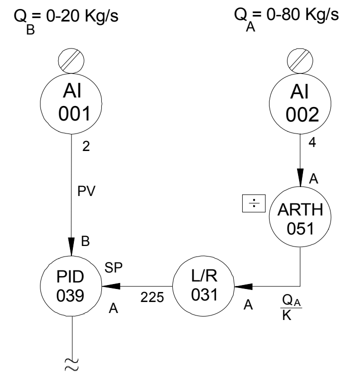


Fig 4.12.1 - Ratio Control with Fixed Ratio Constant

Lets assume that the control shall maintain QA/QB=8.

As the controller "sees" the signals corresponding to Q_A and Q_B as 0-100%, it is necessary to use an internal factor to show the relation between the two variables:

a) Certify that the two flows are in the same units.
b) Normalize the signals.

$[Q_A]$ = 0-100% signal, corresponding to Q_A: 0-80 kg/s.
$[Q_B]$ = 0-100% signal, corresponding to Q_B: 0-20 kg/s.

$$Q_A = \frac{80}{100} \cdot [Q_A] \quad (1) \qquad Q_B = \frac{20}{100} \cdot [Q_B] \quad (2)$$

Dividing (1) per (2):

$$\frac{Q_A}{Q_B} = \frac{80}{20} \cdot \frac{[Q_A]}{[Q_B]} \quad (3)$$

As $\boldsymbol{Q_A/Q_B=8\ (4\ ),}$

Substituting it in (3):

$$8 = 4 \cdot \frac{[Q_A]}{[Q_B]} \quad \therefore\ [Q_B] = 0.5\,[Q_A] = SP \ (5)$$

That means: when the process has the right ratio, the signal corresponding to the Setpoint of flow Q_B is the half of the signal, corresponding to flow Q_A.

c) Calculate the Arithmetic Block as follows:

$$OUTPUT = \frac{G_1 \cdot A \cdot (B + Bias_1)}{C + Bias_2} + G_2 \cdot D + Bias_3 \quad (6)$$

$[Q_A]$ connected to input **A** makes $A=[Q_A]$. The output is the Setpoint for Q_B. Making (5) = (6).

$$SP = \frac{G_1 \cdot [Q_A] \cdot (0 + Bias_1)}{0 + Bias_2} + G_2 \cdot 0 + Bias_3$$

Bias = 100%
$Bias_2$ = 100%
$Bias_3$ = 0 $SP = 0.5[Q_A]$
G_1 = 0.5
G_2 = 0

EXAMPLE 3: Ratio Control with adjustable ratio

Many times the control requires a ratio constant adjustable by the operator. In the last example the ratio constant was fixed. In this example, it must be adjustable between 5 and 10.

In order to achieve this, add to the configuration in Figure 4.12.1 the blocks shown in Figure 4.12.2.

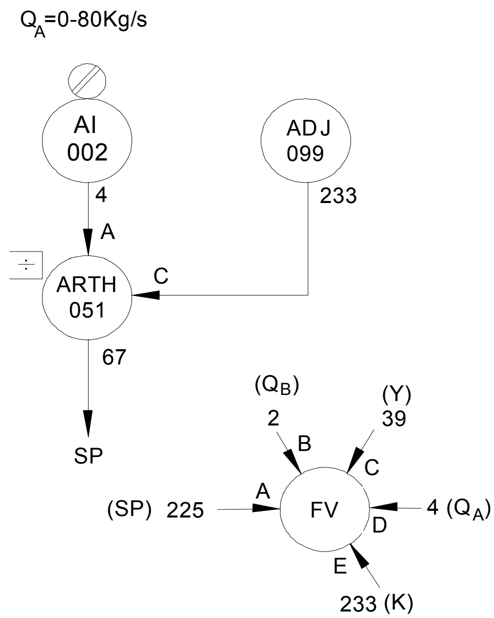


Fig 4.12.2 - Ratio Adjustment

a) In order to have the best resolution in the ratio adjustment, it is better to make the 0-100% variation of the constant adjuster block correspond to the 5-10 variation of the ratio constant.

The **Front View** block 027 may be configured with **AEZ**=5 and **AEM**=10, and have the output of the constant adjuster linked to input **E**. This allows the operator to adjust and visualize the ratio constant between 5 and 10.

b) The signals must be normalized.

As the values are the same of **example 2**, equation (2) of that example may be used:

$$\frac{Q_A}{Q_B} = \frac{80}{20} \cdot \frac{[Q_A]}{[Q_B]} \qquad (2)$$

Q_A/Q_B varies from 5 to 10.

Minimum ratio:

The equation (2) turns:

$$4 \cdot \frac{[Q_A]}{[Q_B]} = 5 \cdot [Q_B] = \frac{4}{5} \cdot [Q_A]$$; *$[Q_B] = 0.8[Q_A] \Rightarrow [Q_B] = SP$ (7)*

Maximum ratio:

The equation (2) turns:

$$4 \cdot \frac{[Q_A]}{[Q_B]} = 10 \qquad [Q_B] = \frac{4}{10} \cdot [Q_A]$$

$[Q_B] = 0.4[Q_A] \Rightarrow [Q_B] = SP$ (8)

c) The Arithmetic Block may have the adjustable ratio connected to input **C** and *[Q_A]* to input **A**.

If $Bias_3 = G_2 = 0$

$$OUTPUT = G_1 \cdot A \cdot \frac{(Bias_1)}{(C + Bias_2)} = SP \quad (9)$$

For minimum ratio B = 0% and equation (7) is applied. Making (7) = (9).

$$0.8 \cdot [Q_A] = G_1 \cdot \frac{[Q_A] \cdot (Bias_1)}{(0 + Bias_2)}$$

$$0.8 = G_1 \cdot \frac{Bias_1}{Bias_2} \quad (10)$$

For maximum ratio C=100% and equation (8) is applied. Making (8) = (9).

$$0.4 \cdot [Q_A] = G_1 \cdot [Q_A] \cdot \frac{(Bias_1)}{(100 + Bias_2)}$$

$$0.4 = G_1 \cdot \frac{(Bias_1)}{(100 + Bias_2)} \quad (11)$$

Making $G_1 = 1$ and substituting (10) in (11):

$$0.8 \ BIAS_2 = 0.4 \ (\ BIAS_2 + 100 \ )$$

$BIAS_2 = 100$
$BIAS_1 = 80$

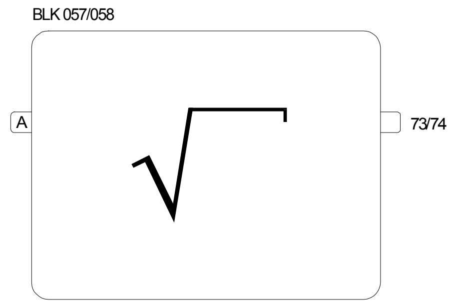
Block configuration:

AGN1 = 1 **ABS2** = -250
AGN2 = 0 **ABS3** = 0
ABS1 = -200

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B		0
I	LIC	Input C		0
I	LID	Input D		0
C	AGN1	Gain G_1	-30.000 to +30.000	1.000
C	AGN2	Gain G_2	-30.000 to +30.000	0.000
P	ABS1	Bias 1	-300.00 to +300.00%	0.00%
P	ABS2	Bias 2	-300.00 to +300.00%	100.00%
P	ABS3	Bias 3	-300.00 to +300.00%	0.00%

Number of Bytes per Type of Parameter: A = 10 C = 0 L = 8

Function 13 - Square Root (SQR)



Operation

This block gives the square root of the input signal.

Since treatment is in percentage values, the formula is:

$Output = 10\sqrt{A(\%)}$

EXAMPLE:

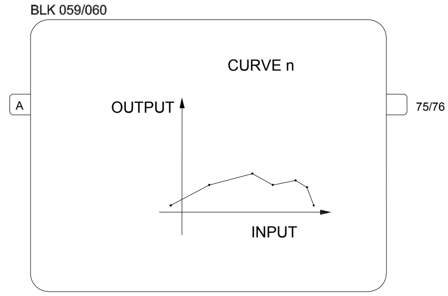
$50(\%) = 10 \,.\, \sqrt{25(\%)}$

The block offers an adjustable cutoff level (**ACUT**). Below this value the output is set to 0%.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Address 0 to 170/225 to 240	0
P	ACUT	Cutoff value	0.00 - 100.00%	0.00%

Number of Bytes per Type of Parameter: A = 2 C = 0 L = 2

Function 14 - Linearization (LIN)



Operation

This block linearizes the input signal in accordance with a curve established in the **Function 31 - Linearization Curve (Blocks 109 to 116)**, configured in loop G. This curve may be used with 13, 26, 52, 78 or 104 pairs of points X, Y, interconnected by straight line segments. The curves that may be performed are shown on Table 4.31.1.

Input (X) and output (Y) variables may take the following values:

Input - axis X → -102.00 to +102.00%
Output - axis Y → -300.00 to +300.00%

It is not necessary to adjust all points available (13, 26, 52, 78 or 104). Should a curve be performed by only 4 points, it is possible to adjust only these four points.

EXAMPLE:

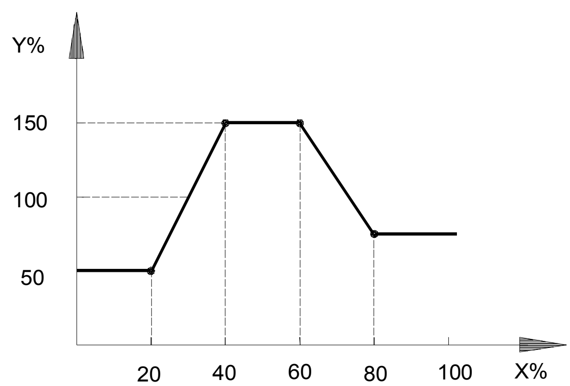


Fig 4.14.1 - Typical Curve

Considering parameter **CLIN**=1, the curve may be adjusted in block 109 of loop G with the following pairs of points:

X1 = 20 Y1 = 50
X2 = 40 Y2 = 150
X3 = 60 Y3 = 150
X4 = 80 Y4 = 75

X1 is the minimum value considered. Even when the input is smaller than the value of X1, in the example 20%, the output will be the corresponding Y1, in the example 50%.

The same principle does not apply for the maximum value! In the example, X4 = 80% is the last point. If the input is bigger than 80%, the program will search for this value at the remaining points (X_5 to X_{13}). If the value is not found, the program would assume the next higher X, for example X_{12} = 55. The output would be the value of Y_{12}.

In order to avoid this problem, it is always convenient to configure the last point of the curve with Xi = 102%, and Yi with the applied value.

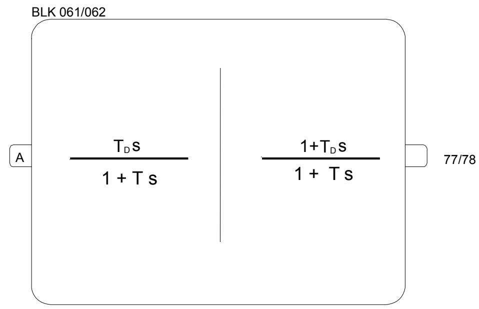
In the example:

X5 = 102 Y5 = 75

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - Abscissa of the curve	Address 0 to 170/225 to 240	0
P	CLIN	Linearization curve	0-None 1→8/Curves 1→8 9-Curves 1 and 2 10-Curves 3 and 4 11-Curves 5 and 6 12-Curves 7 and 8 13-Curves 1 to 4 14-Curves 5 to 8 15-Curves 1 to 6 16-Curves 1 to 8	0

Number of Bytes per Type of Parameter:A = 0 C = 2 L = 2

Function 15 – Derivative / Lead-Lag (LL)



Operation

This is a dynamic compensation block that may operate with a derivative function as well as with a lead-lag compensation function. Selection of either function is done with parameter **CDLL**.

This block reads inputs from -2 to 102% and provides output signals from -102 to +102%.

DERIVATIVE FUNCTION
While operating in the derivative mode, the block performs the following transfer function:

$$O(s) = \frac{T_D s}{1 + Ts} I(s)$$

Where,

O(s) and I(s) - are the Laplace transform of input and output functions, respectively.

T_D - derivative constant, adjusted by parameter **ATLE** (min.)

T - lag constant, adjusted by parameter **ATLA** (min.)

When *T*=0, the output signal represents the input variation rate in the period determined by T_D. For example, if the input signal increases according to a slope of 15% per second and *TD*=6 s (0.1 min.), the output signal will be 15. 6=90% while the slope lasts, returning to zero when there is a constant input value.

When *T*=0, the output signal is submitted to a lag. The response to a step function with amplitude A is shown in Figure 4.15.1.

This function is used when the rate of change of a variable is desired.

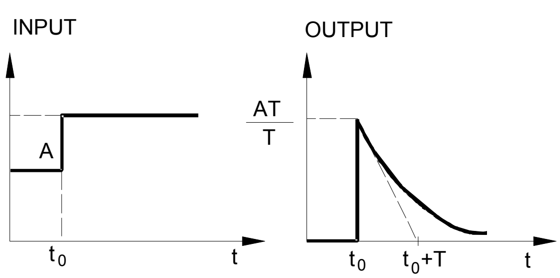


Fig 4.15.1 - Response of Derivative Function with a Lag to an Input Step

LEAD-LAG FUNCTION AND TIME CONSTANT

When operating in the lead-lag mode, the block implements the following transfer function:

$$O(s) = \frac{1 + T_D s}{1 + Ts} I(s)$$

Where,

T_D - Lead constant, adjusted by parameter **ATLE** (min.)

T - Lag constant, adjusted by parameter **ATLA** (min.)

The response to a step function with amplitude A in the input is shown in Figure 4.15.2 for a lag constant **ATLA=**1 and several lead constants (**ATLE**).

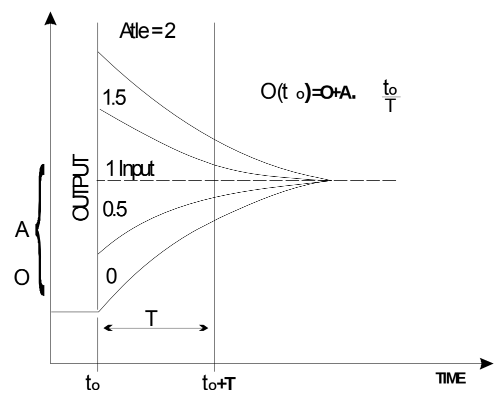


Fig 4.15.2 - Response of the Lead-Lag function to a Step

This block is often used in control loops with feedforward control. Its function is to compensate differences between time constants of the disturbance and the manipulated variable on the controlled variable. The following figure shows a lead/lag block inserted between the disturbance signal (input flow) and the adder which performs the loop's feedforward.

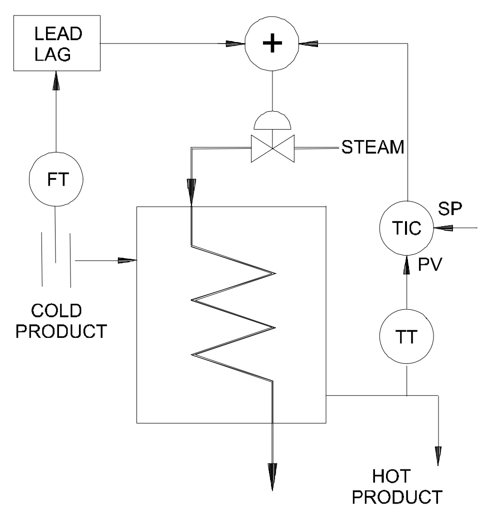
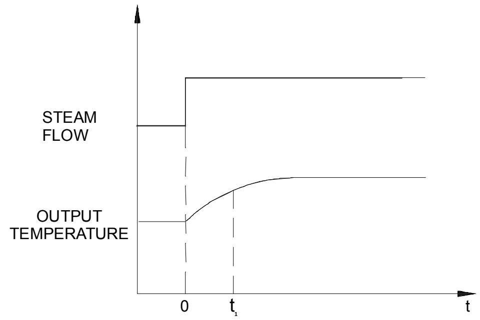


Fig 4.15.3 - Steam flow rate control loop with Lead-Lag

Figure 4.15.4 shows the response of the open loop system to a step variation in the steam flow rate.

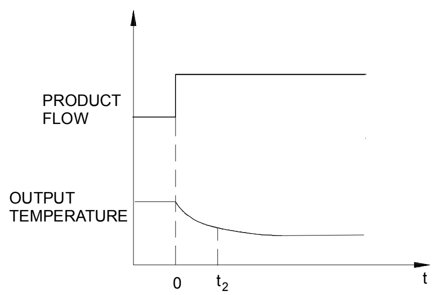


τ_1 - Time constant of the manipulated variable.

Fig 4.15.4 - Open loop response to a step change in steam flow rate (Manipulated Variable).

Note: Time constant is the time required for the variable to reach 63.2% of the end value for a step change.

Figure 4.15.5 shows the response of the open loop system to a step variation in the load.



τ_2 - Time constant for a step variation in the product flow rate.

Fig 4.15.5 - Open loop response to a step variation in product flow rate (disturbance)

By comparing τ_1 and τ_2, it is possible to determine how the lead-lag block shall work:

- if $\tau_1 > \tau_2$ the block should anticipate the disturbance signal (Lead)

- if $\tau_1 < \tau_2$ the block should delay the disturbance signal (Lag)

The block may also be used to generate a first order Lag.

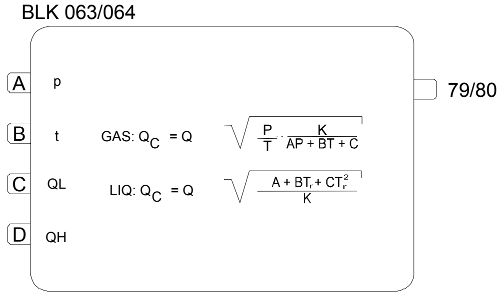
In this case, use **ATLE**=0 and **ATLA** = desired time constant in the lead lag function.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Address 0 to 170/225 to 240	0
I	CDLL	Lead-Lag, time constant or derivative	0 - Derivative 1 - Lead-Lag and time constant	1
P	ATLE	Lead time - Td (min.)	0.00 - 300.00 min.	0.00 min.
P	ATLA	Lag time - T (min.)	0.00 - 200.00 min.	0.00 min.

Number of Bytes per Type of Parameter: A = 4 C = 2 L = 2

Function 16 - Pressure And Temperature Compensation (PTC)

Operation



This block can compensate gas flow for pressure and temperature variation, liquid flow for temperature variation and saturated steam flow for pressure or temperature variation.

The flow transmitter signal shall reach the block input as a linear signal, i.e., should the signal be from a differential pressure transmitter, the square root must be extracted in the analog input block.

It is possible to have higher rangeability measurement, by using signals from two transmitters calibrated in different ranges. For this reason, the block has a parameter (**ALL**) which determines the percentage of the range corresponding to the highest value of the lower range.

$$ALL = \frac{\text{Flow corresponding to } Q_L = 100\%}{\text{Maximum Flow rate}}$$

The lower range transmitter shall be connected to the input **C** and the higher range transmitter shall be connected to input **D**.

When $\mathbf{Q_H > ALL}$ $\mathbf{Q = Q_H}$

If $\mathbf{Q_H \leq ALL}$ $\mathbf{Q = Q_L \cdot \frac{ALL}{100}}$

Input values may vary between -102.00 and +102.00%. Output may go from -2 to +102%.

FORMULA FOR GASES

$$Q_c = Q.\sqrt{\frac{P}{T}}\ \frac{K}{AP + BT + C}$$

Where,

Q_c - Compensated flow rate

Q - Noncompensated flow rate

P - Absolute pressure in engineering units

T - Absolute temperature in engineering units

A, B and C - Coefficients which express the gas compressibility factor *(Z)*. For ideal gases, $A = B = 0$ and $C = 1$.

K - Constant which defines the project conditions of the flow primary element. K is calculated as follows:

$$K = \frac{T_P}{P_P}.(\ AP_P + BT_P + C\ )$$

$$AP_P + BT_P + C = Z_P$$

Where,

T_P and P_P are respectively the absolute temperature and absolute pressure, in engineering units, used in the calculation of the flow primary element.

As the block inputs are in percent and the signals from the pressure and temperature transmitters are seldom in absolute units, the block transforms all measurements in absolute units, as follows:

Where,

$$P = P_0 + \alpha_P . p \ / \ 100$$
$$T = T_0 + \alpha_T . t \ / \ 100$$

P_0 - Value corresponding to 0% of the absolute pressure signal. If the pressure transmitter is of the gage pressure type, the atmospheric pressure shall be added to the value corresponding to 0%.

For example:

Absolute transmitter calibrated from 2 to 10 bar: P_0=2

Gage transmitter calibrated from 2 to 10 bar: P_0=2+1.013=3.013

α_p - Span of the pressure transmitter (in engineering units). From the above example α_p=10-2=8

p - Pressure transmitter signal (in %).

T_o - Value corresponding to 0% of the temperature transmitter + 273.15 Kelvin or + 459.67 Rankine.

α_T - Span of the temperature transmitter (in engineering units).

t - Temperature transmitter signal (in %).

The compressibility factor must be calculated for the particular gas over the particular operating range. Three representative points of operation must be selected from the product thermodynamic table:

P_1, T_1 - corresponding to density d_1.
P_2, T_2 - corresponding to density d_2.
P_3, T_3 - corresponding to density d_3.

These values must be substituted in the following formula:

$$W = \frac{P}{T} \frac{1}{AP + BT + C}$$

Originating three equations that enable the calculation of *A*, *B* and *C*.

Sometimes,

$$\frac{P}{T} \cdot \frac{1}{AP + C} \quad or \quad \frac{p}{T} \cdot \frac{1}{BT + C}$$

are more appropriate to describe the product behavior and are easier to calculate. For many applications P/T is good enough.

Using the normal operating conditions, P_P and T_p, as used for the flow primary element calculation, calculate d_p.

In order to cancel the density for normal flowing conditions:

$$k = \frac{1}{d_p}$$

FORMULA FOR LIQUIDS

$$Q_C = Q \cdot \sqrt{\frac{(A + BT_r + CT_r^2)}{K}}$$

Where,

T_R - Reduced temperature = $\dfrac{T_0 + \alpha_T \cdot t}{T_C}$

T_C - Critical temperature of the liquid.

K - Density of the liquid at the design temperature of the primary element.

The fluid density is given by:

$$\boldsymbol{d = A + BT_r + CT_r^2}$$

Constants A, B and C may be found in chemical manuals for some products or may be calculated using three points of operation as described for gas compensation.

In order to cancel the density for normal flowing conditions:

$$\boldsymbol{K = d_p}$$

FORMULA FOR SATURATED STEAM
The characteristic curve of saturated steam is almost linear in some operation sections.

EXAMPLE:
$d = 0.49315P + 0.2155$ *for* $10 \le P \le 35$

P expressed in bar absolute, d in kg/m^3

In this case is better to use the formula for liquids. The pressure signal must be connected to input **B** so that T_R becomes P. Furthermore, the following shall be done:

T_o = Value equivalent to P_o.

α_T = Value equivalent to α_P.

T_C = 1.

And, in the case presented as an example,

A = 0.2155

B = 0.49315

C = 0

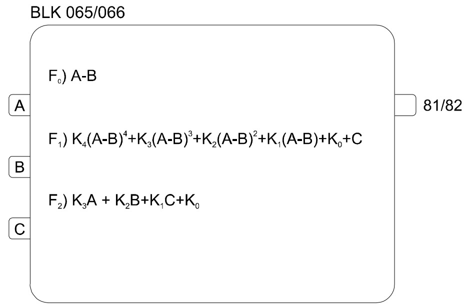
If the orifice plate was calculated for P = 20 bar abs, in order to cancel the density when the pressure is 20 bar abs:

K = 10.08, this being the density of steam at 20 bar absolute. Coefficients A, B and C may be investigated for other operating ranges.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (Pressure or Specific Gravity)	Addresses 0 to 170/225 to 240	0
I	LIB	Input B (Temperature)		0
I	LIC	Input C (Lower range flow rate)		0
I	LID	Input D (Upper range flow rate)		0
I	CTYP	Type of compensation	0-Gas; 1-Liq. 2-Gas without; 3-Liq. without	0
R	C-PO	P_0 for Gas /T_c for Liquid	0 to 10 E 37	1.0000
R	C-AP	αp	0 to 10 E 37	0
R	C-TO	T_0	0 to 10 E 37	273.15
R	C-AT	$\propto t$	0 to 10 E 37	0
R	C-CA	Coefficient A	-10 E 37 to 10 E 37	0
R	C-CB	Coefficient B	-10 E 37 to 10 E 37	0
R	C-CC	Coefficient C	-10 E 37 to 10 E 37	1.0000
R	C-KK	Constant K	0 to 10 E 37	273.15
P	A-LL	Maximum Low Flow	0.00% - 100.00%	0.00%

Number of Bytes per Type of Parameter: A = 2 C = 34 L = 8

Function 17 - Polynomial (POL)



Operation

This block executes mathematical operations established by the functions 0, 1 or 2, as shown in the Figure. The function is selected in parameter **CTYP**:

CTYP = 0 **A**-**B** difference.
CTYP = 1 4th-order polynomial.
CTYP = 2 3-input sum.

Inputs **A**, **B**, **C** and coefficient K_0 are interpreted as percentages, while coefficients K_1 to K_4 are real numbers. Inputs and output may range from -102.00 to +102.00%.

Inputs are standardized as follows:

$$A = \frac{Input\ A\%}{Input\ 100}$$

$$B = \frac{Input\ B\%}{100}$$

$$C = \frac{Input\ C\%}{100}$$

The output signal will be the result of the equation multiplied by 100%.

EXAMPLE 1:
Input **A** = 80%
Input **B** = 55%
Input **C** = 10%

$K_0 = 30$; $K_1 = 1$; $K_2 = 0.5$; $K_3 = 2$; $K_4 = 0.1$

$$A = \frac{80}{100} = 0.8; \quad B = \frac{55}{100} = 0.55; \quad C = \frac{10}{100} = 0.10$$

$$For \quad CTYP = 0$$

$$Output = A - B = 0.80 - 0.55 = 0.25$$

$$Output = 25\%$$

$$For \quad CTYP = 1$$

$$Output = [\ 0.1\,(0.25\ )^4 + 2\,(0.25)^3 + 0.5\,(0.25\ )^2 + 1\,(0.25\ ) + 0.10\ ]100 + 30$$

$$Output = 71.29\%$$

EXAMPLE 2:
Using the Taylor Series, the 4th-order polynomial can be used to represent functions as:

$$e^x = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \frac{x^4}{24}$$

$$a^x = 1 + x.\ \ln\ a + \frac{(x.\ \ln\ a)^2}{2} + \frac{(x.\ \ln\ a)^3}{6} + \frac{(x.\ \ln\ a)^4}{24}$$

$$\ln\ x = (x-1) - \frac{(x-1)^2}{2} + \frac{(x-1)^3}{3} - \frac{(x-1)^4}{24}$$

The coefficients must be adjusted keeping in mind that they will be multiplied by 100. For example, if the polynomial is used to represent e^x, "x" would be given by the input varying from -100 to +100%. Therefore $-1 \leq x \leq 1$ and $0.368 \leq 'e^x \leq 2.718$.

If the coefficients are used like in the Taylor Series, the output would vary between 36.89% and 271.8%. In order to avoid this, the coefficients must be divided by 2.718:

K_0 = 36.79%
K_1 = 0.3679
K_2 = 0.1839
K_3 = 0.06131
K_4 = 0.01533

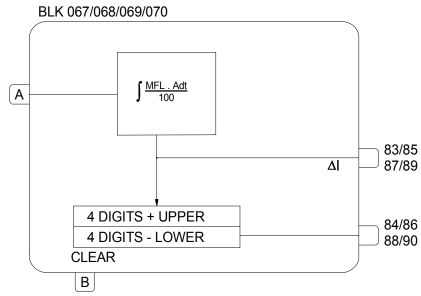
Gives:
13.5% $\leq$ output $\leq$ 100%

If input represents other values than -1 to 1 an output of 0-100% is desired, other coefficients must be calculated.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170/225 to 240	0
I	LIB	Input B		0
I	LIC	Input C		0
P	CTYP	Type of desired equation	0 - A-B difference (F_0) 1 - 4th-order polynomial (F_1) 2 - 3-input sum (F_2)	0
R	A-K0	Coefficient K_0	-300.00% to 300.00%	0.00%
R	A-K1	Coefficient K_1	-10 E 37 to 10 E 37	0
R	A-K2	Coefficient K_2	-10 E 37 to 10 E 37	0
R	A-K3	Coefficient K_3	-10 E 37 to 10 E 37	0
R	A-K4	Coefficient K_4	-10 E 37 to 10 E 37	0

Number of Bytes per Type of Parameter: A = 20 C = 2 L = 6

Function 18 - Totalization (TOT)



Operation

This block is used for flow totalization.

The block integrator provides a ΔI pulse whenever the result of the integration reaches the value pre-adjusted in parameter **ATU**.

The time required for the integrator to provide a pulse depends on **ATU** and on the instantaneous flow rate, which is given by:

$$Q = \frac{MFL \,.\, A}{100}$$

Where,

Q - Instantaneous flow rate in volume or mass engineering units per second.

MFL - Maximum flow rate in volume or mass engineering units per second. This should be equivalent to A=100%.

MFL is adjusted in parameter **AMFL**.

A - Input **A** signal. It is the percent signal corresponding to the flow rate to be totalized.

EXAMPLE:
- Maximum flow rate = 3600 m^3/h = 1 m^3/s.
- The counter indicating totalized flow rate shall have an increment every 10 m^3 of fluid.

The Analog Totalization block shall be adjusted as follows:

- **ATU** = 10 (10 m^3 to generate one pulse)
- **AMFL** = 1 (m^3/s)

At maximum flow, the period between the counting pulses is given by:

$$t = \frac{ATU}{Q} = \frac{10\,m^3}{1\,m^3/s} = 10s$$

If the flow rate is 1800m^3/h, which is equivalent to 0,5m^3/s, the period between pulses would be:

$$t = \frac{10}{0.5} = 20s$$

Therefore, for a steady flow rate of 1800m^3/h, every 20s there will be an increment of the counter and a pulse ΔI will be available at output ΔI (83, 85, 87 and 89).

The output ΔI can only be connected to the input of the blocks F20 - "Batch Comparator" (input **A**) and F19 - "Pulse Totalization Input" (input **B**). If it is intended to use a counter external to the **CD600**, the output ΔI shall be connected to input **A** of the Batch Comparator block. The first output of blocks 073/074 (Address 99 and 103) provides pulses with a duration of one cycle time. These pulses may be connected to a digital output block, that will drive an external counter.

The other output of this block provides the value to the internal counter. The counter has 8 digits. These 8 digits are available only for input G of the visualization blocks. The four digits less significant are available for the regular analog input (0,00% to 99.99%) of any block.The counting is divided by 100. For example, the counting 09827125 shown in input G of the visualization block would read 71.25% at the input of the other blocks.

The counter actualization capacity is limited to 120 countings per cycle. For a cycle of 0.2 s, the maximum actualization capacity would be of 600 countings per second. The counting per cycle which exceeds this value is stored, to be unloaded later. The number of countings per cycle should be kept below the limit, in order to prevent a batch from being interrupted after the real value has been passed. In order to avoid this problem, always keep:

$$\frac{AMFL}{ATU} x \; (cycle \quad time) < 120$$

For cycle time adjustment, refer to **Section 8**.

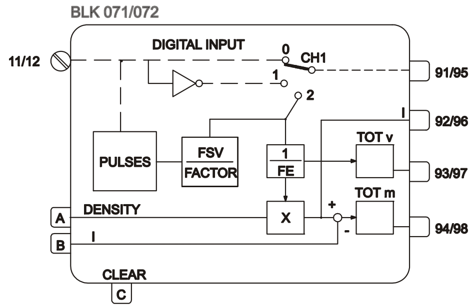
This block may also be used to generate pulses in a frequency adjustable by input **A**. Maximum frequency occurs when **A**=100% and it depends on **AMFL** and **ATU** values.

Pulses thus generated may be used as Setpoint for a flow controller, where PV is measured with a Turbine flow element. See example in **Function 19**. The
counting is zeroed when there is a high level signal at input **B**. The counting starts when input **B** is back to the low logic level.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (to be totalized)	Addresses	0
I	LIB	Input B (clears totalizer)	0 to 170/225 to 240	0
R	A-TU	Totalization value in volume units or mass units, corresponding to one counting unit.	0 to 10 E 37	1.0000
R	AMFL	Flow rate corresponding to 100% at input A, in volume or mass units (the same units used in ATU) per second.	0 to 10 E 37	10.000

Number of Bytes per Type of Parameter: A = 8 C = 0 L = 4

Function 19 - Pulse Totalization Input (P/DI)



Operation

This block can be used as a digital input or for the input of pulses coming from turbine flow meters, or almost any type of pulsing signal for frequency measurement.

Working as a pulse input, it allows the frequency correction by the turbine factor and by the density.

The pulse subtractor input allows totalization of the deviation between two frequencies in one bidirectional totalizer.

DEFINITION OF THE BLOCK FUNCTION (CTYP)
The block is normally used as digital input, **CTYP=**0. If **CTYP=**1, it can be used to receive pulses, and convert the frequency to an analog signal.

TURBINE FREQUENCY RANGE (CMFR)
In order to optimize the microprocessor time distribution, it is recommended to specify the turbine's frequency range. There are two ranges: one below and another above 500 Hz.

If **CMFR=**0 the update time for the frequency to analog conversion is one input cycle.

Example: An instantaneous input of 400 Hz.

$$t = \frac{1}{400} = 2.5ms$$

If **CMFR=**1 the update time for the frequency to analog conversion is eight input cycles.

Example: An instantaneous input of 1000 Hz.

$$t = 8 \cdot \frac{1}{1000} = 8\ ms$$

Note: As the frequency approaches 0 Hz the update time will be longer. However it is only for very low frequencies that the update time is longer than the controller cycle.

TURBINE FACTOR (AFSV) AND ADJUSTMENT FACTOR (AFTR)
In turbine or vortex type meters, a factor for each type of fluid determines the number of pulses per unit of volume.

This factor is provided directly by the meter manufacturer or is calculated as follows:
FTR is normally called the turbine K-factor.

$$FTR = \frac{f\ [\ Hz\ ]}{q_V\ [\ units\ of\ vol\ ]} = \frac{[\ pulses\ ]}{[units\ of\ vol\ ]} \qquad (1)$$

The conversion of frequency into flow is done by dividing the input frequency by **FTR**:

$$q_V = \frac{f}{FTR} \qquad (\ 2\ )$$

Some manufacturers, however, use the so-called turbine factor, which is the reciprocal of the previous factor:

$$FSV = \frac{q_V\ [\ units\ of\ vol\ ]}{f\ [Hz]} = \frac{[\ units\ of\ vol\ ]}{[\ pulse\ ]} \qquad (\ 3\ )$$

Thus,

$$q_V = FSV\ .\ f \qquad (\ 4\ )$$

The **CD600** combines equations (2) and (4), allowing the use of both factors with no need for additional calculations:

$$q_V = \frac{FSV}{FTR}\ .\ f \qquad (\ 5\ )$$

Should the factor be given in [pulses/unit volume], the **FTR** value shall be adjusted in parameter **AFTR** and **FSV** shall be equal to 1 in parameter **AFSV**.

If, otherwise, the factor is given in [units of volume /pulse], **FSV** is adjusted in **AFSV** and it is necessary to make **FTR=**1 in **AFTR**.

INSTANTANEOUS FLOW INDICATION (AMFL)
When the block is selected as a pulse input, output 91/95 provide a signal Q which varies from 0 to 100% proportionally to the flow rate in accordance with the following equation:

$$Q = \frac{q_V}{MFL}\ .100\ [\ \%\ ] \qquad (\ 6\ )$$

Where, MFL is the frequency for the highest expected flow rate. MFL shall be adjusted in parameter **AMFL**.

TOTALIZATION FACTOR (AFE)
This factor determines the number of units of volume or mass corresponding to one totalization unit.

If **AFE**=10, there will be one totalization increment every 10 engineering units of volume.

CORRECTION BY DENSITY (AZDN and AMDN)
Flow rate may be totalized in volume or in volume corrected by the density, which corresponds to mass flow or volume at reference conditions.

Density, which may be calculated by the flow correction block or by the polynomial, is linked to input **A**. Input value, which varies from 0% to 100%, is transformed in engineering units by parameters **AZDN** and **AMDN**.

The density value multiplies the pulses rate, thus implementing the correction for density variation.

NUMBER OF PULSES FOR CALCULATION (APLS)
This is the maximum number of pulses processed per controller processing cycle. This value is applied to optimize the microprocessor time distribution. Larger numbers should be applied for large flows.

APLS=fmax . t_{cycle}
fmax = highest expected input frequency
t_{cycle} = controller cycle time

COUNTING LIMIT
Notice that, as in Function 18, the maximum number of countings sent to the counter in one cycle is 120. The exceeding pulses are stored to be unloaded later. In order to avoid this problem keep:

$$\frac{AMFL}{AFE}\ x(\ cycle\ \ \ time\ ) < 120$$

CLEAR TOTALIZER
A high logic level at input **C** clears the totalizers and keeps them at zero value while present.

The totalizer outputs TOT_V (Total Volume) and TOT_n (Total mass) are 8 digit numbers available only for input G of the Front View blocks. See block F18 - Totalization for more details on these outputs.

EXAMPLE 1:

A turbine measures flow rates of up to 6 m^3/min with a maximum frequency of 600 Hz. The 4-20 mA signal from the density meter corresponds to a density variation of 0.1 to 1.1 g/m^3. The counter increment shall be 1 count for every 1m^3.

$q_v = 6\ m^3/min = 0{,}1\ m^3/s$ $\qquad$ f = 600 Hz

$$FTR - \frac{600}{0.1} = 6000 \text{ pulses/m}^3$$

$$FSV - \frac{0.1}{600} = 0.0001666$$

It is more convenient to use FTR, because FSV is a periodic decimal. Configuration is as follows:

AFTR=6000
AFSV=1
AFE= 1
AMFL=0.1
AZDN=0.1
AMDN=1.1
APLS=32
CTYP=2
CMFR=1

EXAMPLE 2:

An important application of this block is the ratio control of two flow rates or even the control of a single flow rate. It is possible to obtain a more precise control if the Setpoint is in pulse frequency and if it is connected to input **B.** Using the same block of example 1, the following configuration may be used:

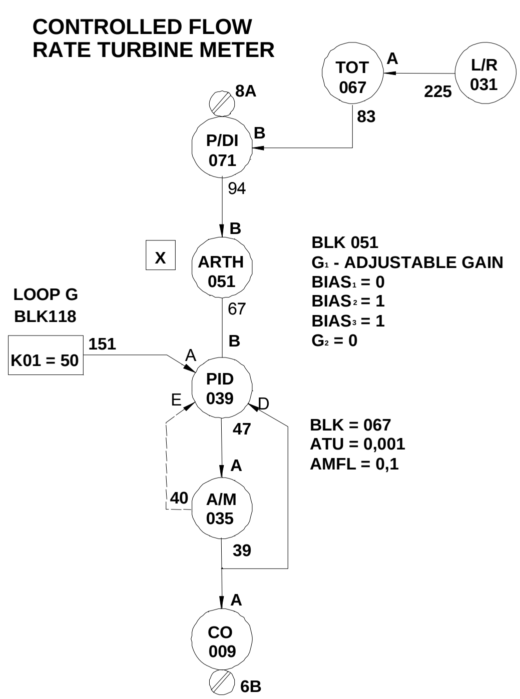
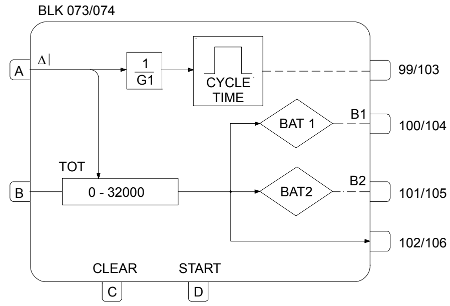


Fig 4.19.1 - Ratio Control

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (Density)	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B (Counting decrement)		0
I	LIC	Input C (Resets totalizer)		0
I	CTYP	Definition of the block function	0 – Digital 1 - Inverted Digital 2 – Totalizer	0
I	CMFR	Turbine maximum frequency	0→f<500 Hz 1→f>500 Hz	1
R	AFSV	Turbine Factor	0 to 10 E 37	1.0000
R	AFTR	Adjusting factor (K-factor)	0 to 10 E 37	1.0000
R	A-FE	Factor FE (totalization unit)	0 to 10 E 37	1.0000
R	AZDN	Density at 0%	0 to 10 E 37	0.2000
R	AMDN	Density at 100%	0 to 10 E 37	0.4000
R	AMFL	Maximum Flow rate in engineering units	0 to 10 E 37	250.00
I	APLS	Number of pulses per cycle	0-32000	32

Number of Bytes per Type of Parameter: A = 26 C = 4 L = 6

Function 20 - Batch Comparator (BAT)



Operation

The batch comparator block counts pulses and compares the count with two preset values, **BAT1** and **BAT2**. When the count reaches the value **BAT1**, the corresponding digital output of the block goes to a high logic level and remains this way, until the counter is zeroed. The same is valid for **BAT2**, which shall be programmed with a value greater than **BAT1**.

BAT1 and **BAT2** are adjusted in parameters, **ABT1** and **ABT2**, respectively.

This block also conditions output pulses for external counters, since pulses ΔI can only be used as input for the internal blocks of the **CD600**. The duration of the pulses for external counters is determined by the Cycle Time Adjustment (see **Section 8 - Communication**).

The parameter G1 determines the number of pulses at the input equivalent to one pulse at the output. For example, if G1 = 10, there will be one pulse at the output for every 10 pulses at the input.

A high logic level at input **C** zeroes the counter and stops the count which will only start again if there is a high logic level signal in **D**. The return of **D** to a low logic level does not stop the count.

The counter may start from zero or from the value at input **B**. As input **B** accepts signals ranging from 0.00 to 100.00, the start value of the counter is given by (B value x 100).

EXAMPLE:
The flow rate through a pipe line varies from 0 to a maximum of 72 Nm^3/h. This pipe feeds a batch reactor, that shall receive 10 Nm^3 of fluid. After totalizing 9.8 Nm^3, the valve shall reduce the flow rate to 10%. This is done to decrease the error caused by the system dead time.

For accounting purpose, the controller shall generate one pulse each 1 Nm^3, to an external counter.

Configuration:
The analog totalization block (**Function 18**) was programmed to provide one pulse ΔI each 0.01 Nm^3. As the batch counter counts pulses, 10 Nm^3 correspond to 10/0.01 = 1000 pulses and 9.8/0.01 = 980 pulses. Each pulse for the external counter shall correspond to 1 Nm^3.

Therefore, one pulse at the output (1Nm^3) will correspond to G1 pulses at input (0.01Nm^3).

$$G1 = \frac{1\,Nm^3}{0.01\,Nm^3} = 100$$

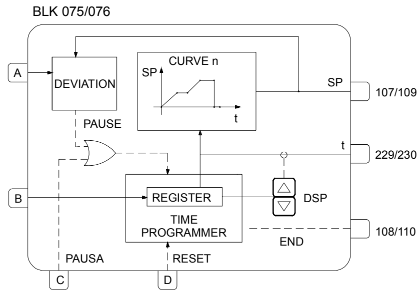
Therefore, the block shall be programmed as follows:

ANOP = 100
ABT1 = 980
ABT2 = 1000

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - Increment	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B - Counter start value		0
I	LIC	Input C - Clears counter		0
I	LID	Input D - Starts Counting		0
I	ANOP	Number of input pulses corresponding to one output pulse	0 - +32000	0
I	ABT1	Preset value in BAT 1	0 - +32000	0
I	ABT2	Preset value in BAT 2	0 - +32000	0

Number of Bytes per Type of Parameter: A = 6 C = 0 L = 8

Function 21 - Setpoint Generator (SPG)



Operation

The function of this block is to make a variable follow a pattern along the time, in accordance with a pre-established curve selected by (**CLIN**). The time variation is plotted along the axis X and the variable is plotted along the axis Y. This variable is available at output "**O**" of the block.

Output **t** informs the time elapsed as percentage of the maximum time programmed for the pattern (**CTME** and **CUNI**).

When the configurated time is reached, output **"END"** goes to a "high logic level", thus indicating the end of the pattern. At this point, the time count stops in 100%, the variable stops in the value corresponding to the maximum time and the output **"END"** remain with high logic level until a high logic level signal in input **D** (RESET) returns the pattern to its initial point. The return of input **D** to a low logic level restarts the pattern.

The pattern always starts in the point of axis X established by input **B**. If nothing is connected to **B** or the signal in **B** is 0%, the pattern starts at t=0%. In case there is a signal of 25% connected to **B** and the maximum programmed time is 2 min., the pattern starts in the point equivalent to 30 sec. (the 0 to 30 sec. track is suppressed).

This block also compares the value of the generated variable with the value of input **A**. Should the deviation be greater than the value adjusted in **ADEV**, the time generation stops until **A** is back to the allowable range. This function can be used to compare the Setpoint with the Process Variable. Should the deviation be greater than an allowable range, the time stops running until the control is effective again. If this function is not desirable, simply make **ADEV**=100, or connect output **"O"** to input "**A**". Thus, there will be no deviation and the time generator will not be interrupted.

The time generator stops in two particular situations:

- When there is a high logic level at input **C** (**PAUSE**).

- When the deviation between output **"O"** and input **A** exceeds the adjusted limit value (parameter **ADEV**).

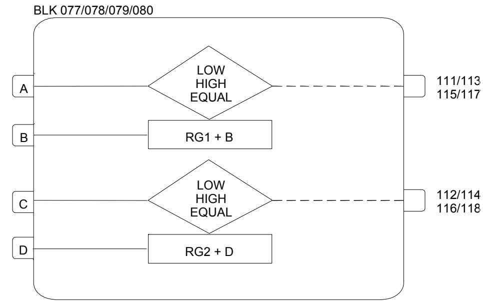
The time count may be manually advanced or delayed with the keys <∆> and <∇> as long as the time (outputs 229 or 230) is on the display.

Parameter **CLIN** selects the curve or the curves of the General Loop which will be used to generate the pattern. The curves are established in the **Function 31 - Linearization Curve (blocks 109 to 116)**. This curve may be used with 13, 26, 52, 78 or 104 pairs of points x, y, interconnected by straight line segments. The curves that may be performed are shown on table 4.31.1 - page 4.59. **CUNI** establishes the unit of time (hours or minutes) and **CTME** adjusts maximum time, i.e., the time equivalent to X=100%.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (input to comparator)	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B (stall time)		0
I	LIC	Input C (Pause)		0
I	LID	Input D (Reset)		0
I	CLIN	Curve(s) used to determine the time pattern	0 - None (output - 0) 1 to 8 -Curves 1 to 8 9 - Curves 1 and 2 10 - Curves 3 and 4 11 - Curves 5 and 6 12 - Curves 7 and 8 13 - Curves 1 to 4 14 - Curves 5 to 8 15 - Curves 1 to 6 16 - Curves 1 to 8	0
I	CUNI	Time unit	0 – Minutes 1 - Hours	0
P	CTME	Time corresponding to 100%	0.00 - 300.00	60.00
P	ASPD	Time register Actuation Speed	0.00%/s - 200.00%/s	10.00%/s
P	ALOW	Lower time register limit	-102.00% to +102.00%	0.00%
P	AUPP	Upper time register limit	-102.00% to +102.00%	100.00%
P	ADEV	Deviation (in modules)	0.00 - 100.00%	100.00%

Number of Bytes per Type of Parameter: A = 8 C = 6 L = 8

Function 22 - Double Alarm (ALM)



Operation

This block has two separated and independent alarm comparators.

At the first comparator the variable to be compared is linked to the input **A**, and the reference signal is connected to input **B**. When a constant reference signal is desired, it can be adjusted through RG1, using the parameter **ARG1**, and leaving the input **B** free. The second comparator is similar to the first one, i.e., the inputs **C** and **D** are used in the same way as inputs **A** and **B**. Similarly, if the reference signal is a constant, it can be adjusted through RG2, using the parameter **ARG2**.

All the inputs may range from -102.00 to +102.00%. Each comparator can be independently configured in order to generate a discrete alarm output according to the following options:
- Variable ≤ Reference → Low Alarm
- Variable ≥ Reference → High Alarm
- Variable = Reference → Equal Alarm

The reference is the sum of the input **B** (or **D**) value in % and the value of the parameter **ARG1** (or **ARG2**).

To avoid an oscillation of the output signal when the variable is very near the alarm point, the hysteresis can be used, which is adjusted at the parameter **ADB1** (or **ADB2**).

The actuation work as follows:

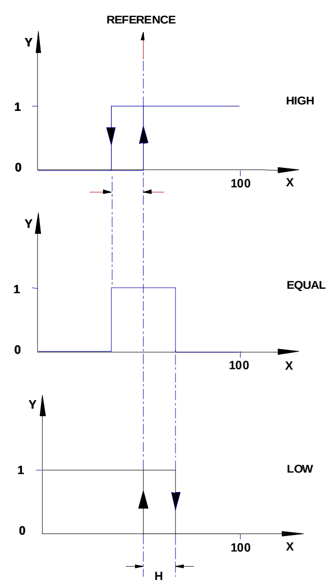


Fig 4.22.1 - Alarm Action with Hysteresis

Where:
X - Variable (input **A** or **C**)
Y - Output logic level: 0 = 0%; 1 = 100%
H - Hysteresis

It is mandatory to set the hysteresis when using the Equal Alarm. The minimum hysteresis value is 0.01%.

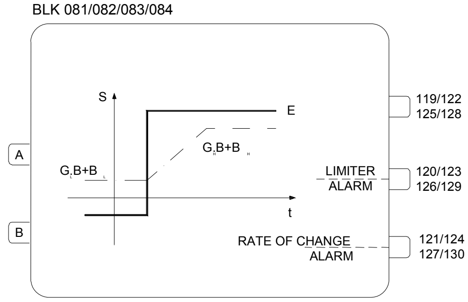
Besides giving the corresponding high logic level output, the alarm status can also be shown on the front panel display (see **SECTION 1 - ALARMS ACKNOWLEDGMENT**). It can be configured through the parameter **CFRT**.

It is also possible to program an eight-characters alarm message, using the parameter **CMN1** (or **CMN2**).

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170/225 to 240	0
I	LIB	Input B (Comparator Reference)		0
I	LIC	Input C		0
I	LID	Input D (Comparator Reference)		0
I	CTY1	First Comparator	0-Low/1-High/2-Equal	0
S	CMN1	First Comparator Message	******	LOW COMP
I	CTY2	Second Comparator	0-Low/1-High/2-Equal	1
S	CMN2	2nd Comparator Message	******	HGH COMP
I	CFRT	Indication on Front Panel	0 - None 1 - Indicates 1 2 - Indicates 2 3 - Indicates 1 and 2 4 - Indicates 1 with Auto Ack. 5 - Indicates 2 with Auto Ack. 6 - Indicates 1 and 2 with Auto Ack.	0
P	ARG1	1st Comparator Limit	-102.00% to +102.00%	0.00%
P	ADB1	1st Comparator Hysteresis	0.00% to 100.00%	0.00%
P	ARG2	2nd Comparator Limit	-102.00% to +102.00%	100.0%
P	ADB2	2nd Comparator Hysteresis	0.00% to 100.00%	0.00%

Number of Bytes per Type of Parameter: A = 8 C = 22 L = 8

Function 23 - Limiter With Alarm (LIMT)



Operation

The function of this block is to limit a signal within static or dynamic limits. As the variable reaches one of these limits, it can generate a high logic level signal. The block also generates an alarm every time the variable **"Rate-of-Change"** reaches a preset limit.

The inputs can vary from -102.00 to +102.00% and the output from 0 to 100%.

STATIC LIMITS
By connecting the variable *A* to the input **A** and keeping the input **B** disconnected or with 0%, the signal *A* will be limited between B_L and B_H, i. e., the output signal *Y* will be:

$Y = B_L$	*if*	$A \leq B_L$
$Y = A$	*if*	$B_L < A < B_H$
$Y = B_H$	*if*	$A \geq B_H$

B_L and B_H are adjusted at the parameters **ABL** and **ABH**, respectively.

DYNAMIC LIMITS
In this case, the limit is set by the variable *B*, which is connected to the input **B**. In order to give more flexibility, the limits can be established with individual gains and polarities.

$Y = B \,.\, G_L + B_L$	*if*	$A \leq B \,.\, G_L + B_L$
$Y = A$	*if*	$B \,.\, G_L + B_L < A < B \,.\, G_H + B_H$
$Y = B \,.\, G_H + B_H$	*if*	$A \geq B \,.\, G_H + B_H$

LIMIT ALARM
Whenever the variable reaches the limit, the digital output "**Limiter Alarm**" goes to a high logic level. At the parameter **CLIM**, it can be specified which limit actuates the digital output: the low limit, the high limit or both.

The alarm can also be annunciated on the instrument Front Panel. To do that, the parameter **CFRT=**1, 3, 4, or 6 shall be programmed, according to the desired effect.

In order to avoid an output oscillation of the discrete output signal, as the variable is very near to the limit value, the hysteresis can be used, which acts in the same way of the **Function 22 - Alarm**. The hysteresis is adjusted in the parameter **ADB**.

RATE-OF-CHANGE LIMIT AND RATE-OF-CHANGE ALARM
The output **Rate-of-Change** can be limited through the parameter **ASLW**.

The digital output "**Rate-of-Change Alarm**" switches to a high logic level whenever the **Rate-of-Change** reaches the limit value introduced at the **ASLW** parameter. At the same time, the alarm can be shown on the Front Panel when **CFRT** is 2, 3, 5, or 6.

Note that when A changes faster than **ASLW**, the output changes at the "**Rate-of-Change Limit**" value, and it keeps this rate until the output A reaches the new A value or one of the limits. Within this period, the output "**Rate-of-Change Alarm**" keeps the high logic level.

The **Rate-of-Change Limit** can be applied in modules, i.e, the limit applies for both increasing or decreasing signals or it can be applied for a particular direction.

When the limit is for any direction, **CLIM** must be configured with 0, 1 or 2.

If the limit is for a particular direction, **CLIM** must be configured with 3, 4 or 5 and **ASLW** must be adjusted with the respective signal:

+ for increasing signal
– for decreasing signal

OTHER APPLICATIONS
This block can also be used to compute the equation:

Output = $G_L \cdot B + B_L$

To do that, it is just enough to make A = 0% or to keep the input **A** free. The block is also used to generate alarms. The dynamic limits are extremely useful in one of its most important applications: combustion control with double cross limits.

This type of control tries to keep the air-fuel ratio strictly within the limits. A sudden change on the load would require a corresponding air and fuel variation. The "double cross limits" prevents that the fastest variable unbalance the desired ratio.

On conventional controllers it is done using relays to select high and low values plus the adder/subtractor stations. Typically, this control is implemented as shown in the Figure 4.23.1.

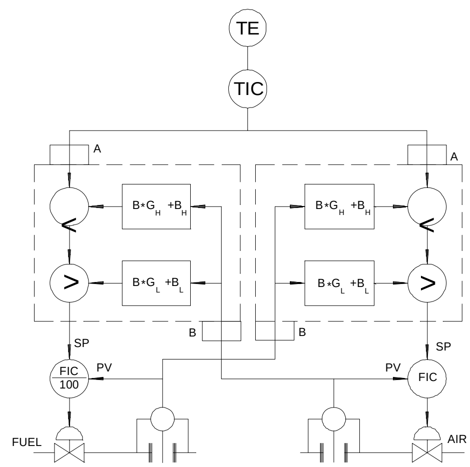


Fig 4.23.1 - Combustion Control with double cross limits

This configuration allows the air flow (Q_a) to vary just between $(Q_c - B_2)$ and $(Q_c - B_1)$ and the fuel flow (Q_c) to vary just between $(Q_a - B_4)$ and $(Q_a - B_3)$.

In this manner, even when there are large transients on the Master signal, the air and fuel flow keeps the required ratio.

The limiter block perform the functions indicated inside the broken line area, i.e., two of these blocks can implement the double cross limits function. The Figure 4.23.2 shows one of these blocks.

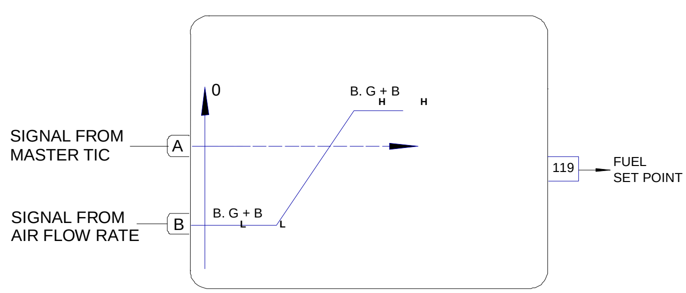


Fig 4.23.2 - Fuel Setpoint from a double cross limit configuration (TIC)

The Table 4.23.1 shows the block response to a Master signal variation and the air flow for $G_H = G_L = 1$, $B_L = -10\%$, and $B_H = 5\%$. The table rows show the instants in which the air flow or the fuel flow have changed 5%.

The air flow valve is slower than the fuel flow valve.

INSTANTS	TIC OUTPUT	AIR FLOW	LOW LIMIT	HIGH LIMIT	FUEL SETPOINT
1	50	50	40	55	50
2	60	50	40	55	55
3	60	55	45	60	60
4	60	60	50	65	60
5	60	60	50	65	60
6	45	60	50	5	50
7	45	55	45	60	45
8	45	50	40	55	45
9	45	45	35	50	45

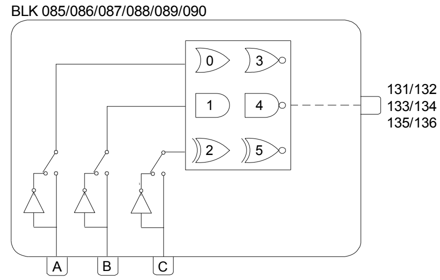
Table 4.23.1 - Block response to master signal variations

Note that the output for the fuel Setpoint is always between the low and high limits. It is supposed that the fuel flow follows the Setpoint change within a very narrow time interval. The air flow follows the fuel flow but more slowly, as the air Setpoint is function of the fuel flow, according to a similar table, but with $|B_L| < |B_H|$.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (Variable)	Addresses 0 to 170/225 to 240	0
I	LIB	Input B (dynamic limit)		0
I	CLIM	Limiter Alarm Output Actuation and Rate-of-Change Alarm	Rate-of-Change alarm in modules and: 0 - Limiter alarm LOW 1 - Limiter alarm HIGH 2 - Limiter alarm LOW and HIGH Rate-of-Change considering (+)increase/ (–) decrease signal and: 3 - Limiter alarm LOW 4 - Limiter alarm HIGH 5 - Limiter alarm LOW and HIGH	0
I	CFRT	Alarm(s) on the Frontal	0 – None 1 – Limit 2 - Rate-of-Change 3 - Limit/Rate-of-Change 4 - Limit Alarm Auto Ack. 5 - Rate-of-Change Alarm Auto Ack. 6 - Limit Alarm/Rate-of-Change Auto Ack.	0
C	A-GL	Low Limit Gain	0.000 - 30.000	0.000
P	A-BL	Low Limit Bias	-300.00% to +300.00%	0.00
C	A-GH	High Limit Gain	0.000 to 30.000	0.000
P	A-BH	High Limit Bias	-300.00% to +300.00%	100.00%
P	A-DB	Comparison Alarm Hysteresis	0.00% - 100.00%	0.00%
P	ASLW	Maximum Rate-of-Change	-200.00 to +200.00%	200.00%/s

Number of Bytes per Type of Parameter: A = 12 C = 4 L = 4

Function 24 - Logic (LOG)



Operation

This block performs several types of three input logic operations with the inputs **A**, **B** and **C**. If one input is not connected it is not considered in the operation, i.e, the logical operation will be performed with only two inputs.

The table 4.24.1 shows the results of the several logic operations available. The choice is made with **CLOG**.

When the result of the logic performed is a high logic level or "1", the output is 100%, and when the result is a low logic level, the output is 0%.

INPUTS*			OUTPUT					
A	**B**	**C**	**OR(0)**	**AND(1)**	**XOR(2)**	**NOR(3)**	**NAND(4)**	**NXOR(5)**
0	0	0	0	0	0	1	1	1
0	0	1	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0
0	1	1	1	0	0	0	1	1
1	0	0	1	0	1	0	1	0
1	0	1	1	0	0	0	1	1
1	1	0	1	0	0	0	1	1
1	1	1	1	1	1	0	0	0
0	0		0	0	0	1	1	1
0	1		1	0	1	0	1	0
1	0		1	0	1	0	1	0
1	1		1	1	0	0	0	1
0			0	0	0	1	1	1
1			1	1	1	0	0	0

*With no inversion (CNOT = 0)

Table 4.24.1 - Truth Table for 3-Input Logic Block

A signal ranging from 0 to 100% connected to one of the inputs of this block will be interpreted as follows:

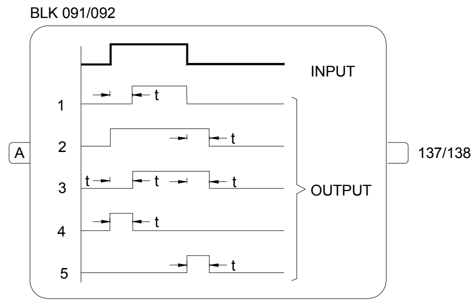
- Less than 70%: level 0
- More than 80%: level 1
- Between 70% and 80%: previous state

The inputs can be inverted with parameter **CNOT**.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A (Digital Interpretation)	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B (Digital Interpretation)		0
I	LIC	Input C (Digital Interpretation)		0
I	CLOG	Defines the logic operation between connected inputs	0 - OR 3 - NOR 1 - AND 4 - NAND 2 - XOR 5 - NXOR	0
I	CNOT	Inverts the input	0 - No inversion 1 - Inverts input A 2 - Inverts input B 3 - Inverts input A and B 4 - Inverts input C 5 - Inverts input A and C 6 - Inverts input B and C 7 - Inverts input A, B and C	0

Number of Bytes per Type of Parameter: A = 0 C = 4 L = 6

Function 25 - Timer (TMR)



Operation

This block gives a delay on a digital signal as defined in parameter **CACT**. The time of delay is established by parameter **ADEL**.

The timing diagrams of the block show the several types of actuation available.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A - Binary Signal	Address 0 to 170/225 to 240	0
I	CACT	Type of actuation	0 - None 1 - Delay on Operate 2 - Delay on Release 3 - Delay on Operate and Release 4 - Monostable, triggered positive flank 5 - Monostable, triggered negative flank	0
P	ADEL	Delay Time	0.01 min to 180.00 min	1.00 min

Number of Bytes per Type of Parameter: A = 2 C = 2 L = 2

NOTE
On the online change of the **CACT** parameter, it should be **first** changed to “0” and then, to the desired value.

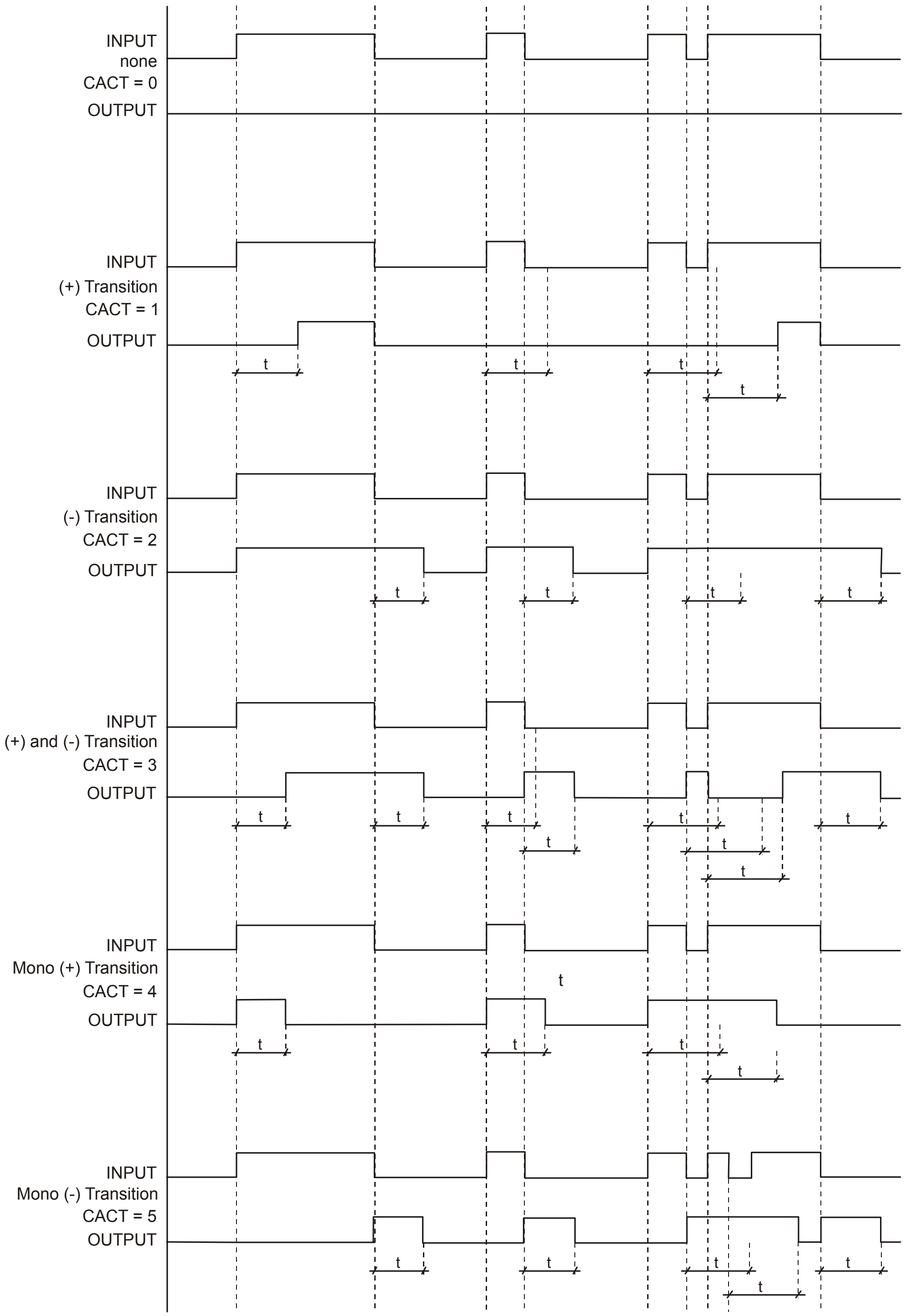
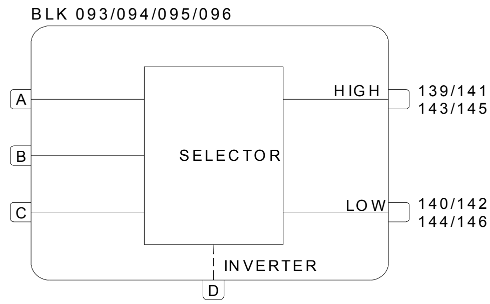


Figure - 4.25.1 CACT Parameter Graph

KEY
t = Time informed by the ADEL parameter - Delay.
INPUT = Block input.
OUTPUT = Block output.

Function 26 - High/Low Selector (H/L)



Operation

The two outputs supply the largest and the smaller value of the three inputs **A**, **B** and **C**. Any unconnected input is disregarded.

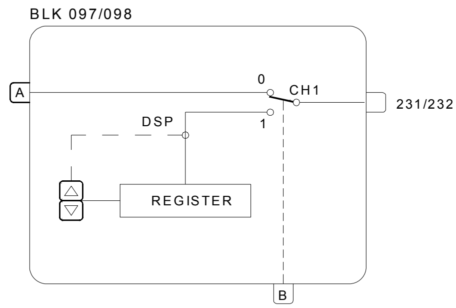
Input **D** inverts the meaning of the outputs. When **D** is at high logic level, the first output supplies the lower value and the second, the higher.

The inputs and outputs of this block may range from -102.00 to +102.00%.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170/225 to 240	0
I	LIB	Input B		0
I	LIC	Input C		0
I	LID	Input D - Inverts the meaning of the outputs		0

Number of Bytes per Type of Parameter: A = 0 C = 0 L = 8

Function 27 - Internal/External Selector (SSEL)



Operation

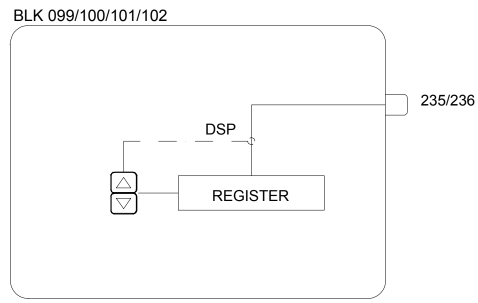
When the switch CH1 is at the position "0", the signal from input **A** goes directly to the output. When CH1 is switched to position "1" through a high logic level signal at input **B**. This switching is balanced, i.e., the last value of input **A** goes to the register, which takes over the output of the block. The output can then be activated by the <Δ> and <∇> keys, as long as the output of this block is selected to be indicated on the front panel display.

The input and output of this block may range from -102.00 to +102.00%.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses	0
I	LIB	Input B - Switches CH1	0 to 170/225 to 240	0
P	ASPD	Register Actuation Speed	0.00%/s to 200.00%/s	10.00%/s
P	ALOW	Lower Register Limit	-102.00% to 102.00%	0.00%
P	AUPP	Upper Register Limit	-102.00% to 102.00%	100.00%

Number of Bytes per parameter: A = 6 C = 0 L = 4

Function 28 - Constant Adjuster (ADJ)



Operation

This block contains a register which can have its value changed by the <Δ> and <∇> keys, as long as one of the following two conditions is fulfilled:

a) The block output is connected to a block of **Function 06 -Loop Visualization** (*BLK027* through *BLK030*) or of **Function 32 - General View** (*BLK117*) and is selected to be indicated on the front panel display.

b) The block output is connected to a block of the **Function 29 - Input Selector** (BLK103 through BLK106) or of **Function 27 - Internal/External Signal Selector** (*BLK097* through *BLK098*), whose internal switch guides the register signal directly to its output. This output must be connected to any of the visualization blocks mentioned in item a), and must be selected to be indicated on the display.

The output may range from -102.00 to +102.00%. The lower limit is adjusted in the parameter **ALOW** and the upper limit in the parameter **AUPP**. The actuation speed is adjusted in the parameter **ASPD**.

There are three actuation forms:

1) **CTYP=0 Continuous Actuator**
The output is changed by the <Δ> and <∇> keys, with continuous increment/decrements of 0.01%. The maximum changing speed is adjusted by **ASLW**. The output will range from the lower limit (**ALOW**) to the upper limit (**AUPP**).

2) **CTYP=1 Discrete Command Type Switch**
The keys <Δ> and <∇> act as a push-button station.
<Δ> - Put the value adjusted in **AUPP**, e.g., 100%, in the block output
<∇> - Put the value adjusted in **ALOW**, e.g., 0%, in the block output

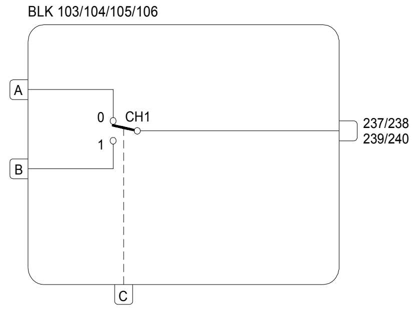
3) **CTYP=2 Discrete Command Type Push-Button**
When <Δ> is pressed, the output signal goes to the Upper Register Limit (**AUPP**) (normally 100%).

When <Δ> is released, the output signal returns to the Lower Register Limit (**ALOW**) (normally 0%).

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	CTYP	Actuation Type	0 - Analog Value 1 - Binary Command 2 - Push Button	0
P	ASPD	Register Actuation Speed	0.00%/s to 200.00%/s	10.00%/s
P	ALOW	Lower Register Limit	-102.00% to +102.00%	0.00%
P	AUPP	Upper Register Limit	-102.00% to +102.00%	100.00%

Number of Bytes per Type of Parameter: A = 6 C = 2 L = 0

Function 29 - Input Selector (ISEL)



Operation

This block selects one of the two inputs to be the output signal, by means of switch CH1. The switch is activated by a high logic level at input **C**.

The inputs and the output may range from -102.00 to +102.00%. A high logic level at C switches CH1 to position "1".

It is possible to lock the switch in position "0" with the parameter **CLCK**.

If the block output is linked to a visualization block (**Front View or General View**), any register actuator linked to either one of the block inputs, can be actuated as it would be, if it were directly linked to the visualization block. An example where that applies is shown in Figure 4.29.1.

EXAMPLE:

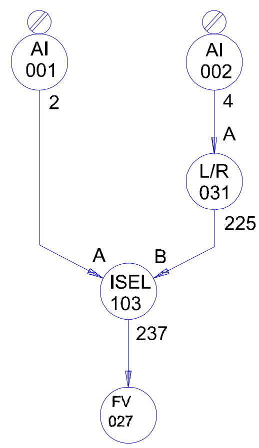


Fig 4.29.1 - Control Loop with two-setpoint actuators

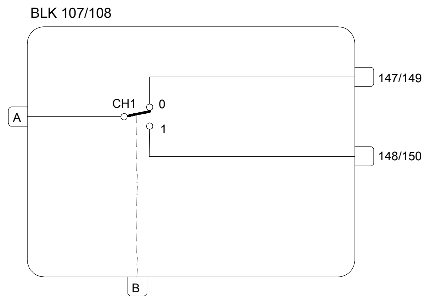
In that configuration, if the switch CH1 of the block 103 is at position "0", the register actuator cannot be actuated.

But if CH1 is at position "1" and the block 031 is in Local mode, the register actuator of the block 031 can be actuated.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170/225 to 240	0
I	LIB	Input B		0
I	LIC	Input C - Switches CH1		0
I	CLCK	Locks switch CH1 in position 0	0 - No/1 - Yes	0

Number of Bytes per Type of Parameter: A = 0 C = 2 L = 6

Function 30 - Output Selector (OSEL)



Operation

This block directs the input signal to one of the two outputs through switch CH1. When CH1 is activated (high level at input **B**), it directs the input to output 148 or 150.

When there is an output switching, the output not selected can hold the last signal value, or it can be forced to go to 0 or 100%, as determined by parameter **CLST**.

It is possible to lock the switch at position "0" with parameter **CLCK**.

EXAMPLE:
In pH control it is after useful to freeze the input while calibrating the pH - transmitter which is a rather frequent procedure.

For this case the OSEL block can be used as a Sample-and-hold switch.

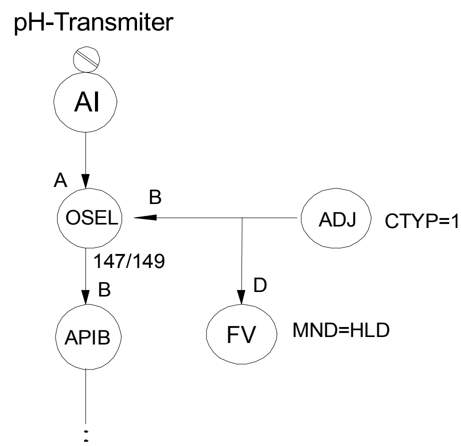


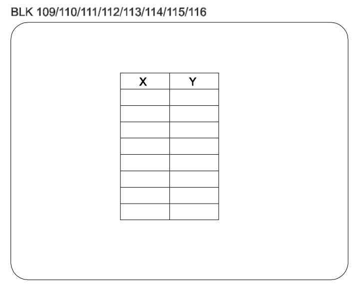
Fig 4.30.1 - L/R Selector Configuration for setpoint tracking

The ADJ block is here used to turn the hold ON or OFF, when it is OFF (OSEL block input B is low) the signal passes straight through the OSEL block, but when the OSEL block input B is high the hold function is ON and the last value remains the input to the APID block. Hence the pH - transmitter may be calibrated without disturbances.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses	0
I	LIB	Input B - Selects the output	0 to 170/225 to 240	0
I	CLST	Condition of output when not connected to the input	0 - Holds last value 1 - 0% / 2 - 100%	0
I	CLCK	Locks switch CH1 in position 0	0 - No/1 - Yes	0

Number of Bytes per Type of Parameter: A = 0 C = 4 L = 4

Function 31 - Linearization Curve (PNT)



Operation

The function of these blocks is to store pairs X, Y for the curves used in the following blocks:

Function 01 - Analog Input

Function 14 - Linearization Curve

Function 21 - Setpoint Generator

Function 09 - Advanced PID Controller (Adaptative Gain)

As the same curve may be used by different blocks of different loops, it must be allocated in the General Loop (Loop G).

Each block contains 13 points, defined through pairs X, Y. The curve is determined by these points interconnected by straight segments.

If a curve requires more than 13 points, the blocks can be grouped as shown in Table 4.31.1.

For example, a Setpoint Generator requires a curve with 70 points. The Setpoint Generator block has an option that groups 6 blocks. That will give 6 x 13=78 points.

When more than one block is used to represent a curve, the first portion of the curve is defined by the first block, the following section by the second and so on.

<table>
<tr><th>CURVE</th><th>DEFINED BY PAIRS X, Y IN BLOCK#</th><th>No. OF POINTS</th></tr>
<tr><td>1</td><td>109</td><td rowspan="8">13</td></tr>
<tr><td>2</td><td>110</td></tr>
<tr><td>3</td><td>111</td></tr>
<tr><td>4</td><td>112</td></tr>
<tr><td>5</td><td>113</td></tr>
<tr><td>6</td><td>114</td></tr>
<tr><td>7</td><td>115</td></tr>
<tr><td>8</td><td>116</td></tr>
<tr><td>9</td><td>109 + 110</td><td rowspan="4">26</td></tr>
<tr><td>10</td><td>111 + 112</td></tr>
<tr><td>11</td><td>113 + 114</td></tr>
<tr><td>12</td><td>115 + 116</td></tr>
<tr><td>13</td><td>109 to 112</td><td rowspan="2">52</td></tr>
<tr><td>14</td><td>113 to 116</td></tr>
<tr><td>15</td><td>109 to 114</td><td>78</td></tr>
<tr><td>16</td><td>109 to 116</td><td>104</td></tr>
</table>

Table 4.31.1 - Linearization Curves

EXAMPLE:
A Setpoint Generator with the following pattern:

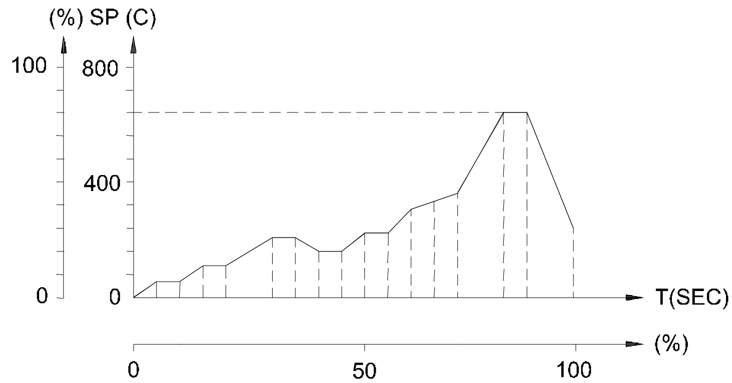


Fig 4.31.1 - Pattern for setpoint generator

In order to represent this curve of 17 points, two blocks are necessary. If the Setpoint Generator block is configured with **CLIN=9**, the blocks 109 and 110 shall be configured as shown on the Table 4.31.2.

POINT No.	T (X)	SP (Y)	BLOCK
1	0	0	BLK 109
2	5	5	
3	10	5	
4	15	10	
5	20	10	
6	30	20	
7	35	20	
8	40	15	
9	45	15	
10	50	25	
11	55	25	
12	60	30	
13	65	33	
14	72	42	BLK110
15	80	80	
16	90	80	
17	100	25	
18	102	25	

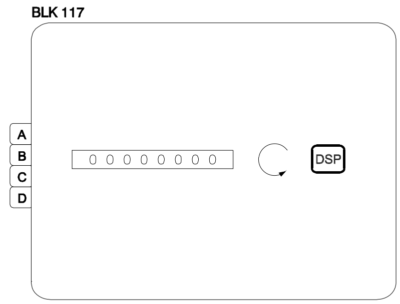
Table 4.31.2 - Points of the Curve

It is recommended to program the last point of the curve with the maximum value possible for the input (X). To be in the safe side, it is good to program the last X with 102% and the last Y with the appropriate value.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
P	AX01	X1	-300.00 to +300.00%	0.00%
P	AY01	Y1	-300.00 to +300.00%	0.00%
P	AX02	X2	-300.00 to +300.00%	5.00%
P	AY02	Y2	-300.00 to +300.00%	5.00%
P	AX03	X3	-300.00 to +300.00%	10.00%
P	AY03	Y3	-300.00 to +300.00%	10.00%
P	AX04	X4	-300.00 to +300.00%	15.00%
P	AY04	Y4	-300.00 to +300.00%	15.00%
P	AX05	X5	-300.00 to +300.00%	20.00%
P	AY05	Y5	-300.00 to +300.00%	20.00%
P	AX06	X6	-300.00 to +300.00%	25.00%
P	AY06	Y6	-300.00 to +300.00%	25.00%
P	AX07	X7	-300.00 to +300.00%	30.00%
P	AY07	Y7	-300.00 to +300.00%	30.00%
P	AX08	X8	-300.00 to +300.00%	35.00%
P	AY08	Y8	-300.00 to +300.00%	35.00%
P	AX09	X9	-300.00 to +300.00%	40.00%
P	AY09	Y9	-300.00 to +300.00%	40.00%
P	AX10	X10	-300.00 to +300.00%	45.00%
P	AY10	Y10	-300.00 to +300.00%	45.00%
P	AX11	X11	-300.00 to +300.00%	50.00%
P	AY11	Y11	-300.00 to +300.00%	50.00%
P	AX12	X12	-300.00 to +300.00%	55.00%
P	AY12	Y12	-300.00 to +300.00%	55.00%
P	AX13	X13	-300.00 to +300.00%	105.00%
P	AY13	Y13	-300.00 to +300.00%	105.00%

Number of Bytes per Type of Parameter: A = 52 C = 0 L = 0

Function 32 - General Visualization (GV)



Operation

This block is used to display variables common to all loops configured. The variables connected to A, B, C and D of this block will be on the display of any loop, in the scroll sequence after the variables of that particular loop. Therefore this block must always work associated to a loop visualization block.

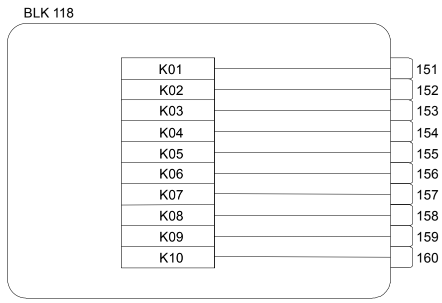
As it is common to more than one loop, it must be configured in the General Loop (Loop G).

The variables are shown on the display, in engineering units, and with a programmable 3-character mnemonic.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A	Addresses 0 to 170 / 225 to 240	0
I	LIB	Input B		0
I	LIC	Input C		0
I	LID	Input D		0
M	AMNA	Mnemonic for A	***	VGA
R	A-AZ	0% for input A in engineering units	-10000 to +10000	0
R	A-AM	100% for input A in engineering units	-10000 to +10000	100.00
M	AMNB	Mnemonic for B	***	VGB
R	A-BZ	0% for input B in engineering units	-10000 to +10000	0
R	A-BM	100% for input B in engineering units	-10000 to +10000	100.00
M	AMNC	Mnemonic for C	***	VGC
R	A-CZ	0% for input C in engineering units	-10000 to +10000	0
R	A-CM	100% for input C in engineering units	-10000 to +10000	100.00
M	AMND	Mnemonic for D	***	VGD
R	A-DZ	0% for input D in engineering units	-10000 to +10000	0
R	A-DM	100% for input D in engineering units	-10000 to +10000	100.00

Number of Bytes per Type of Parameter: A = 48 C = 0 L = 8

Function 33 - Constants (K)



Operation

This block generates a constant value to be used at any point of the configuration. As the same constant may be used in more than one loop, this block must be configured in the General Loop (Loop G). It has ten adjustable constants, each one being available at one output. These outputs can be connected to blocks located in any loop.

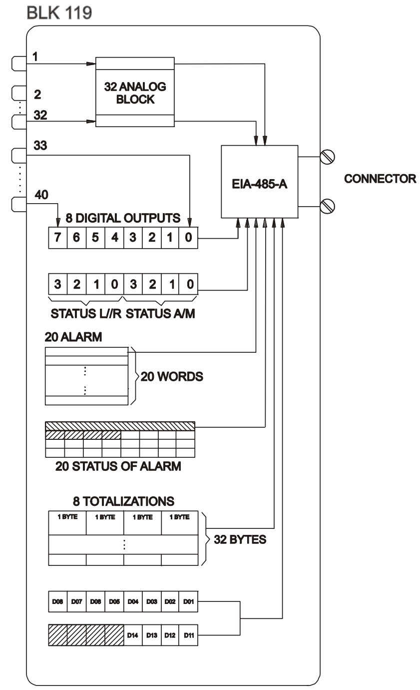
This block should be used when it is necessary to generate a constant value for the other blocks of the configuration. An example of this type of application is a process which demands that the controller output should go to 10% when a digital signal changes from Low to high logic level.

The constant value 10% can be adjusted in **AK01** of this block and its output (151) connected to the input **B** of a block of the **Function 08 - Automatic/Manual Station**. The digital signal is connected to input **C** of the A/M block.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
P	AK01	Constant K01	-300.00 to +300.00%	10.00%
P	AK02	Constant K02	-300.00 to +300.00%	20.00%
P	AK03	Constant K03	-300.00 to +300.00%	30.00%
P	AK04	Constant K04	-300.00 to +300.00%	40.00%
P	AK05	Constant K05	-300.00 to +300.00%	50.00%
P	AK06	Constant K06	-300.00 to +300.00%	60.00%
P	AK07	Constant K07	-300.00 to +300.00%	70.00%
P	AK08	Constant K08	-300.00 to +300.00%	80.00%
P	AK09	Constant K09	-300.00 to +300.00%	90.00%
P	AK10	Constant K10	-300.00 to +300.00%	100.00%

Number of Bytes per Type of Parameter: A = 20 C = 0 L = 0

Function 34 - Scan (SCN)



Operation

This block is used for the digital communication. As it deals with variables of more than one loop, it must be allocated in the General Loop (LOOP G).

This block enables the selection of analog or digital variables used in the **CD600** configuration and makes them accessible by the digital communication bus.

The variables can be classified into five groups:

I. ANALOG VARIABLES

Up to 32 analog variables can be allocated in this group, chosen freely among the outputs of the blocks used in a configuration. These variables are defined by the linking parameters **LI01** through **LI32**, and contain the output addresses of the blocks of the respective variables. For example, **LI01=**2 means that the analog input 1 is accessible for the communication bus at **LI01**.

Each variable is reported in a word form.

The digital communication reads the **Linking Parameters** in sequence. When the scan reaches a **LIxx** Parameter with zero (0), the scan of the analog block outputs is interrupted.

II. DIGITAL VARIABLES

Up to eight digital output signals can be allocated to this group, chosen freely among the outputs with digital interpretation of the blocks used in the current configuration. These digital outputs are defined by the linking parameters **LI33** through **LI40**. The status of the blocks Local/Remote and Auto/Manual are specified in the block for digital communication (*BLK121*) of **Function 36 - Actuation**.

Each variable is reported in a bit form.

III. STATUS AND ALARM LIMITS

Up to 20 alarm points, with their respective limits, can be allocated in this group.

Status will be reported in bit form and alarm limits in word form.

The reading sequence of the alarms is defined in the Actuation block (*BLK121*), by the parameters **AL01** through **AL20**.

IV. TOTALIZATIONS

The eight totalizations corresponding to the blocks of **Function 18 - "Totalization"** and **Function 19 - Pulse Input** are allocated in this group.

It is not necessary to list the totalization parameters. They will be included in the digital communication automatically, in the same order they appear in the configuration.

The Pulse Input block has two totalization registers. The totalization register occupies 4 bytes.

V. DIGITAL INPUTS AND OUTPUTS

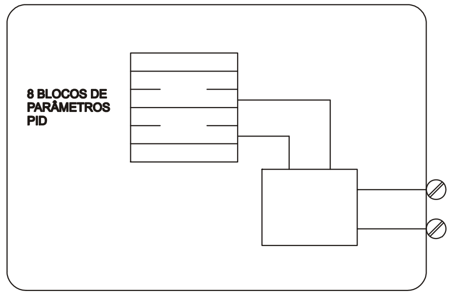
The status of the four inputs and the eight digital outputs, in a fixed order, are located in this group.

They are represented in bit form, and are not necessary to list.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LI01	Address of analog block output	Addresses 0 to 170/225 to 240	0
I	LI02	Address of analog block output		0
I	LI03	Address of analog block output		0
I	LI04	Address of analog block output		0
I	LI05	Address of analog block output		0
I	LI06	Address of analog block output		0
I	LI07	Address of analog block output		0
I	LI08	Address of analog block output		0
I	LI09	Address of analog block output		0
I	LI10	Address of analog block output		0
I	LI11	Address of analog block output		0
I	LI12	Address of analog block output		0
I	LI13	Address of analog block output		0
I	LI14	Address of analog block output		0
I	LI15	Address of analog block output		0
I	LI16	Address of analog block output		0
I	LI17	Address of analog block output		0
I	LI18	Address of analog block output		0
I	LI19	Address of analog block output		0
I	LI20	Address of analog block output		0
I	LI21	Address of analog block output		0
I	LI22	Address of analog block output		0
I	LI23	Address of analog block output		0
I	LI24	Address of analog block output		0
I	LI25	Address of analog block output		0
I	LI26	Address of analog block output		0
I	LI27	Address of analog block output		0
I	LI28	Address of analog block output		0
I	LI29	Address of analog block output		0
I	LI30	Address of analog block output		0
I	LI31	Address of analog block output		0
I	LI32	Address of analog block output		0
I	LI33	Address of logic level block output	Addresses 0 to 170/225 to 240	0
I	LI34	Address of logic level block output		0
I	LI35	Address of logic level block output		0
I	LI36	Address of logic level block output		0
I	LI37	Address of logic level block output		0
I	LI38	Address of logic level block output		0
I	LI39	Address of logic level block output		0
I	LI40	Address of logic level block output		0
I	CBID	User free identification number		0

Number of Bytes per Type of Parameter: A = 0 C = 2 L = 80

Function 35 - Scan/Actuation Of The Parameters PID (PRM)



Operation

This block allows the actuation and reading of the parameters K_P, T_R, T_D and Bias of the PID and advanced PID blocks through the communication bus.

The order of the information in the scan communication buffer is also the order of actuation. It will be determined by the parameters **CTR1** through **CTR8**, with the values from 0 to 8, each number corresponding to a block, according to the Table 4.35.1.

0	***Interrupts the Scan***	
1	BLK039	**Function 09 Advanced PID**
2	BLK040	
3	BLK041	
4	BLK042	
5	BLK043	**Function 10 Simple PID**
6	BLK044	
7	BLK045	
8	BLK046	

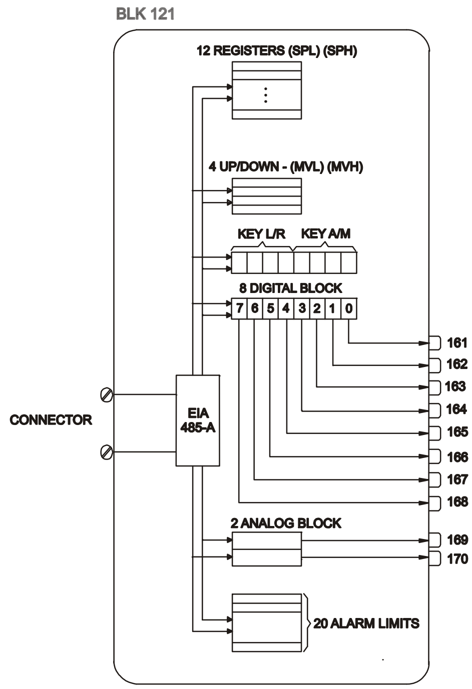
Table 4.35.1 - PID Block Corresponding numbers

If a parameter is found with the **DEFAULT** value ("0"), the scan is interrupted.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
P	CBID	User free identification number	0 - 100	0
P	CTR1	Number of 1st PID	0 - 8	0
P	CTR2	Number of 2nd PID	0 - 8	0
P	CTR3	Number of 3rd PID	0 - 8	0
P	CTR4	Number of 4th PID	0 - 8	0
P	CTR5	Number of 5th PID	0 - 8	0
P	CTR6	Number of 6th PID	0 - 8	0
P	CTR7	Number of 7th PID	0 - 8	0
P	CTR8	Number of 8th PID	0 - 8	0

Number of Bytes per Type of Parameter: A = 0 C = 18 L = 0

Function 36 - Actuation (ATU)



Operation

This block allows actuation of digital and analog variables of the **CD600** blocks by the commands received via the communication bus.

These variables are classified into 6 groups:

I. REGISTER ACTUATORS

The register actuators correspond to the keys <Δ> and <∇ > on the **CD600** front panel.

The twelve analog registers contained in the Constant Adjuster, Internal/External Signal Selector, Local/Remote SP and Setpoint Generator blocks are defined by the parameters **CR01** through **CR12**. In order to establish the actuation sequence, the **CRxx** parameters must be set with the numbers corresponding to the blocks as shown in Table 4.36.1.

<table>
<tr><th>CR</th><th>BLOCK No.</th><th>BLOCK NAME</th></tr>
<tr><td>0</td><td>BLK031</td><td rowspan="4">Function 07
Local/Remote SP Selector</td></tr>
<tr><td>1</td><td>BLK032</td></tr>
<tr><td>2</td><td>BLK033</td></tr>
<tr><td>3</td><td>BLK034</td></tr>
<tr><td>4</td><td>BLK075</td><td rowspan="2">Function 21
Setpoint Generator</td></tr>
<tr><td>5</td><td>BLK076</td></tr>
<tr><td>6</td><td>BLK097</td><td rowspan="2">Function 27
Internal/External Signal
Selector</td></tr>
<tr><td>7</td><td>BLK098</td></tr>
<tr><td>8</td><td>BLK099</td><td rowspan="4">Function 28
Constant Adjuster</td></tr>
<tr><td>9</td><td>BLK100</td></tr>
<tr><td>10</td><td>BLK101</td></tr>
<tr><td>11</td><td>BLK102</td></tr>
</table>

Table 4.36.1 - Block Corresponding numbers for CR Parameters

II. AUTO MANUAL KEYS
The actuation sequence for the A/M stations is established by the parameters **CMV1** through **CMV4**. These parameters are used for both analog (increase and decrease) and digital (Automatic/Manual) signals.

The blocks corresponding numbers are given in Table 4.36.2.

CMV	BLOCK No.	BLOCK NAME
0	BLK035	**Function 08 A/M Station**
1	BLK036	
2	BLK037	
3	BLK038	

Table 4.36.2 - A/M Block Corresponding numbers for CMV Parameters

III. LOCAL/REMOTE KEYS
The actuation sequence of the digital (Local/Remote) signals of the L/R SP Selector blocks is established by the parameters CLR1 through CLR4. The Table 4.36.3 shows numbers related to the blocks.

IV. DIGITAL VARIABLES
Up to eight digital signals can be accessed via the communication bus. These variables are available at the gates 161 through 168, and can be used by any block of the configuration.

Remember that the digital actuation of the L/R and A/M front panel keys is done through parameters CLRx and CMVx, respectively.

Representation of digital variables is in bit form.

V. ANALOG VARIABLES
Up to two analog variables can be received in this group. They are available at the outputs 169 and 170, and can be used by any block of the configuration.

Representation is in word form.

VI. ALARM LIMITS
The commands for actuation on the individual alarm limits can be received in this group, in the sequence determined in the parameters AL01 through AL20. The selection range of these parameters is from 0 to 20, as shown in Table 4.36.4.

AL	BLOCK No.	BLOCK NAME	BLOCK IDENTIFICATION
0	-	**Interrupts the Scan**	-
1	BLK039	**Function 09 Advanced PID Control**	Parameter AMXD
2	BLK040		
3	BLK041		
4	BLK042		
5	BLK077	**Function 22 Double Alarm**	Parameters ARG1; ARG2
6	BLK077		
7	BLK078		
8	BLK078		
9	BLK079		
10	BLK079		
11	BLK080		
12	BLK080		
13	BLK081	**Function 23 Limiter with Alarm**	Parameters A-BL; A-BH
14	BLK081		
15	BLK082		
16	BLK082		
17	BLK083		
18	BLK083		
19	BLK084		
20	BLK084		

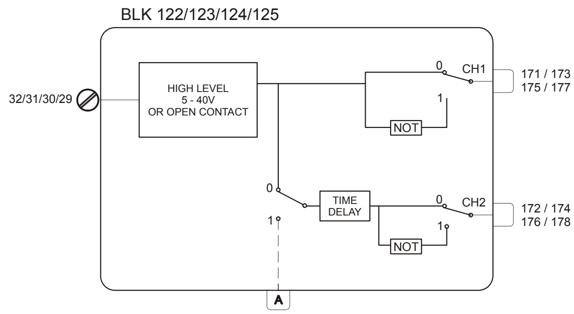
Table 4.36.4 - Alarm Corresponding numbers for AL Parameters

If a parameter is found with the **DEFAULT** value "0", the scan sequence is interrupted.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	CBID	User free identification number	0 – 100	0
I	CR01	Number of 1st register	0 – 11	0
I	CR02	Number of 2nd register	0 – 11	0
I	CR03	Number of 3rd register	0 – 11	0
I	CR04	Number of 4th register	0 – 11	0
I	CR05	Number of 5th register	0 – 11	0
I	CR06	Number of 6th register	0 – 11	0
I	CR07	Number of 7th register	0 – 11	0
I	CR08	Number of 8th register	0 – 11	0
I	CR09	Number of 9th register	0 – 11	0
I	CR10	Number of 10th register	0 – 11	0
I	CR11	Number of 11th register	0 – 11	0
I	CR12	Number of 12th register	0 – 11	0
I	CMV1	Number of 1st A/M Station	0 – 3	0
I	CMV2	Number of 2nd A/M Station	0 – 3	1
I	CMV3	Number of 3rd A/M Station	0 – 3	2
I	CMV4	Number of 4th A/M Station	0 - 3	3
I	CLR1	Number of 1st L/R Selector	0 - 3	0
I	CLR2	Number of 2nd L/R Selector	0 - 3	1
I	CLR3	Number of 3rd L/R Selector	0 - 3	2
I	CLR4	Number of 4th L/R Selector	0 - 3	3
I	AL01	1st Alarm	0 - 20	0
I	AL02	2nd Alarm	0 - 20	0
I	AL03	3rd Alarm	0 - 20	0
I	AL04	4th Alarm	0 - 20	0
I	AL05	5th Alarm	0 - 20	0
I	AL06	6th Alarm	0 - 20	0
I	AL07	7th Alarm	0 - 20	0
I	AL08	8th Alarm	0 - 20	0
I	AL09	9th Alarm	0 - 20	0
I	AL10	10th Alarm	0 - 20	0
I	AL11	11th Alarm	0 - 20	0
I	AL12	12th Alarm	0 - 20	0
I	AL13	13th Alarm	0 - 20	0
I	AL14	14th Alarm	0 - 20	0
I	AL15	15th Alarm	0 - 20	0
I	AL16	16th Alarm	0 - 20	0
I	AL17	17th Alarm	0 - 20	0
I	AL18	18th Alarm	0 - 20	0
I	AL19	19th Alarm	0 - 20	0
I	AL20	20th Alarm	0 - 20	0

Number of Bytes per Type of Parameter: A = 40 C = 42 L = 0

Function 37 - Digital Input with Timer Control (DIT)



Operation

If the block terminal is open (impedance > 50 KΩ) in relation to the Digital Ground or a 3 to 24 Vdc voltage, the signal will be considered as a high logic level and the value of 100% (high logic level) will be available at the output of the block.

If the input is short-circuited (impedance < 200Ω) or its voltage is between 0 and 1.7 Vdc, the signal will be considered low logic level and a 0% value on the output of the block.

This condition can be inverted by the **CNOT** parameter.

This block also offers a delay on the digital signal, as defined on the **CACT** parameter. This delay time is through the **ADEL** parameter.

TYPE	MNEM	DESCRIPTION	RANGE	DEFAULT
I	LIA	Input A		
I	CNOT	Inverse switches	0 - Direct / Direct 1 - Inverse / Direct 2 - Direct / Inverse 3 - Inverse / Inverse	0
I	CACT	Actuation type	0 - None 1 – Delay for operation (Input connector) 2 – Delay for output (Input connector) 3 – Delay for output and operation (Input connector) 4 – Monostable Positive Transition (Input connector) 5 – Monostable Negative Transition (Input connector) 6 – Delay for operation (Input A) 7 Delay for output (Input A) 8 – Delay for output and operation (Input A) 9 – Monostable Positive Transition (Input A) 10 – Monostable Negative (Input A)	0
P	ADEL	Time delay	0.01 min to 180.00 min	1.00 min

Number of Bytes per Type of Parameter:

LINK	CONF	ADJ
2	4	2

NOTE
On the online change of the **CACT** parameter, it should be **first** changed to “0” and then, to the desired value.

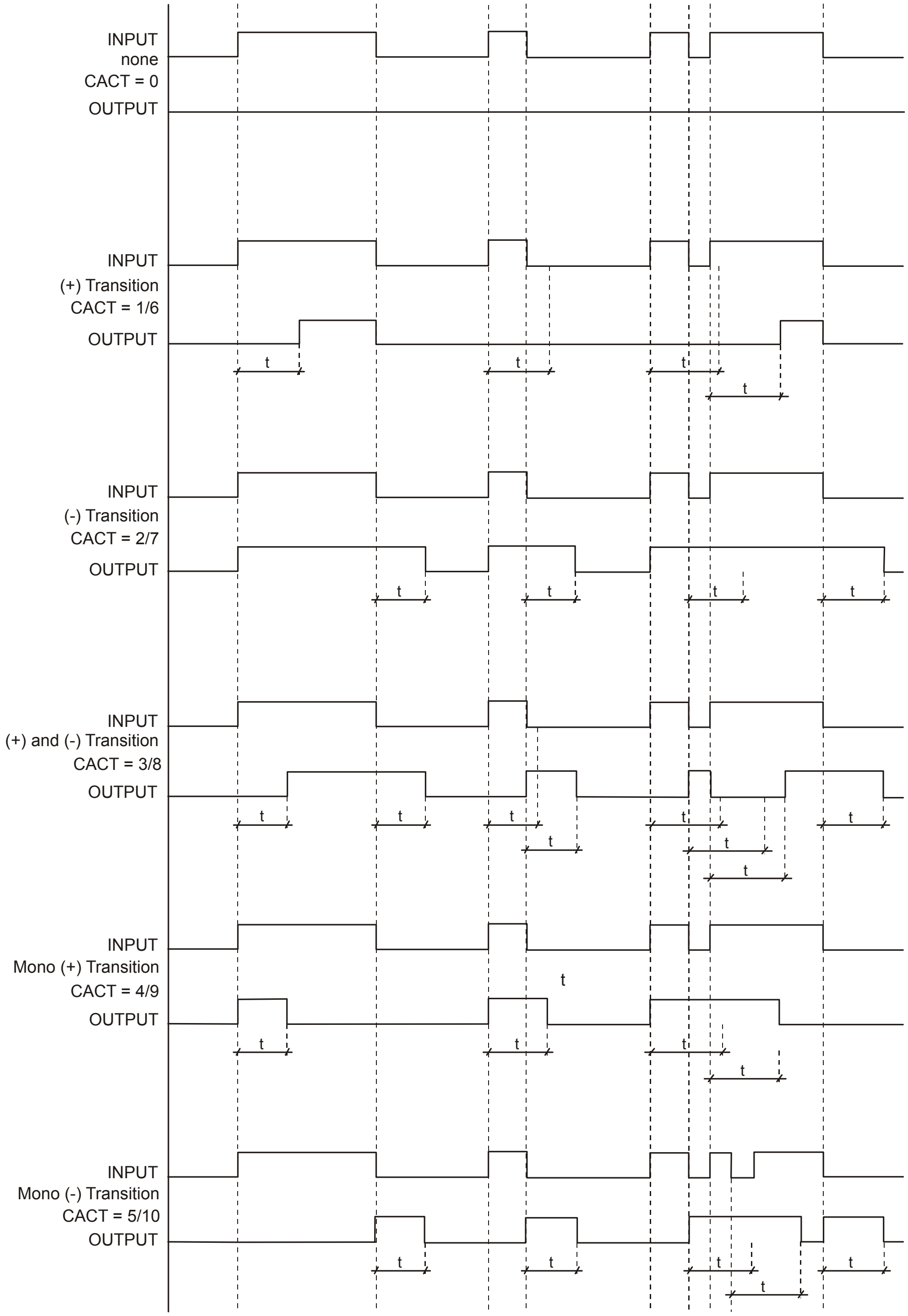
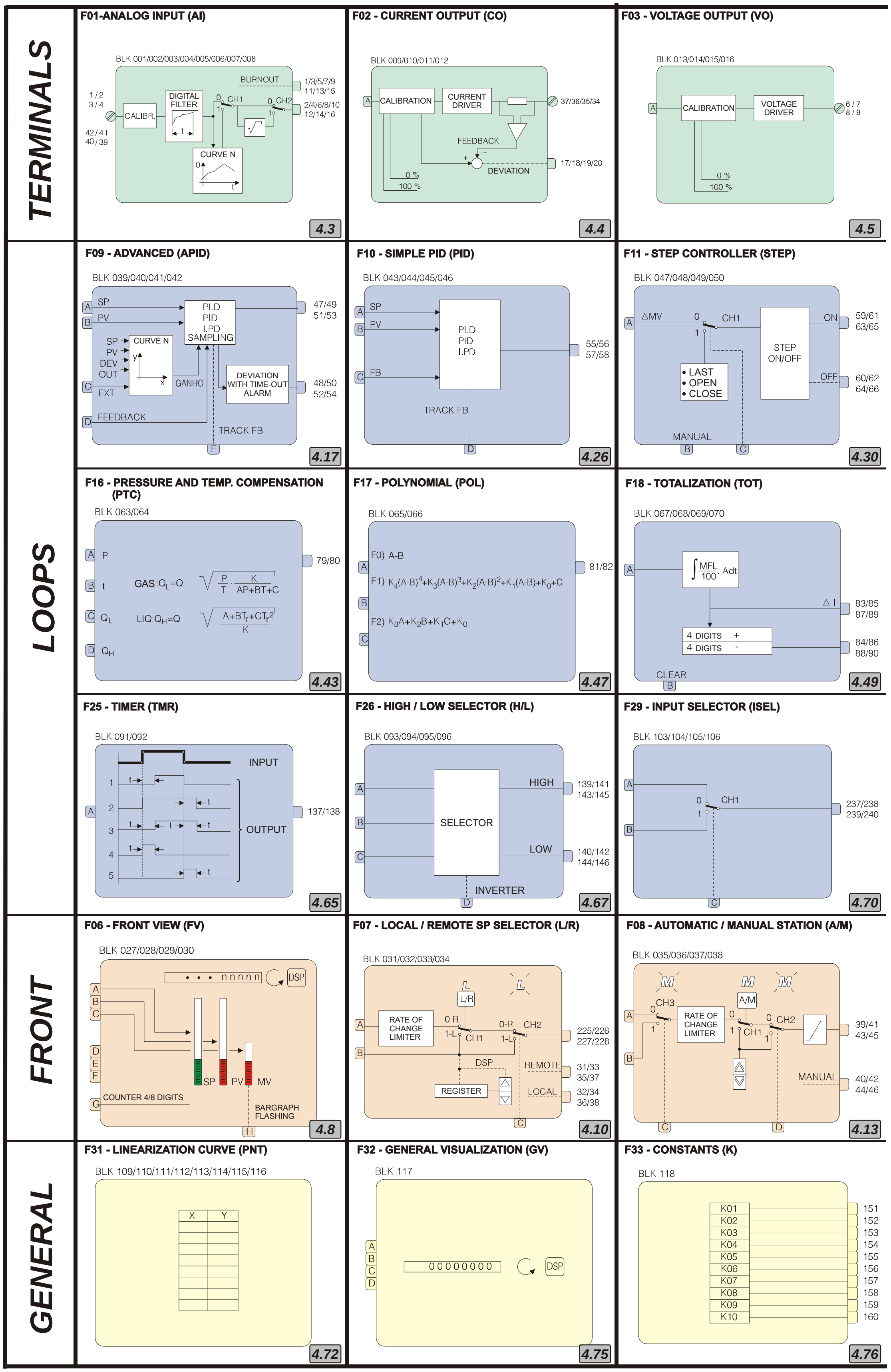


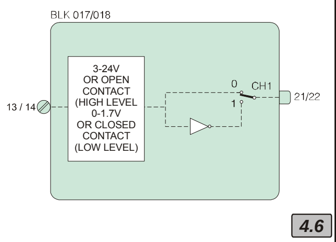
Figure - 4.37.1 CACT Parameter Graph

KEY
t = Time informed by the ADEL parameter - Delay. **INPUT =** Block input through outside terminals (ED5 to ED8), or block inout A. **OUTPUT =** Second block output. **Notes :** 1) For the graph above, the switch SW2 should bei n the 0 position. The CNOT parameter should be at value 0. 2) The first block output was not represented on the graph.

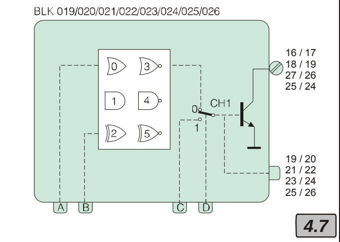
Control Function Blocks



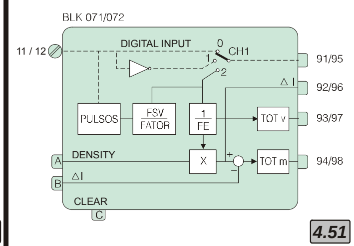
F04- DIGITAL INPUT (DI)



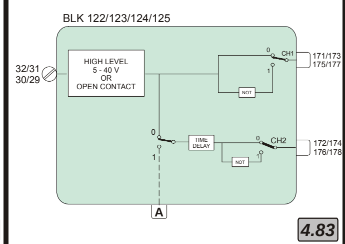
F05 - DIGITAL OUTPUT (DO)



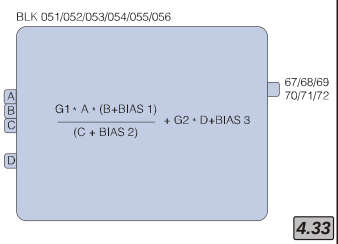
F19- PULSE TOTALIZATION INPUT (P/DI)



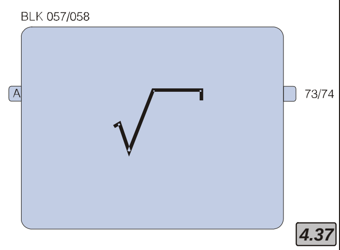
F37 - DIGITAL INPUT WITH TIMER CONTROL (DIT)



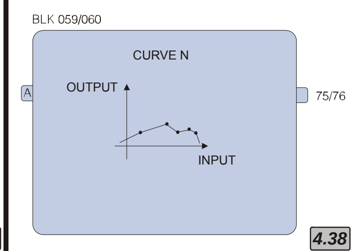
F12 - MULTIPLIER-DIVIDER-ADDER-SUBTRACTOR (ARTH)



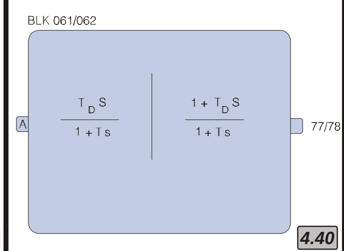
F13 - SQUARE ROOT (SQR)



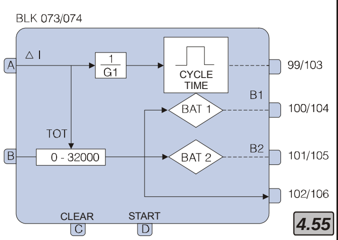
F14 - LINEARIZATION (LIN)



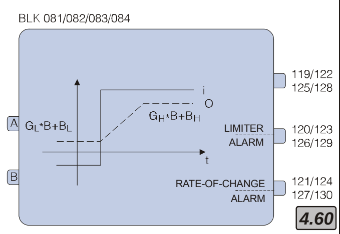
F15 - DERIVATIVE / LEAD-LAG (LL)



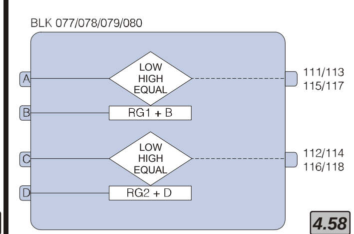
F20 - BATCH COMPARATOR (BAT)



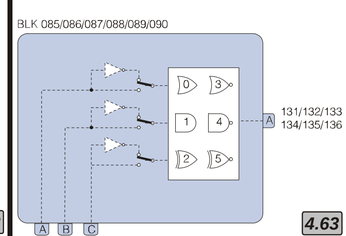
F23 - LIMITER WITH ALARM (LIMT)



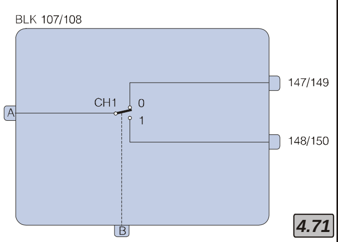
F22 - DOUBLE ALARM (ALM)



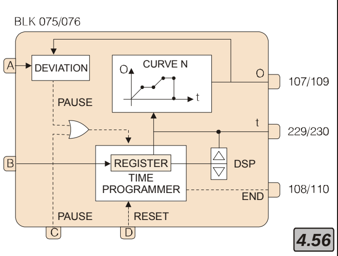
F24 - LOGIC (LOG)



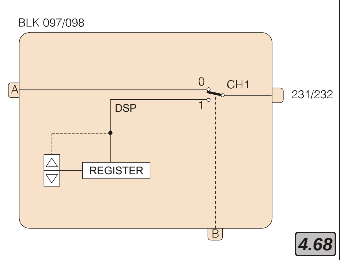
F30 - OUTPUT SELECTOR (OSEL)



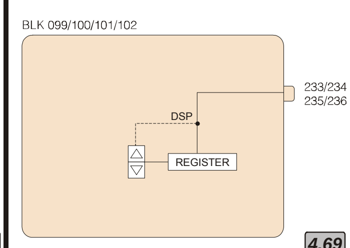
F21 - SETPOINT GENERATOR (SPG)



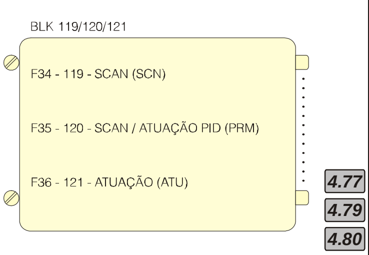
F27 - INTERNAL / EXTERNAL SELECTOR (SSEL)



F28 - CONSTANT ADJUSTER (ADJ)



COMMUNICATION



RESIDENT CONFIGURATION

A control configuration is a set of instructions which define the blocks to be used, the connections between them, their internal configuration and the required adjustments.

When the configuration is loaded in the controller, it is stored in the NVRAM (Non Volatile Random Access Memory), which is re-writable, allowing the user to change the controller configuration at any moment. If the controller is switched off, the configuration remains in the memory.

When a new configuration is downloaded to the controller, it replaces the old one.

When the **CD600 Plus** leaves the factory, a program that configures the controller to operate as a Multi-loop is stored in its NVRAM. This configuration is mostly used in process control applications and is known as “**resident configuration**”.

The configuration’s name is “4 LOOPS” and the main characteristics are:

- Execution of 4 independent control loops;

- The control block of each loop can be configured as PI.D, PID, I.PD or PI SAMPLING. These blocks can also work with adaptative gain;

- Each loop may have Local Adjustment Setpoint or Remote Setpoint for ratio control. The ratio constant may be adjusted by the front panel for each loop, independently;

- The SP, PV, MV, PV totalization ratio and present alarm messages can be seen individually in the display for each loop;

- Each loop has two points of PV alarm (high or low) and an error alarm with time out, so the actuation values are independently configurable. For each point, there is a corresponding digital output;

- For each loop, there is a manual input. When a digital input is actuated, it takes the control to manual mode. The digital inputs will be actuated, with their respective contacts open;

- Loops 1 and 2 have a dynamic Lead-Lag compensator in the feed forward control.

The other configuration characteristics can be viewed through the Functional Diagram analysis (Figure 5.1) and the block list for each of the loops (Figures 5.2 to 5.6).

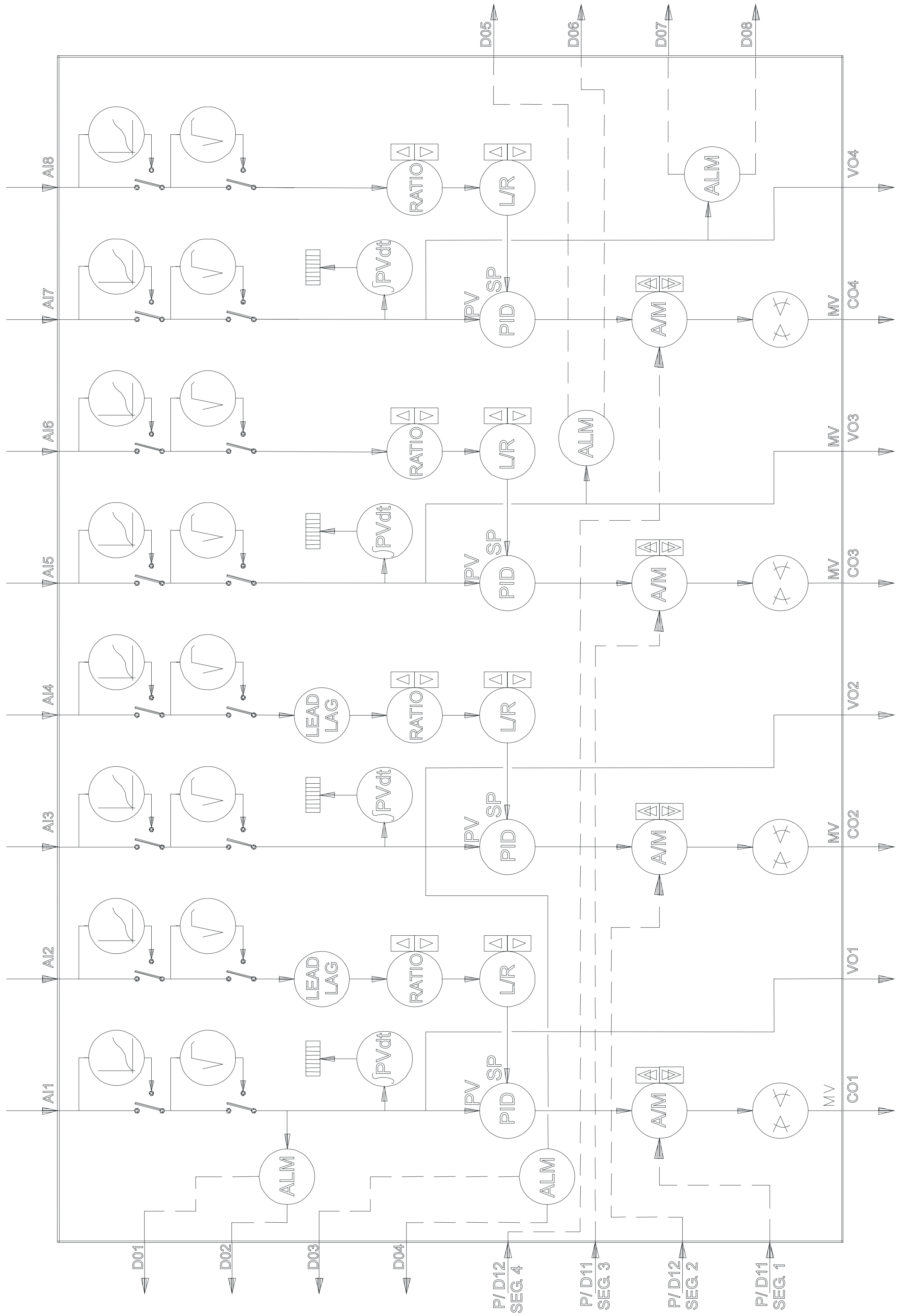
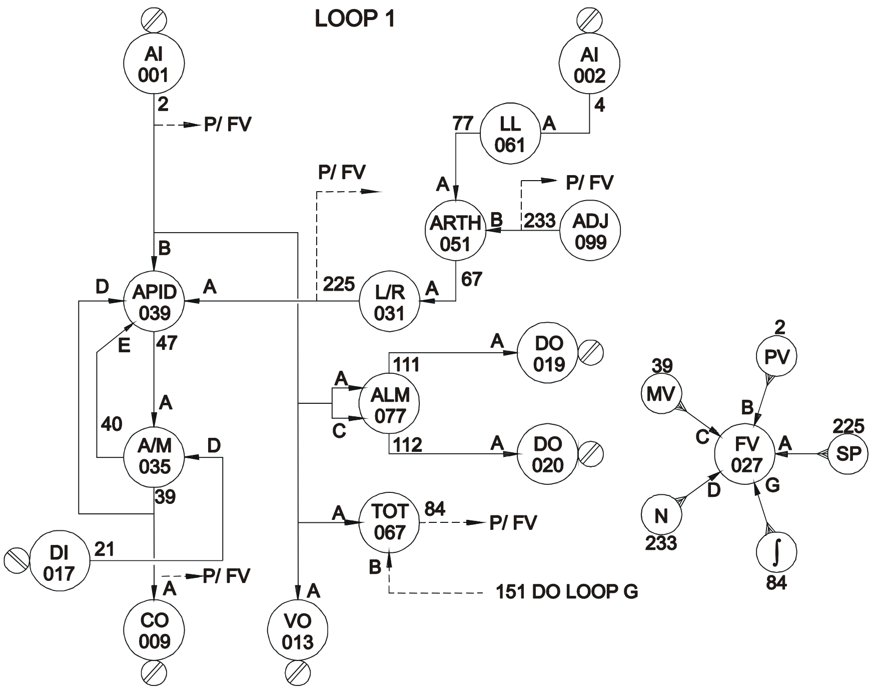
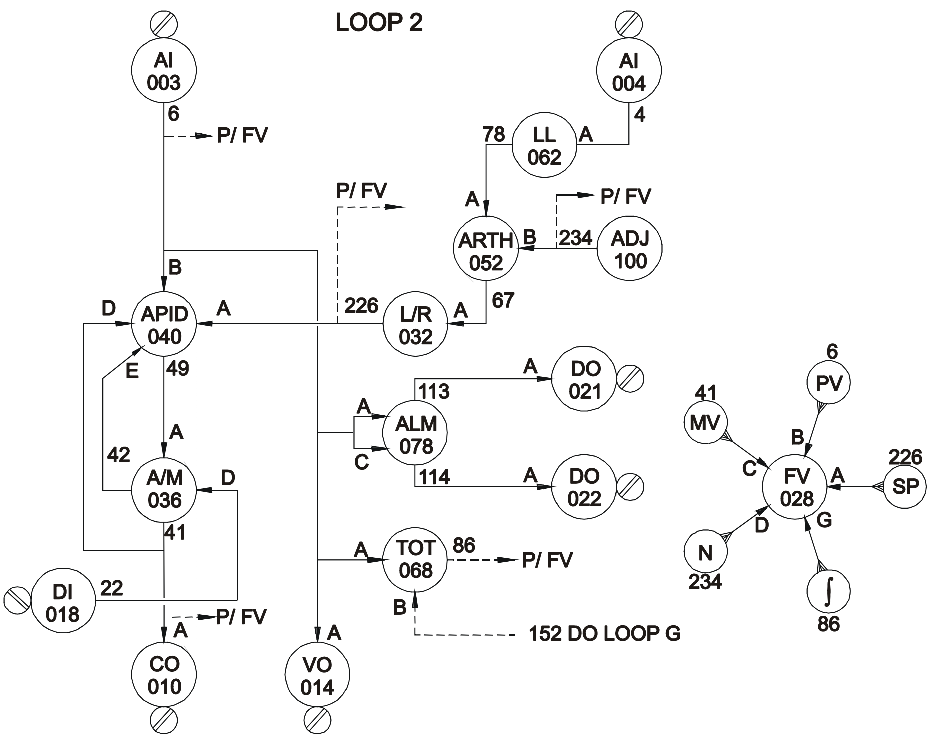


Fig 5.1 "4 LOOPS"Functional Diagram (Resident Configuration)



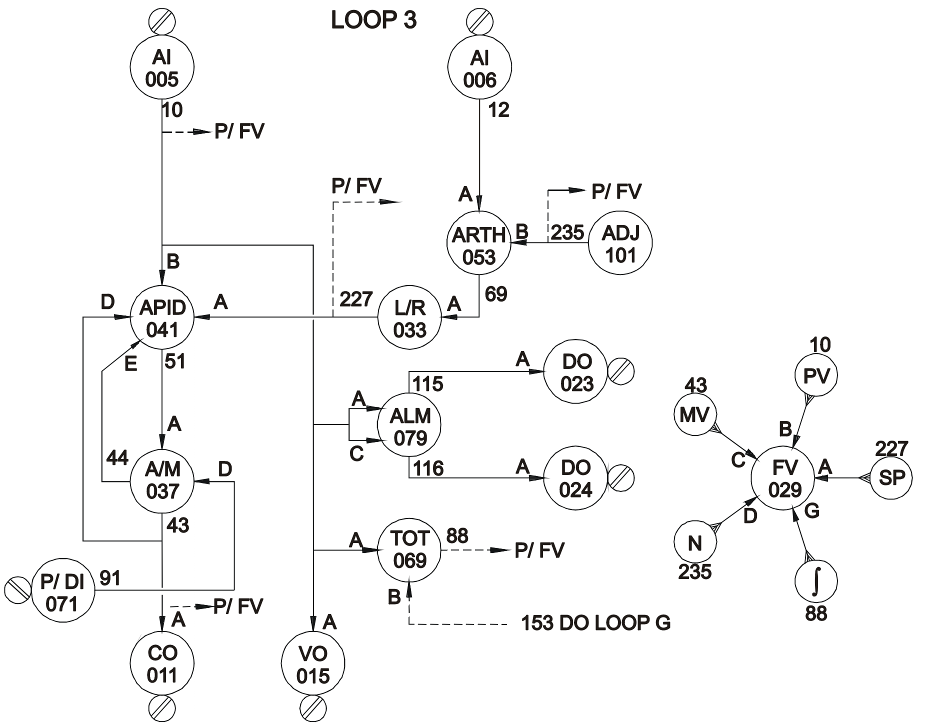
BLOCK LIST:
TAG: LOOP 1
CHANGED PARAMETERS:
BLK 001
002
061 LIA = 4
099 ALOW = 6,00%; AUPP = 60,00%
051 LIA = 77; LIB = 233; ABS2 = 20,00%
031 LIA = 67
039 LIA = 255; LIB = 2; LID = 39; LIE = 40
017 CNOT = 1
035 LIA = 47; LID = 21
009 LIA = 39
077 LIA = 2; LIC = 2; CFRT = 3
019 LIA = 111
020 LIA = 112
067 LIA = 2; LIB = 151
013 LIA = 2
027 LIA = 225; LIB = 2; LIC = 39; LID = 233;
LIG = 84; AMND = R1; ADM = 5,0000

Fig 5.2 – List of Blocks of the "4 LOOPS" Configuration - LOOP 1



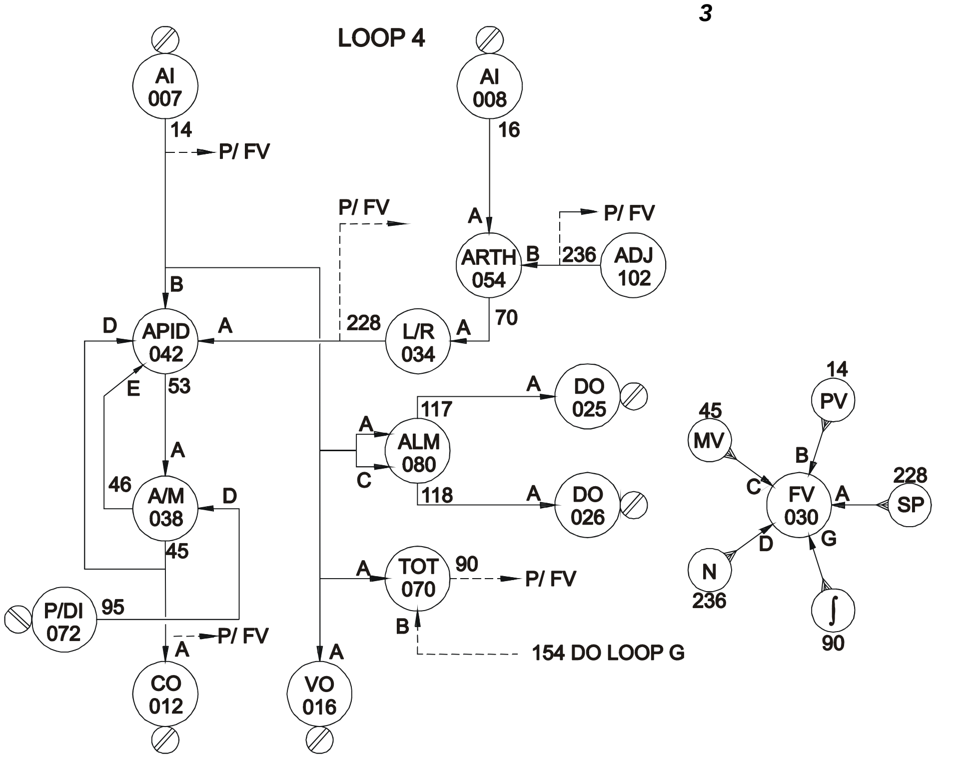
BLOCK LIST:
TAG: LOOP 2
CHANGED PARAMETERS:
BLK 003
004
062 LIA = 48
100 ALOW = 6,00%; AUPP = 60,00%
052 LIA = 78; LIB = 234; ABS2 = 20,00%
032 LIA = 68
040 LIA = 226; LIB = 6; LID = 41; LIE = 42
018 CNOT = 1
036 LIA = 49; LID = 22
010 LIA = 41
078 LIA = 6; LIC = 6; CFRT = 3
021 LIA = 113
022 LIA = 114
068 LIA = 6; LIB = 152
014 LIA = 6
028 LIA = 226; LIB = 6; LIC = 41; LID = 234;
LIG = 86; AMND = R2; ADM = 5,0000

Fig 5.3 - List of Blocks of the "4 LOOPS" Configuration "4 LOOPS - LOOP 2



LISTAGEM DE BLOCOS:
TAG: LOOP 3
PARAMETROS ALTERADOS:
BLK 005
006
101 ALOW = 6,00%; AUPP = 60,00%
053 LIA = 12; LIB = 235; ABS2 = 20,00%
033 LIA = 69
041 LIA = 227; LIB = 10; LID = 43; LIE = 44
071 CTYP = 1
037 LIA = 51; LID = 91
011 LIA = 43
079 LIA = 10; LIC = 10; CFRT = 3
023 LIA = 115
024 LIA = 116
069 LIA = 10; LIB = 153
015 LIA = 10
029 LIA = 227; LIB = 10; LIC = 43; LID = 235; LIG = 88; AMND = R3; ADM = 5,0000

Fig 5.4 List of Blocks of the "4 LOOPS" Configuration - LOOP 3



LISTAGEM DE BLOCOS:
TAG: LOOP 4
PARÂMETROS ALTERADOS:
BLK 007
008
102 ALOW = 6,00%; AUPP = 60,00%
054 LIA = 12; LIB = 236; ABS2 = 20,00%
034 LIA = 70
042 LIA = 228; LIB = 14; LID = 45; LIE = 46
072 CTYP = 1
038 LIA = 53; LID = 95
012 LIA = 45
080 LIA = 14; LIC = 14; CFRT = 3
025 LIA = 117
026 LIA = 118
070 LIA = 14; LIB = 154
016 LIA = 14
030 LIA = 228; LIB = 14; LIC = 45; LID = 236; LIG = 90; AMND = R4; ADM = 5,0000

Fig 5.5 - List of Blocks of the "4 LOOPS" Configuration - LOOP 4

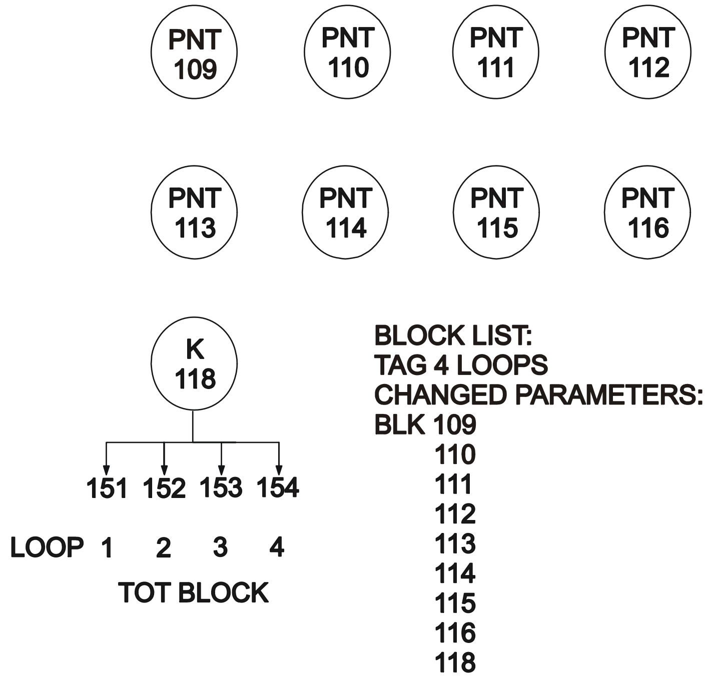


Fig 5.6 - List of Blocks of the "4 LOOPS" Configuration - LOOP G

Section 6

CALIBRATION

The **CD600 Plus** is factory calibrated according to ISO 9000 standard. If a new calibration is necessary, it can easily be executed through the **CONF600 Plus**.
The controller needs a program to read all the analog inputs that will be calibrated, and also reads and adjusts all voltage/current that will be calibrated.
The analog input signal should be linear. The square root extraction and the linearization are not allowed during the calibration. The voltage and current outputs should be a direct action signal, which is 0-100% corresponding to 0-5 V (0-20 mA) or 1-5 V (4-20 mA).
It is recommended to use a voltage/current indicator with at least 0.03% accuracy and a low oscillation voltage/current generator.

Analog Input (AI)

The analog inputs are voltage inputs of 0-5 V. With the 250 Ω shunt resistor connected, these voltage inputs are converted to current.
The Analog Input Block allows two types of input signals:

a) Dead Zero:
0-5 Vdc or 0-20 mA, corresponding to 0-100% of the block output.

b) Live Zero:
1-5 Vdc or 4-20 mA, corresponding to 0-100% of the block output.

To calibrate an analog input **J** (**J**=1 to 8), follow these steps:

a) Check whether the input to be calibrated will work with voltage or current input. If it is current, it is recommended to use the same shunt that will be used for the operation;

b) Connect the voltage/current generator as an indicator to the corresponding terminal of the J input;

c) Select the analog input block output J to be shown in the controller. Check if the square root extraction and linearization are active;

d) Connect the computer to the controller through the ICS2.0-1 interface;

e) Go to the Tool menu and click on Calibration to open the Calibration dialog box. Select the equipment addresses using the device address value and then click on the Look button in order to find the device:

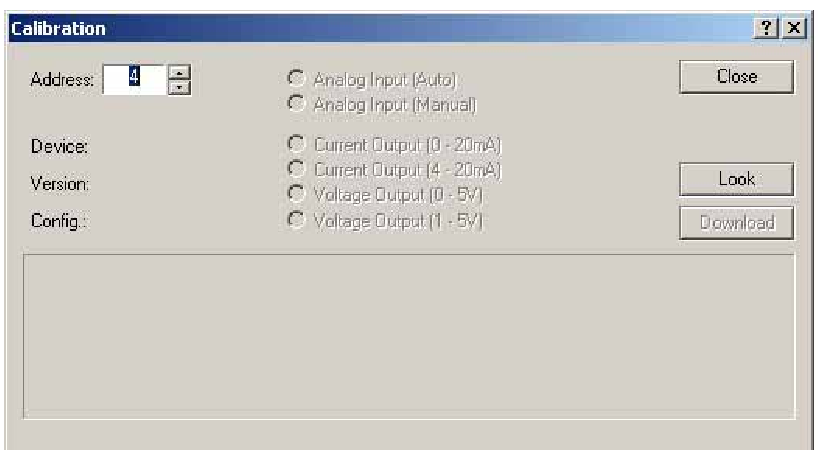


Figure 6.1. CONF600 Plus Calibration Dialog Box

The selected equipment will be shown:

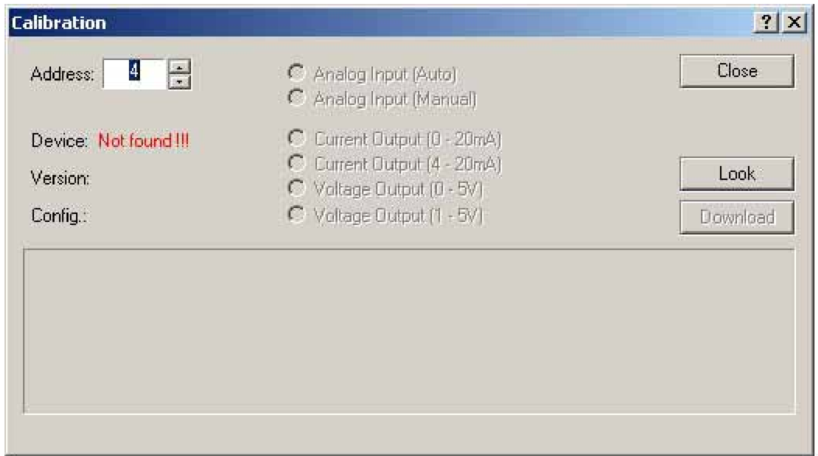


Figure 6.2 Selected Device

The controller has two options: *Automatic and Manual*. The *Automatic* mode is much faster, while the *Manual* mode allows the user to read the parameters during calibration.

Analog Input Calibration–Automatic Mode

a) Select the ***Analog Input (Auto)*** option in the *Calibration* dialog box.

b) Select the input to be calibrated, from AI1 to AI8. The background color will be changed to red.

The user can select all inputs to be calibrated at once.

c) Apply 0V or 0mA with the voltage/current generator and select the cell with the "0V" heading on the table.

d) Apply 1V or 4mA with the voltage/current generator and select the cell with the "1V" heading on the table.

e) Apply 3V or 12mA with the voltage/current generator and select the cell with the "3V" heading on the table.

f) Apply 5V or 20mA with the voltage/current generator and select the cell with the "5V" heading on the table.

Repeat these steps from ***c*** to ***f*** for the inputs to be calibrated, if the user has not selected all inputs to be calibrated at once.

Calibration of Analog Inputs - Manual Mode

This option enables the user to eventually read and write the calibration parameters. This mode is not as fast and direct as the *Automatic* mode, but it is safer.

a) Select the ***Analog Input (Manual)*** option in the *Calibration* dialog box.

b) A dialog box will open asking if the user wants the default configuration to be opened. Click *Ok* to open this configuration or *Cancel* to start a new calibration.

c) Double click on the field to be edited and the field is enabled for edition. On the 0V cell, type the new value **0** and press *Enter* on the keyboard.

d) Repeat step 3 for the cells 1V, 3V, and 5V.

NOTE

Once the parameter values are changed, the *Download* button will be enabled. This means that the default values were not downloaded for the CD600 Plus.

e) After these values are edited, click on the download button on the *Calibration* dialog box, in order to download the new values for the equipment. The following message will appear to indicate that the calibration to the device was successful:

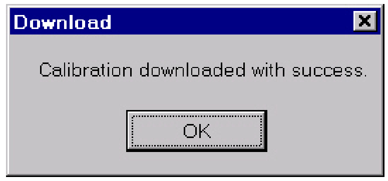


Figure 6.3 Calibrating the Equipment

NOTE
After downloading the values to the CD600 Plus, the *Download* button will be disabled, which means the default values were downloaded to the controller.

f) In front of the **CD600 Plus**, select the analog input using the <LP> key.

g) For each analog input, repeat these steps for the **AI1** execution:

i. Apply 0V or 0mA with the voltage/current generator for the AI1.

ii. Read the indicated value for AI1 in the front display of the **CD600 Plus**.

NOTE
Press <DSP> in front of the CD600 Plus to view the input values.

iii. On the Calibration dialog box , double click on the field to be changed, that corresponds to 0V and type the AI1 value read on the display.

iv. Press Enter on the keyboard and the new value will be edited. Repeat these steps for 1V or 4mA, 3V or 12mA, 5V or 20mA.

h) To select another input, connect the voltage/current generator to the desired input and repeat the steps from i to iv to calibrate all inputs.

i) After editing the values, click the item Download on the Calibration dialog box, in order to download new values for the equipment. The following message will appear to indicate that the calibration was downloaded successfully:

Figure 6.4. Calibrating the equipment

Current Output (CO)

The current output can be 4-20 mA (live zero) or 0-20 mA (dead zero). The selection done on blocks 009 to 012.
Connect the current indicator (mA) to the output that will be calibrated and select the output to be adjusted in the front panel. The program used in the controller has the current output 1 (BLK009) guided by the Loop 1 A/M station. It is possible to adjust the current output with the controller in Loop 1 and in the Manual mode.

a) Select the option ***Current Output*** (***0-20 mA*** or ***4-20 mA***) in the *Calibration* dialog box.

b) A dialog box will appear asking if the user needs to open the default configuration. Click on Ok to open this configuration or Cancel to start a new configuration.

c) Click on the output cells to apply the default values.

d) Click the download button.

e) In front of the CD600 Plus, select the outputs using the <LP> key.

f) Adjust the output values to 0% using the <∇> key in the front, and check the ammeter (that should be connected to the corresponding output of the CD600 Plus). If the value indicated is not 0 or 4mA, type the new value in the output field in the Calibration dialog box :

i. Double-click the value field, corresponding to 0%.

ii. Type the correct value read in the ammeter.

iii. Press Enter to confirm the new value.

g) Adjust the output values to 100% using the <Δ> key in the front panel and check the ammeter. If the value indicated is not 20 mA, type the new value in the output field in the Calibration dialog box :

iv. Double-click the value field, corresponding to 100%.

v. Type the correct value read in the ammeter.

vi. Press Enter to confirm the new value.

h) After editing the values, click the Download button in the Calibration dialog box in order to download these new values to the equipment. To indicate that the download was successful, the following message will appear:

Figure 6.5. Calibrating the Equipment

Voltage Output (VO)

The voltage output is calibrated as current output. The only difference is that instead of a voltmeter, an ammeter should be connected to the output to be calibrated.

Section 7

COMMUNICATION

Introduction

The data to be sent and/or received, as well as the order that it will be in the communication bus, are defined by the user through the configuration of the CD600 Plus communication blocks (blocks 119, 120 and 121).

These blocks should be placed in the configuration's loop G, and each one has a specific function:

- BLK119 (**SCAN**) – It is used to place the desired data in the communication bus. Data such as analog and/or digital outputs of any block of the configuration can be read as well as configuration, limits and alarm statuses, inputs, L/R and A/M switch status and totalizations.

- BLK 120 (**PID**) – The gain values (K_P), integral time (T_R), derivative time (T_D) and the Bias (B), of the PID blocks of the controller, can be read and changed through the communication, with the use of this block in the configuration.

- BLK 121 (**ACTUATION**) – Used to act in the controller's commands, such as, L/R and A/M transferences; change values such as SP, manual output and internal registers of the controller; changes in the alarm limits and alarm generation through analog variables and discrete signals for the controller.

Fig. 7.1 shows the information exchange between the MASTER (the supervisory, for example) and the SLAVE, that is, the controller on the bus.

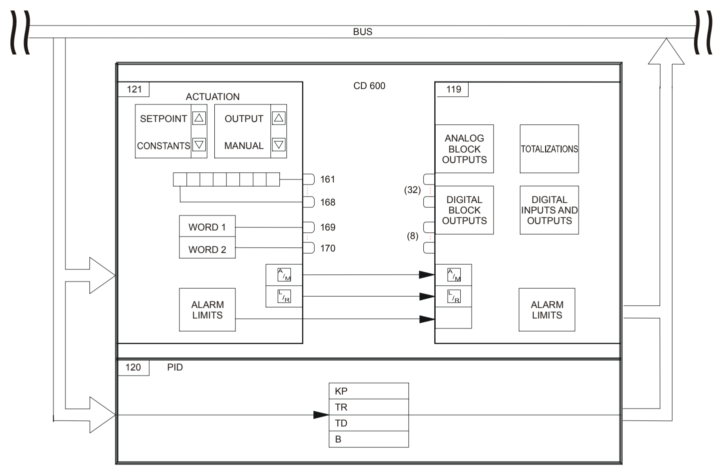


Fig 7.1 Block Communication Diagram

NOTE
In order for the MASTER to communicate with a network controller, it is necessary that on this configuration, the three communication blocks (BLK 119, 120 and 121) are present, even if any of these blocks does not contain necessary information for the communication.

Controller Address

The **CD600 Plus** has a serial communication channel in the **EIA-485-A** standard and function blocks in the software that allow the implementation of a <Master-Slave> communication.

The controllers should be connected in a multi-drop, in parallel, with a maximum number of 29 controllers per channel. Each controller on the network should have a specific address, in order to allow access by the MASTER. The procedure to address a controller is as described:

a) Hold the **<ACK>** key in front of the display, until the display changes.

b) Press **<ACK>** and **<DSP>** together, and the display will show the ID address of the **CD600 Plus**. In this point the display will be showing:

I	A					0	1

("Default" Condition)

c) Through the keys <Δ> or <∇>, change the numeric value in the display.
When the display value is "**1**", it means that the controller only accepts communication through the PDA.
Values from "**2**" to "**30**" are the addresses the controllers will assume on the serial network.

d) 20 seconds without changing the display, or pressing <LP>, the display and the keyboard will reassume regular operation.

IMPORTANT
If a controller address needs to be changed, it should be disconnected from the network. Since this change is done by single increments / decrements by the keys <Δ> and <∇>, without any confirmation, the controller will assume other controllers' addresses, causing "network collision".

Baud-Rate

The Baud-Rate adjustment of a controller is also done through the display, according to the following procedure:

a) Repeat the procedures a, b and c used in the "controller addressing".

b) Press <DSP>. To this point, the display will show:

B	R			1	9.	2	0

a) Change the baud rate value through the keys: <Δ> and <∇>.

b) Leave the keyboard and the display for 20 seconds without changing, and they will reassume regular operating functions.

Time Cycle Adjustment

INTRODUCTION
The time cycle is the time the controller needs, to execute the following functions:

- Input scan;
- Executing the block functions that belong to the configuration;
- Output scan.
- Updating the indications in the front panel and read the switches' status.
- Communicating with the PDA or the supervisory system.

The time cycle can be adjusted between 100 and 250 ms, with 5 ms intervals.

The time cycle is used in applications that demand a quick response, such as anti-surge control for air compressors.

A long time cycle is recommended for long-time rensponse processes, such as temperature controls.

For most applications, it is recommended to adjust the cycle in 200 ms, which is the default condition.

TIME CYCLE ADJUSTMENT
Follow these steps to adjust the time cycle:

1) Press <ACK> in the front panel
2) Press <DSP> until the **"CYC 0.200"** appears on the display (default condition).

C	Y	C		0	2	0	0

The LED corresponding to the cycle in the front panel, will blink every 10 controller cycles.

3) Adjust the desired value using the <▲> or <▼> keys. The time cycle can be adjusted from 100 to 250 ms.
4) Press <LP> to return to normal operation.

CHECKING THE TIME CYCLE
There are 2 ways, in case the controller has a time cycle greater than what was adjusted.

MODE A: USING THE FRONT PANEL
1. Repeat the procedures from 1 to 3 of "ADJUSTING THE TIME CYCLE ".
   The led "**CYC**" will blink every ten cycles.

2. Define a number of blinks (n) to be counted (it is recommended to use ≥10). With a chronometer, measure the time interval for the "n" blinks.

3. This way, the time cycle can be calculated using the equation below:

$$CYC = \frac{t_m}{10.n}$$

Where,

CYC = Controller time cycle (ms)
N = Number of blinks of the "**CYC**" Led.
t_m = Time interval between "n" blinks.

MODE B: USING AN OSCILLOSCOPE
1. Build a strategy with a digital output linked and parameterized as follows:

Fig. 7.2 – Configuration to check the time cycle, using an oscilloscope

2. Download this configuration to the controller.

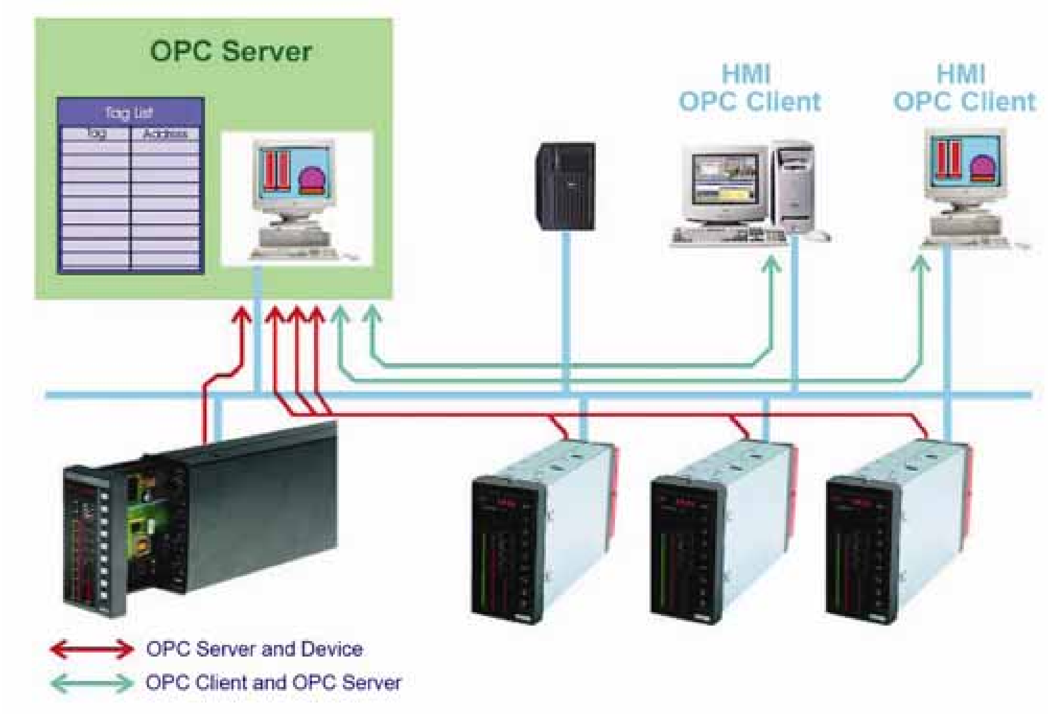
3. Measure the frequency signal on terminals 23 and 24.

OPC Supervision

Through the OPC Server the CD600s can be integrated with just about any process visualization software. Moreover, integrating auxiliary software such as autotuning, link to Office applications, statistical process control, and batch is easy. The industrially hardened ICS2.0P or any other interface converter can be used to connect the CD600 network to a PC. To connect the CD600Plus to an Ethernet network, the ENET-710 interface is available.

The CD600 OPC Server accesses the controllers on the EIA-485 network. Multiple users can simultaneously access the local server in the same workstation or remotely over the Ethernet. This enables real time data to be shared among workstations eliminating inconsistencies. All of the information in the controllers is made available to the OPC client applications.

OPC is a widely accepted industry standard client server technology for interchanging parameter values between applications. OPC eliminates the need for specific drivers for every HMI application. It opens up a wide, and fast growing, selection of auxiliary software from a vast array of suppliers. Using the OPC as a bridge, data can be exchanged with other sub-systems. The configuration tool automatically generates the communication configuration for the OPC server.



Serial Communication Network

The interface ICS2.0P replaced converting the old interface ICS2.0-1 and converts the RS232 to RS485 port of the computer to the network controller. This new converter can be mounted on DIN rail using only one slot in the rack. The converter has great improvements incorporated.

Radical changes in the controller has not been made because of its design is beyond its time, and also because the compatibility with the systems installed before an application was very important for their development. CD600 Plus is compatible with the existing engineering tools, drivers, and the HMI system Smarcom. The configurator software for the portable terminal and are able to configure the CD600.

Ethernet communication Network

The ENET-710 interface converts RS485 to Ethernet network controllers. For more details, see the manual of the ENET-710.

Section 8

TECHNICAL SPECIFICATIONS

Power Supply and Consumption

The table below specifies the maximum current values.

MODEL	SUPPLY VOLTAGE	CONSUMPTION
CD600plus A	85-264 Vac 50-60 Hz	16 VA @ 110 Vac / 10VA
CD600plus-D	20-30 Vdc	22.7 W @ 24 Vdc / 23 W @30 Vdc

Table 8.1. Power Consumption

Integral Power Supply for Transmitters

- Regulated Output Voltage: 24 V ±10%
- Maximum Output Current: 200 mA
- Short-circuit current limitation

NVRAM (Non-volatile RAM)

The data is stored in the memory built in battery. It is a non-rechargeable battery, made of Lithium, and in normal operation lasts up to 10 years of data storage.

Analog Inputs and Outputs

	Q	TYPE	LOAD/IMPEDANCE	ACCURACY
Analog input	8	4-20 mA / 0-20 mA (1)	250 Ω	± 0.010 V
		1-5 V / 0-5 V	1 MΩ	
Current Output	4	4-20 mA / 0-20 mA (2)	Max. 750 Ω	± 0.050 mA
Voltage Output	4	1-5 V / 0-5 V	Min. 1.5 KΩ	± 0.015 V (3)

NOTES:

(1) To change the current input to voltage input and vice-versa, it is necessary to remove or insert a 250 Ohm shunt resistor placed behind the panel, between the terminal bars. The position of each shunt is marked with the corresponding input number.

(2) For each tim cycle < 200 ms; the accuracy will be: □0.020V.

Digital Inputs (DI1 to DI8)

Quantity: 08
Type: Voltage or relay contact
Frequency: 0 to 10 KHz (**DI1** to **DI2**)
Accuracy: 0.05% (10 Hz < f < 10 KHz)
0.3% (1 Hz ≤ f ≤ 10 Hz)
Isolation: Optical – 5kV
Auxiliary Voltage Vext: 20-30 Vdc
Recognition of Low Logic Level "0": Closed contact with a 200Ω resistance maximum or 0 to 1.7 Vdc

Recognition of high Logic Level "1": Open contact with a 50 KΩ resistance minimum or 3 to 24 Vdc

NOTE: A "Debouncing Circuit" is necessary when a pulse input is connected to a relay (electromechanical switch). The mechanic switch will not generate an instant reset, but the millisecond oscillation caused by the input signal may cause a mis-interpretation of the relay status.

Digital Outputs (DO1 to DO8)

Quantity:	08
Type:	Open collector (max. Vext = 30 Vdc; maximum current = 400 mA)
Internal Protection:	reverse diode
Output Protection:	Independent from the overcurrent protection for each output independent; thermal protection for each output.

WARNING
Always use the "V Ext" when connecting inductive loads to the digital outputs. Refer to the connection diagrams (Figure 8.3) and for V_{EXT} (Figure 8.1). It is recommended to use "V Ext", the same way, that when an external supply is available, to prevent damage due to the overvoltage during the load switching.

NOTE: The V_{EXT} protects the transistors through parallel built in diodes conncted to the "load". See Fig. 8.1.

NOTE: Inverting the digital outputs' polarity will damage the equipment.

Digital Output to indicate the Controller Failed
If there is a failure in the main electronic board, the relay corresponding to this input will be in the closed status.

ESPECIFICATION	
Output Type	Solid-state relay, normally closed (NC), isolated
Maximum voltage	30 Vdc
Maximum current	200 mA
Overload protection	Should be provided externally
Normal operation	Contact Open
Safe condition	Contact Closed

NOTE
To meet the EMC standards requirements, the wires' length to the failure relay must be less than 30 meters. The power supply of activated load by the failure relay must not be from external network.

Remark: To protect the controller from reverse voltage damage, externally connect a snubber RC circuit in parallel with the inductive AC load, or a diode for DC load.

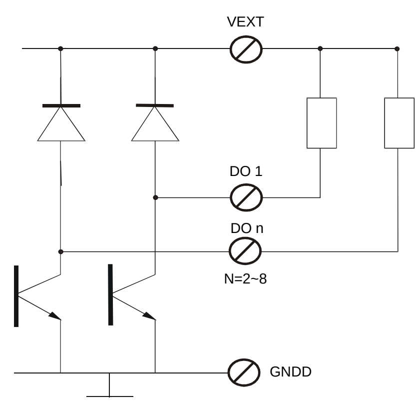


Figure 8.1. V Ext

1	+RCV+
2	+RCV-
3	GND I
4	GND
5	+5V

Figure 8.2. Communication Controller

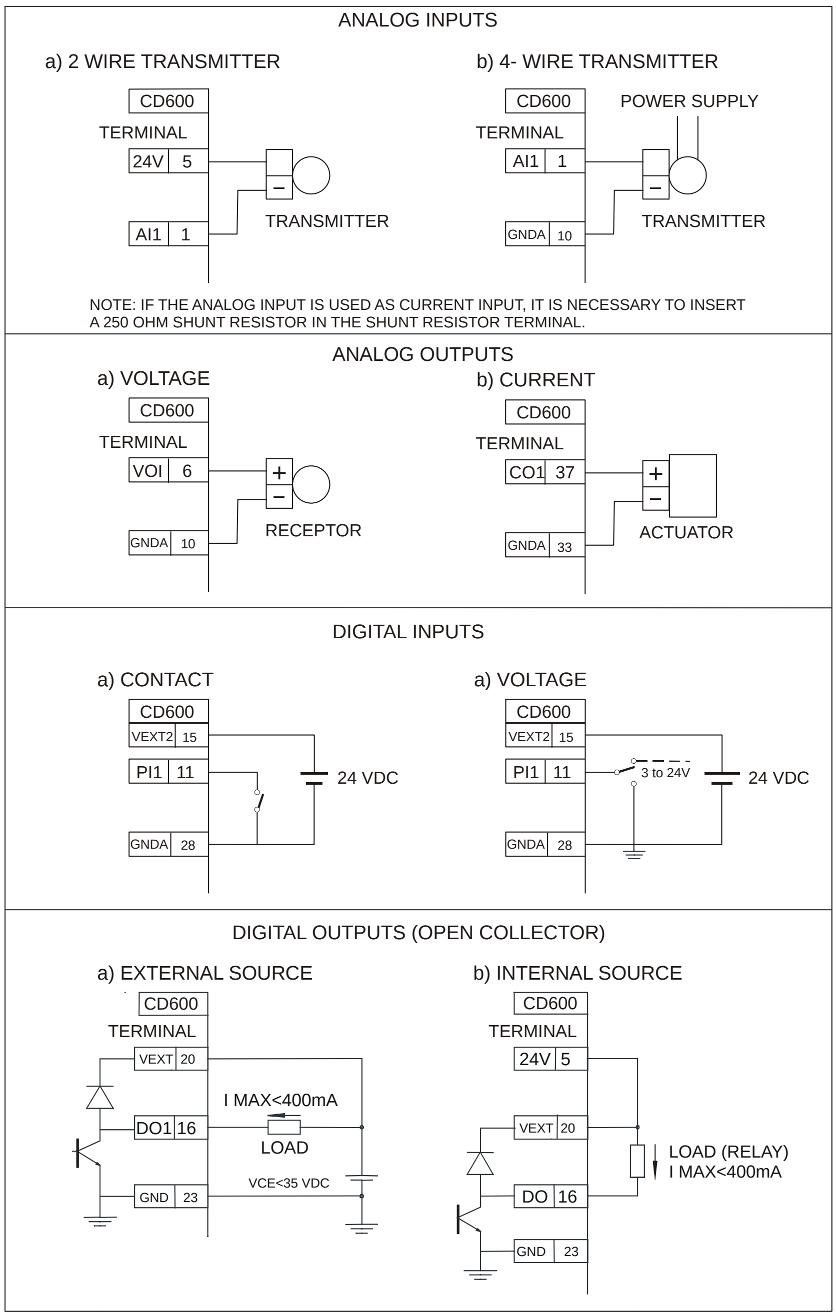


Figure 8.3. Cabling Diagram for Inputs and Outputs

Installation Conditions

Environment: 0 to 60 ºC, 5 to 90% non condensed Relative Humidity.

Front Panel

LED Bargraphs (101 points):	2
LED Bargraphs (41 points):	1
Status Indicator:	23 LEDs
Alphanumeric Display:	8 characters
Keyboard:	9 keys

Rear Panel Diagram

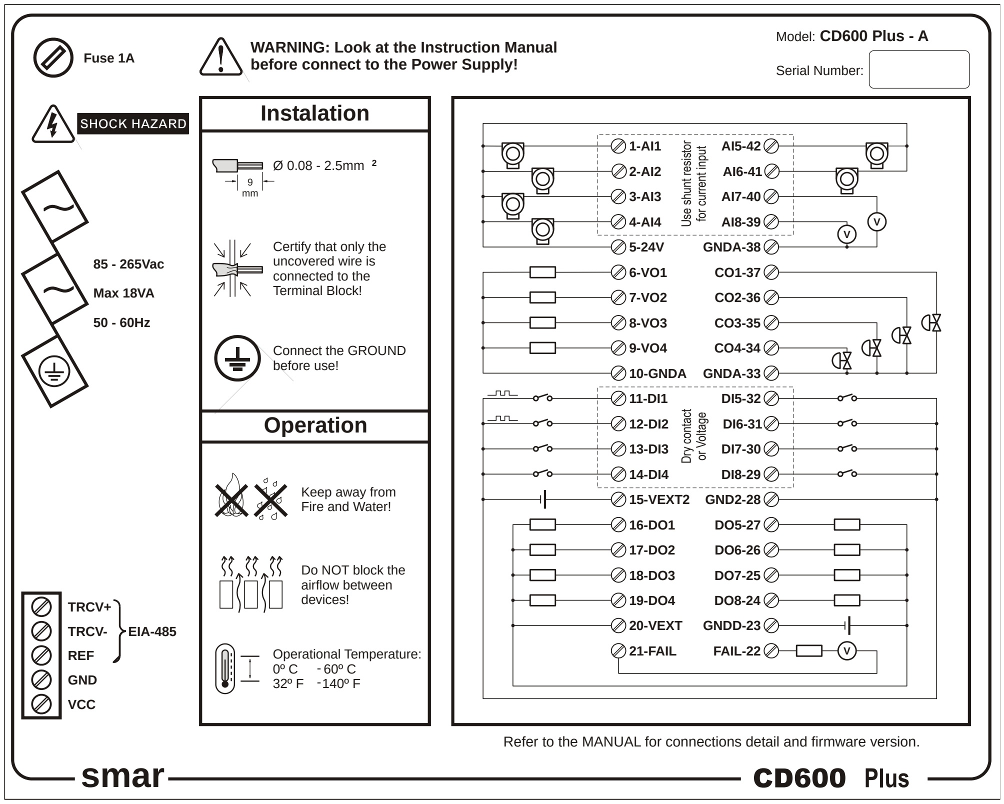


Figure 8.4. CD600 Plus side tag with terminal diagram AC

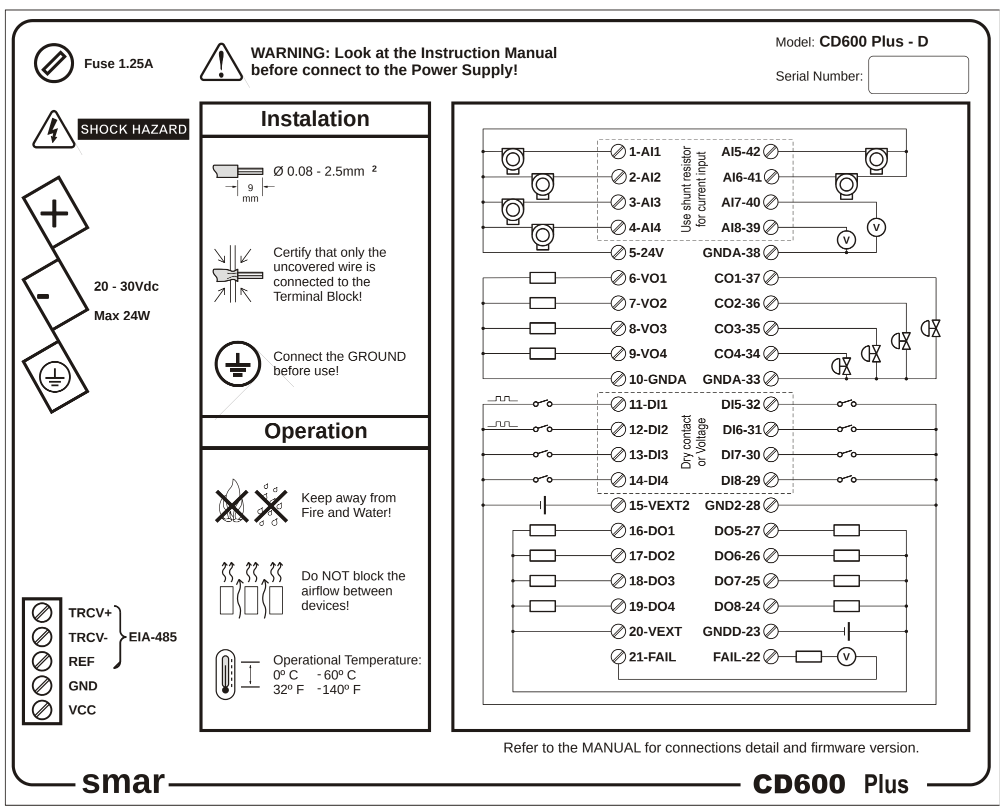


Figure 8.5. CD600 Plus side tag with terminal diagram DC

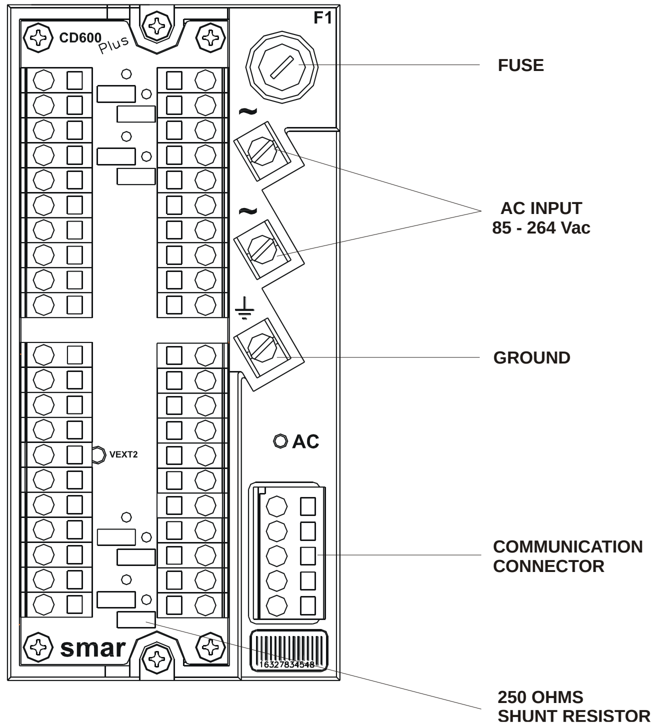


Figure 8.6a CD600 Plus AC Rear Terminals

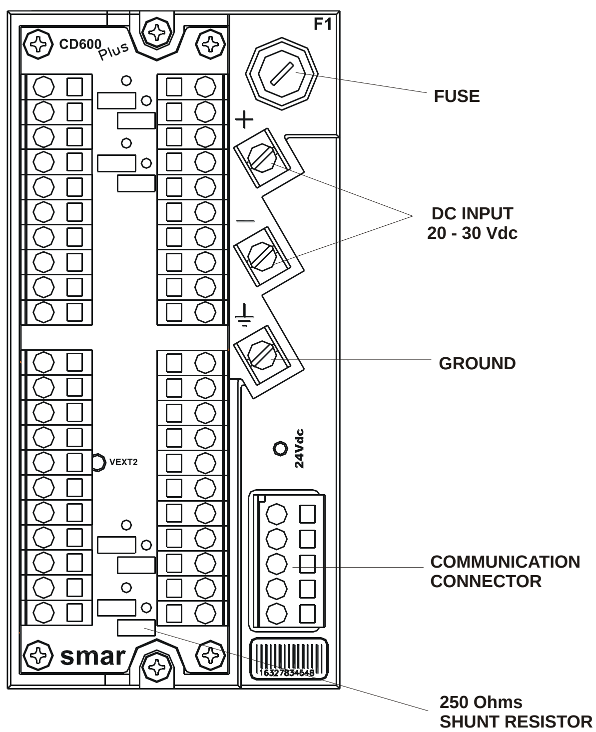


Figure 8.6b CD600 Plus DC Rear Terminals

Physical Characteristics

Microprocessor:	80C196, 16 bits
Memory:	4 Mbytes (FLASH) + 64 Kbytes (NVRAM)
Control Cycle:	adjustable from 100 to 250 ms
Housing:	Carbon steel with superficial electrolithic Blue Bichorome zinc treatment
Color:	Brown
Front Panel:	Engineering plastic
Circuit Boards:	Fiberglass reinforced Polyester
Front Dimensions:	72 x 144 x 250 mm
Weight:	1.6 kg

Accessories

DESCRIPTION	CODE
Panel spacer	206-0110
Supply cable	SC80
Digital Output isolator for CD600 Plus	ISD600P
Panel Interface for CD600PLUS	ITF-CD-
- Digital output without fuse;	0
- Digital output with fuse for AC;	A
- Digital output with fuse for DC.	D
Connection cables between CD600PLUS (left) and ITF interface	ITF-CDE-
- 0.5 m;	0
- 1 m;	1
- 1.5 m;	2
- 2.0 m;	3
- 2.5 m;	4
- 3.0 m;	5
- 3.5 m;	6
- 4.0 m;	7
- 4.5 m;	8
- 5.0 m.	9
Connection cables between CD600PLUS (right) and ITF interface	ITF-CDD-
- 0.5 m;	0
- 1 m;	1
- 1.5 m;	2
- 2.0 m;	3
- 2.5 m;	4
- 3.0 m;	5
- 3.5 m;	6
- 4.0 m;	7
- 4.5 m;	8
- 5.0 m.	9

Ordering Code

CD600 Plus		
	A	85 – 264 Vac/50-60 Hz
	D	20 – 30 Vdc

Typical CD600 Plus

Exploded View

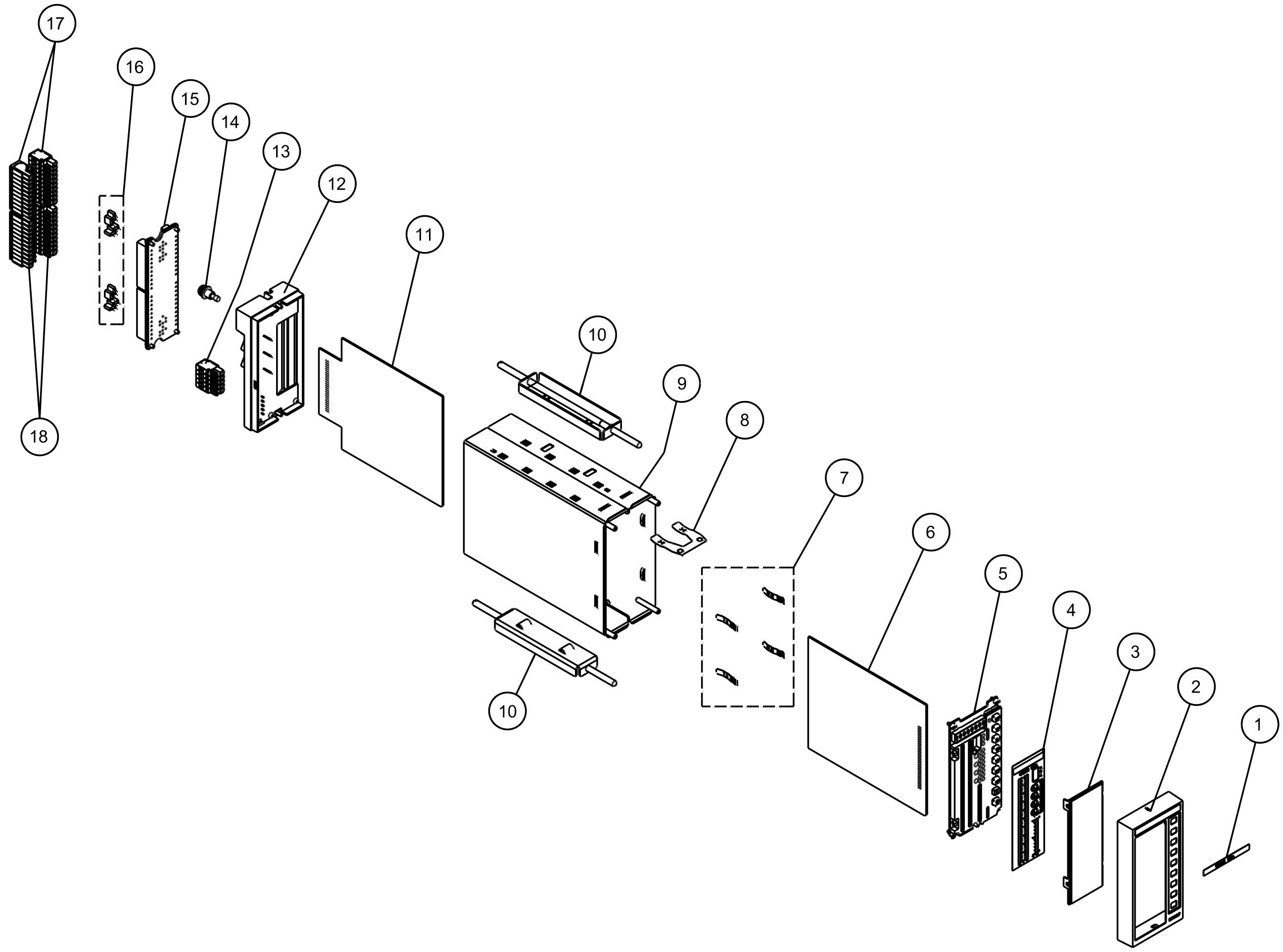


Figure 8.7. Exploded View - CD600 Plus Digital Controller

Spare parts

DESCRIPTION	POSITION	CODE
Tag Handle	1	206-0101
Front Panel	2	400-0658
Blind Front	2	206-0109
Acryllic Window	3	206-0105
Scale	4	400-0659
Front Panel PC Board	5	400-0660
Main Board	6	400-0661
Front Panel Grounding Spring (04 pieces)	7	400-0662
Front Panel Locking Spring (screws and washers included)	8	400-0663
Controller's housing	9	400-0664
Fixing Clip (02 pieces)	10	400-0665
Auxiliary board AC power supply Auxiliary board DC power supply	11	400-0666 400-0674
Rear panel with filter board [GLL1199] and without AC terminal (with screws; o-rings and inserts) Rear panel with filter board [GLL1289] and without DC terminal (with screws; o-rings and inserts)	12	400-0667 400-0675
5 way terminal block	13	400-0668
Supply fuse of the AC back panel Supply fuse of thw DC back panel	14	400-0669 400-0676
Terminal board	15	400-0670
Shunt resistor [250 Ohms] (08 pieces)	16	400-0671
10 way terminal block (02 pieces)	17	400-0672
11 way terminal block (02 pieces)	18	400-0673
Main board with complete front set	1 a 6	400-0677
Complete front set	1 a 5	400-0678
Rear AC panel complete set Rear DC panel complete set	12 a 18	400-0679 400-0680

INSTALLATION

Initial inspection

After receiving the CD600 Plus, check:

- If the model of the device corresponds to your purchase;
- If the device has not suffered external damage in the handling and/or transportation;
- The instructions manual and the CONF600 software CD is attached to the manual, as ordered.

LOCAL CONDITIONS FOR INSTALLATION

Power Supply
To obtain a stable and reliable system operation, it is required a high quality energy system, following the requirements on the table below:

AC Supply @ 85-264 V 47-65 Hz	Voltage Variation	85-264 Vac
	Frequency Variation	48 to 64Hz
	Maximum Energy Interruption Period	14 ms (100 Vac)
24 Vdc Power Supply	Voltage variation	20-30 Vdc
	Maximum Energy Interruption Period	14ms (24Vdc)

Table 9.1 Power Supply Requirements

Environment Conditions
The temperature and relative humidity in the control room should be within the ranges specified below:

- Temperature: 0 to 60° C
- Relative Humidity: 5 to 90% RH (non condensed).
- Storage temperature: -25 to 70° C

Air purity
The amount of dust in the air of the control room should preferably be controlled to below 0.2 mg/m^3. It is particularly desirable to minimize the corrosive gases and other conductive particles in the air.

Vibration
The equipment should be located where it is not subjected to vibration greater than:

Acceleration: $g \leq 0.3$ g;
Frequency: $f \leq 100$ Hz;
Amplitude: $a = 500*g/f^2$ (mm).

Precautions Against Electromagnetic Noise

The noise should be the least possible, to avoid interference with the equipment.

a) Transceiver
When using a transceiver in the control room, the following precautions should be observed:

- Never use a transceiver in the surroundings (less than one meter) of any instrument or within any panel;
- The antenna of the transceiver should be set at least one meter away from the instrument or the wiring of the instrument;
- The output of the transceiver should be limited to 1 W or less;

b) Noise From Relays
- To prevent noise and protect contacts, it is recommended the use of transient suppressors in each relay or solenoid coil, See the item “Precautions using relays” – page 9.7.

c) Grounding Quality
The grounding quality is associated with noise suppression. The equipment, noise shield and the housing should be grounded, as described in the item “Grounding” - page 9.4. The noise suppression can also be improved if the signal cables are properly arranged. For better details, please refer to the item "Signal Cable Installation" – page 9.7.

EQUIPMENT INSTALLATION

Dimensions

The dimensions of the controller and the cut in the panel, for the installation of the CD600 Plus, are showed in fig. 9.1.

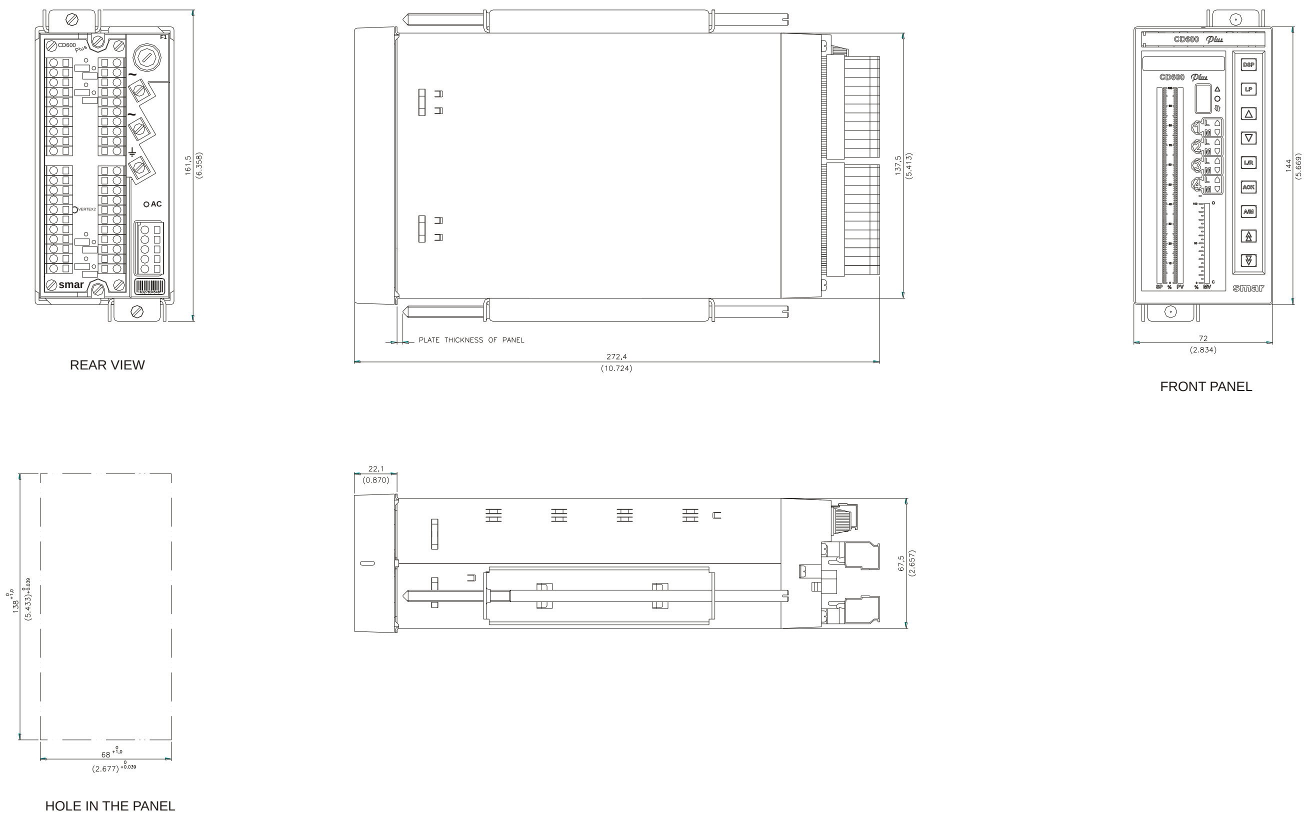


Fig. 9.1 – Dimensional Drawing

Panel Layout

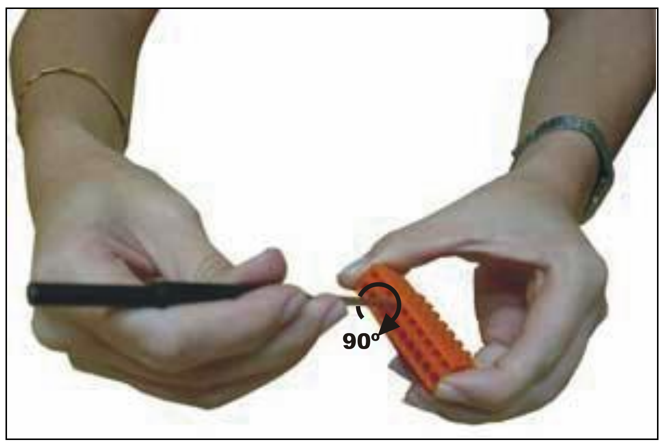
The factors that will determine the equipment distribution in the panel, are maintenance and operation frequency. The following points should be considered:

- Group distribution of systems and sub-systems, following a relative order, or operational sequency of the equipment;
- Placing in adequate height levels, following the principles of operationability;
- Operational priority, frequency of use, dimension and quantity of instruments;
- Priorities, risks and tasks of the operator.

Disassembling the Front Panel

Step 1: To disassemble the front, push the panel and insert a screwdriver in the hole, located at the top of the front, as shown in the figure.
Step 2: Pull out the front panel and remove the front.
Step 3: To re-assemble the front panel, attach the bottom, and push the top until it is fastened.

Terminal Block Assembly
To connect the wire on the terminal block, insert a screwdriver in one of the rectangular cavities of the block. Give a 90 degree twist on the screwdriver, and the cavity will be open for the wire insertion. See the figure below.



WIRING

Grounding
The purpose of grounding is not only to protect the operators from electrical shock, but to keep all equipments on the same stable electrical potential. The grounding system should be of low impedance, capable of absorbing currents from noises that cause malfunctioning of the system.

On the panel that the controllers will be installed, there should be two grounding buses:

- Housing Grounding bus: it corresponds to the plant grounding bus. That is where the housing of each **CD600 Plus** (see Fig. 8.4 - pag. 8.5) should be connected (see Fig. 9.2).
- Analog Grounding Bus: It corresponds to the bus where the analog input and output return (-) and the internal 24 Vdc power supply are connected. The analog grounding of each CD600 Plus (see Fig. 8.4 - pg. 8.5) should also be connected to the bus (see Fig. 9.3).

Each controller should have its own connection for both kinds of grounding. See figures 9.2 and 9.3.

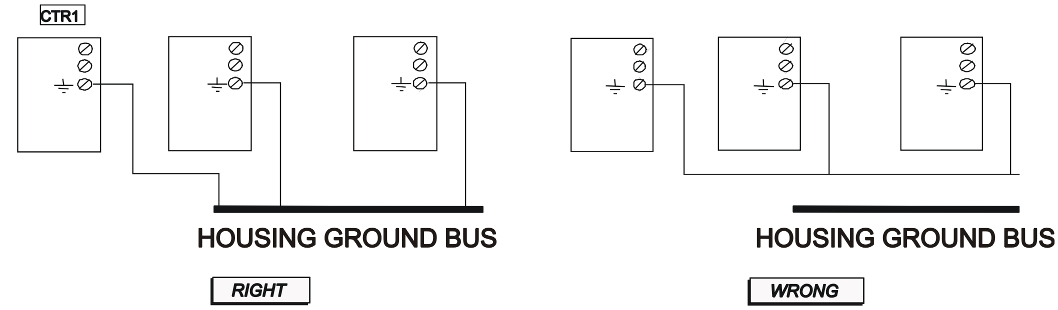


Figure 9.2 – Housing Ground Connection

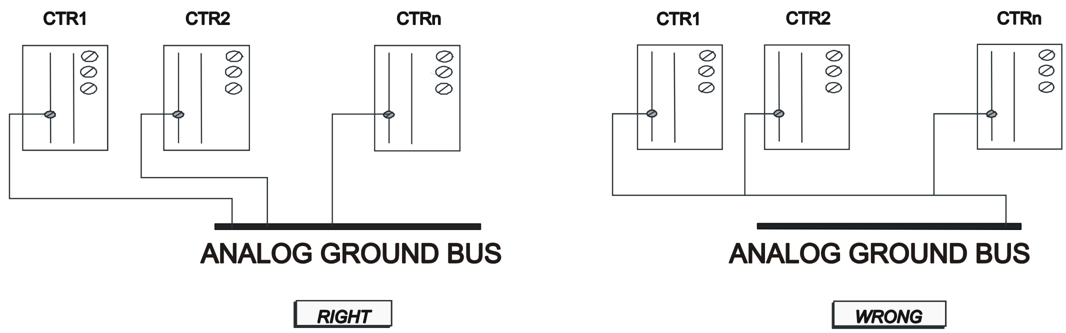


Figure 9.3 – Analog Grounding Connection (Terminals: 10,33,38)

NOTES:

- The digital grounding (terminal 23 DGND) is internally connected to the analog ground (terminal 10,33,38 AGND).
- The equipment connected to the analog voltage input/output should be isolated from the digital ground. Otherwise, it is recommendable signal isolators.

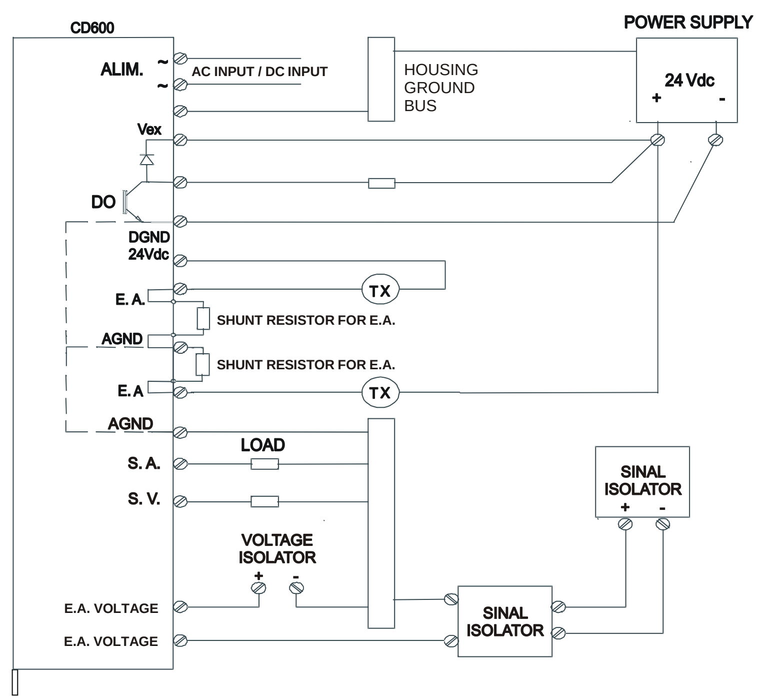


Fig. 9.4 – Power Supply CD600 Plus AC / DC

Communication

For each controller on the communication line, a terminal block should be placed, as shown in fig. 9.5.

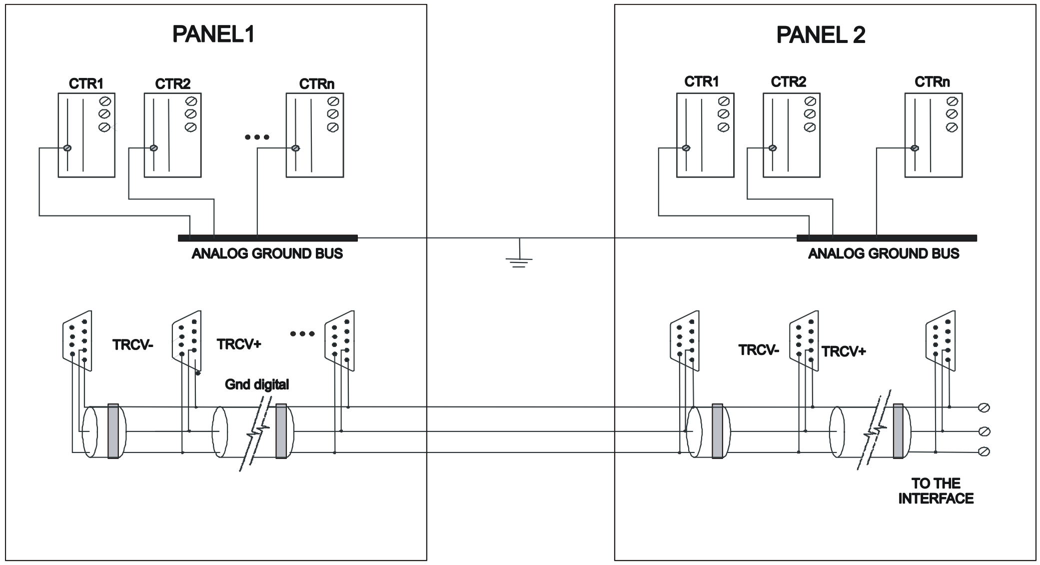


Fig. 9.5 – Communication cable

Alarm

When the digital outputs are used to activate relays, lamps, solenoids, etc., the following precautions should be taken:

a) Precautions Using Relays and Solenoids

When activating relays and solenoids through the controller contacts (digital outputs and controller fail output), make sure that:

- All loads commanded by the digital outputs should be designed for DC voltage (maximum 30 Vdc);
- The maximum current should be 400 mA
- The relays and solenoids are specified with the lowest voltage possible, in order to increase operation safety;
- The positive terminal from the source, should be connected to terminal 20 (Vext), being necessary to connect a diode in parallel with the relay and solenoid coils, for inductives loads generate a reverse voltage on the relay commutation. Without this procedure, this phenomenon will damage the digital outputs' signal.

All loads connected to the digital outputs of the same controller, should have the same supply voltage.

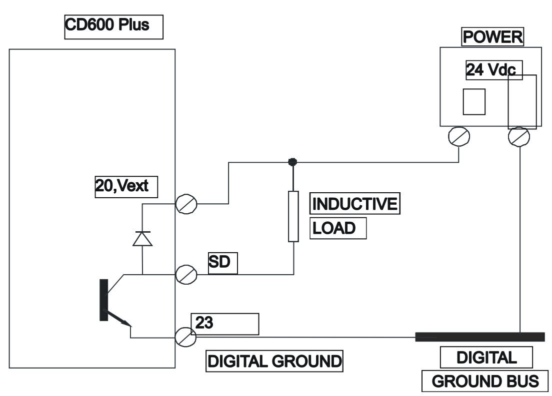


Fig. 9.6 – Inductive Loads on the Digital Outputs

NOTE
The last configuration can be used as long as the negative from the power supply (-) is isolated from the analog ground (AGND terminal).

SIGNAL CABLE INSTALLATION

Always install the signal cables in separate trays from the power cables. The signal cable installation and power cable installation on the same tray should satisfy one of the three conditions:

1) Install a grounded metallic separator, as illustrated in figure 9.7.

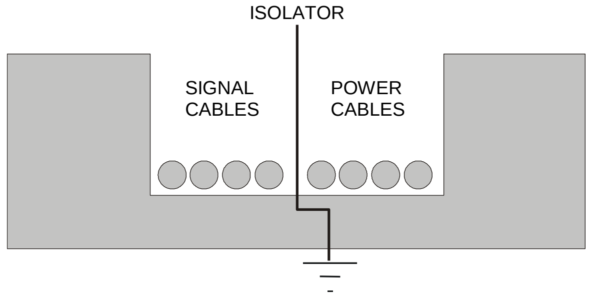


Fig. 9.7 – Cable Arrangements on the Tray

2) Predict a tolerance between the power cables and signal cables, using a cable tray, as illustrated in figures 9.8 and 9.9.

NOTE
If the power cables operate with a voltage greater than 220 V and a current greater than 10 A, and are NOT shielded, the distance from the signal cables should be at least 60cm.

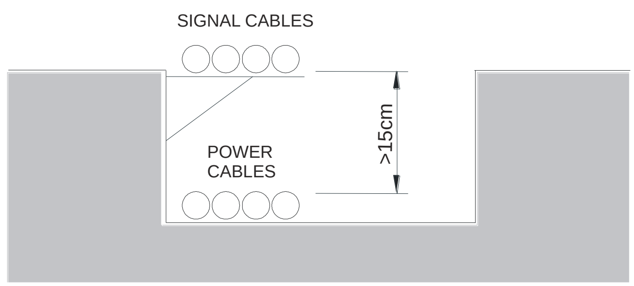


Fig. 9.8 – Cable Arrangements on the Tray

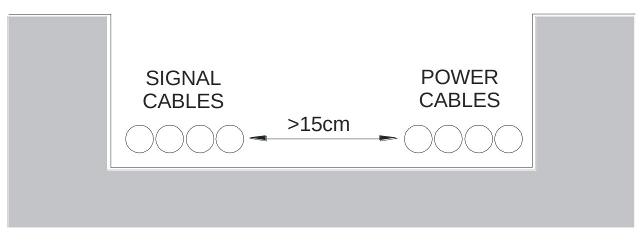


Fig. 9.9 - Cable Arrangements on the Tray

3) Cross the power cables and the signal as illustrated on figure 9.10.

NOTE
When using non-shielded cables, it is recommended to use a 1.6mm thick iron board between the signal and power cables as indicated in figure 9.10

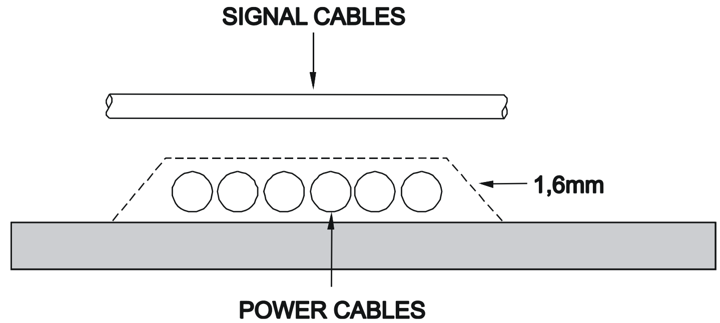


Fig. 9.10 – Arrangements of the non-shielded cables on the tray

TRANSPORTATION AND STORAGE

Requirements for Transportation and Storage
The transportation, storage and temporary stop of the controllers should follow certain environment conditions described below:

	Transportation and storage in packages supplied by **Smar**
Environment Temperature	-25 to 70° C
Environment Humidity	5 to 95% RH

Table 9.2 – Environment Conditions for Transportation and Storage

Caution in the Transportation
- Always carry the controllers on the packages supplied by Smar according to the position indicated on the box;
- Always protect the product from sunlight, moisture, shocks and vibration when transporting;
- If the boxes need to be opened for some reason, be sure to re-package, according to what was previously packaged by **Smar**.

Storage Precautions
- Always keep the packages indoors, away from direct sunlight, corrosive gases, shocks and vibrations;
- Be sure to place the packages in the indicated position;
- If a package is opened for re-packing, it should follow the same Smar packing pattern;
- When storing the controllers out of the package, make sure they are in the same installation position (protected from dust).

CD600 Versus CD600 Plus

The CD600 Plus's main differences from the CD600 (which should help on the installation) are:

Item	CD600Plus	CD600
Power Supply	Universal 85 to 264 Vac 50/60 Hz / 24 Vdc	110 or 220 Vac / 24 Vdc
Alphanumeric Display	Matrix 5x7 Dots	16 segments
Digital Inputs	8 galvanically isolated (needs an external power supply)	4 non isolated
PC Configurator	Windows XP SP3, Windows 7 SP1 Professional 64-bit, Windows 10 Professional, Windows Server 2008 R2 64-bit, Windows Server 2012 R2, and Windows Server 2016 Standard.	DOS
Function Blocks	4 New Blocks	-
Backup	-	Available with an extra PC board
Compatibility	Imports configurations from the CD600	Does not apply
Length	250cm	480cm
Weight	1600g	3600g
Front color	Brown	Black
Housing	Galvanized with transparent protection	Block with Epoxy

Item	CD600Plus	CD600
Rear terminal blocks (see diagrams)	Detachable in 5 parts	1 Block screwed to the panel
Mobile parts	Front (to change the scale and the front tag)	Front and main Board
RS-485	Isolated	Non-Isolated
Connector for RS-485	Industrial Terminal	DB9
Number of boards	5	7
Environment Temperature	0 – 60 °C	0 – 43 °C
Leds on the rear panel	For AC supply indication and Vext	-

smar - CONF600 PLUS

USER'S MANUAL

CONF600 PLUS

CONF600
PLUS

INTRODUCTION

The **CONF600 Plus** is a complete configuration software to create, edit, optimize and download the control strategy to the **CD600 Plus**. It is also capable of calibrating I/Os, monitoring function blocks online, setting network parameters, adding notes and printing documentation.

The **CONF600 Plus** runs in Windows XP SP3, Windows 7 SP1 Professional 64-bit, Windows 10 Professional, Windows Server 2008 R2 64-bit, Windows Server 2012 R2, and Windows Server 2016 Standard.

It provides a powerful and still very easy to use graphic interface.

The **CONF600 Plus** guides the user during the configuration, almost needlessly to consult the manual. Most of the essential function block information is displayed on screen during editing and strategy creation.

Main features

- Advanced graphic interface to assemble the control strategy for the application.
- Very easy parameter setting for all Function Blocks.
- Includes editing, calibration, optimization, and online monitoring tools.
- Documentation printing capability for configurations and parameters.
- Network parameter setting for serial (RS-485) or Ethernet.
- Configuration transfer between the computer and PDA.

Section 10

SYSTEM INSTALLATION

System Requirements

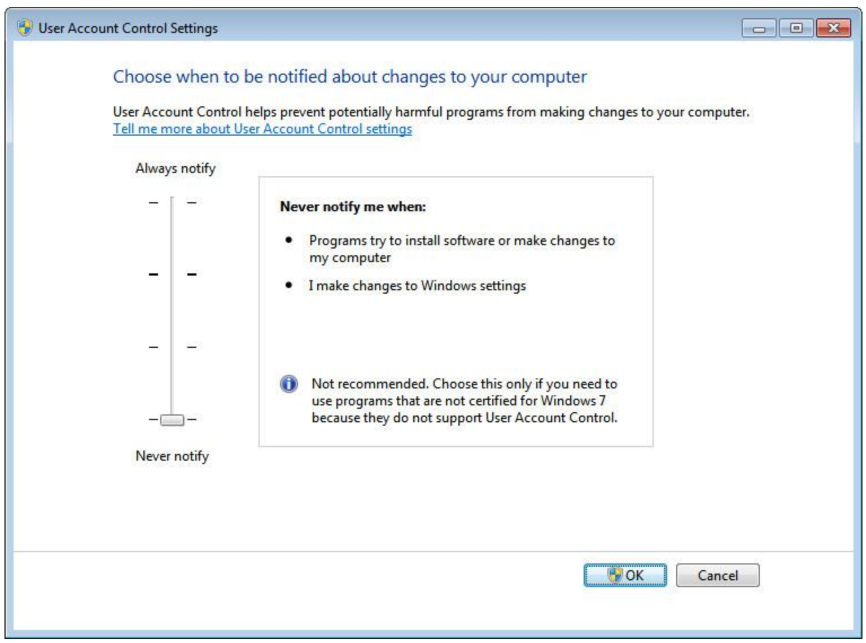
Operating System: Windows XP SP3, Windows 7 SP1 Professional 64-bit, Windows 10 Professional, Windows Server 2008 R2 64-bit, Windows Server 2012 R2, or Windows Server 2016 Standard.
Processor and RAM Memory: Suitable for the operating system used
Free Disc Space: 20 MB
Display: 800x600 - True Color
CD-ROM

Installation

ATTENTION

Before installing **CONF600 Plus** you must disable **UAC** (User Account Control). For such on the **Control Panel**, click **User Accounts > Change User Account Control settings**.

The **User Account Control Settings** dialog box will open. Configure security to the **Never Notify**, as indicated below.



Click **Ok.** A message box will open requesting the confirmation to apply the changes, click **Yes** to conclude. It is necessary to restart the operating system.

Place the **CONF600 Plus** installation CD in the CD-ROM drive.

NOTE

The CONF600 Plus installation software can be obtained directly from the Smar website: https://www.smar.com/en/softwares

Wait a few minutes while the installation software initializes.

The **Installation** dialog box will automatically open:

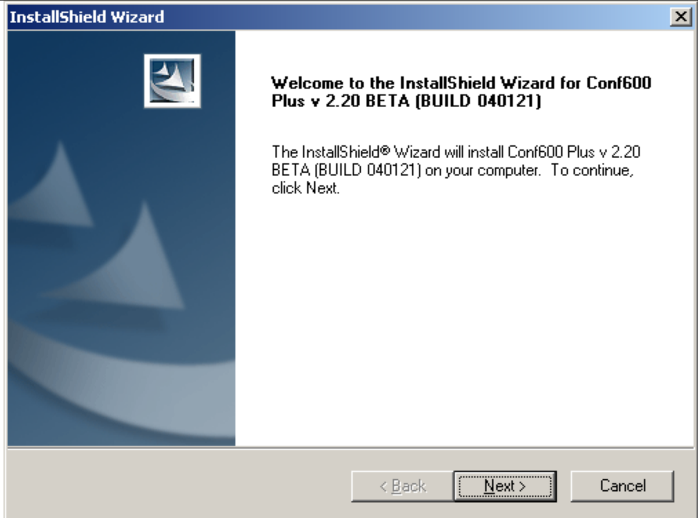


Figure 10.1 - Initializing the Installation

Click **Next** and follow the instructions in the dialog boxes to complete the installation.

When the installation is complete, the following dialog box will open:

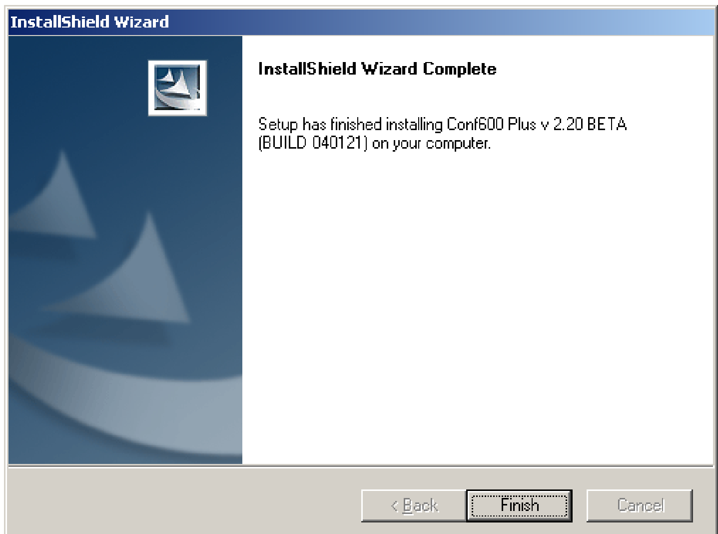


Figure 10.2 - Installation Complete

Click **Finish** to exit the installation program and close this window.

To initialize **CONF600 Plus** click the button **Start**, at the **Task Bar**, point the cursor to the item **Programs**, then the item **Smar.** Click the group **Conf600 Plus**, then click **Conf600 Plus** to initialize the application software as indicated in the next figure:

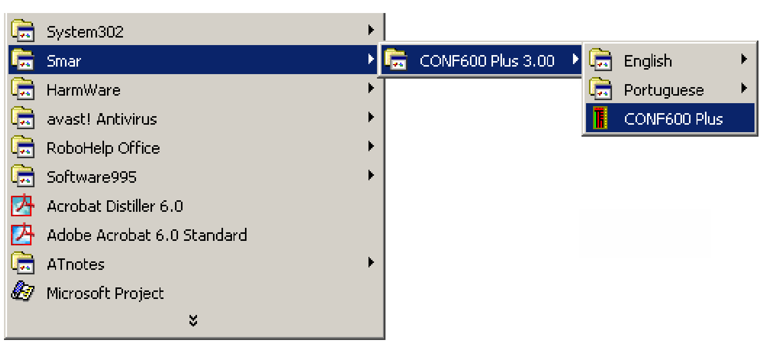


Figure 10.3 - Initializing the CONF600 Plus

OPERATION

Project Files

Creating a project file

To create a project file, go to the *File* menu and click *New*. A new project window will open.

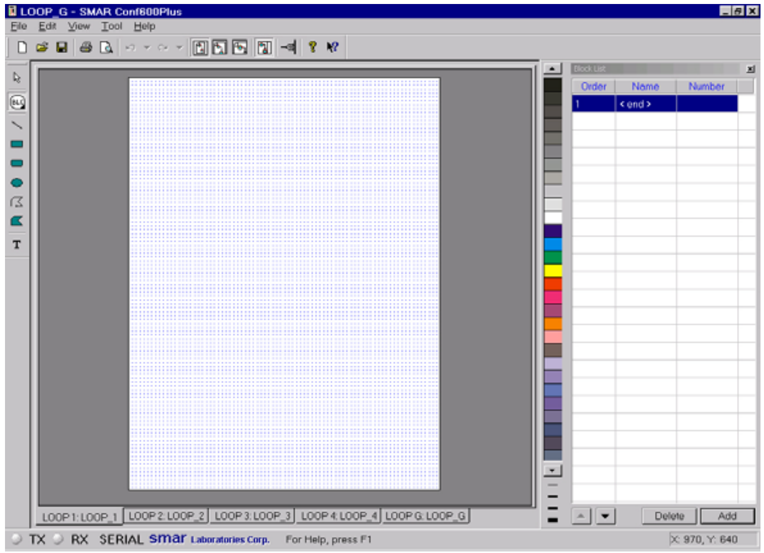
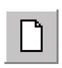


Figure 11.1 - New CONF600 Plus Project

<u>Shortcut:</u>

Toolbar: 

Keyboard: Ctrl + N

Opening a project file

To open an existing project file, open the *File* menu and click *Open*. The *Open* dialog box will appear:

1. Select the folder that contains the project file to be opened.
2. Click the project file icon or type its name in the *File Name* box.
3. Click *Open* to finish this task.

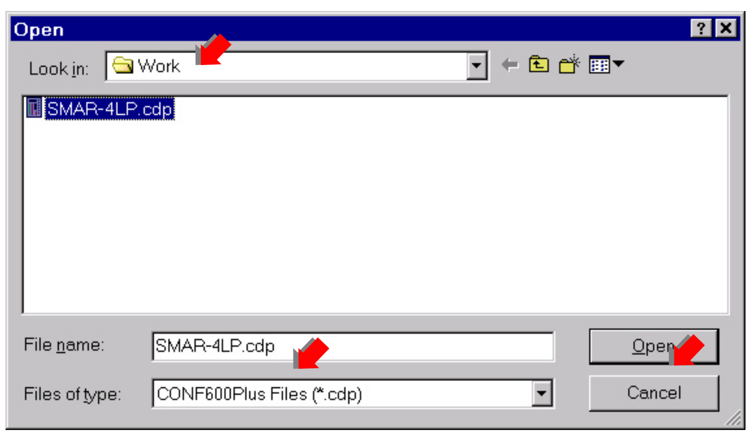


Figure 11.2 - Opening the Project File

Shortcut:

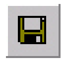
Toolbar: 

Keyboard: Ctrl + O

Saving a project file

To save the project file, go to the *File* menu and click *Save*.

Shortcut:

Toolbar: 

Keyboard: Ctrl + S

At the first time the user tries to save the project file, the Save As dialog box will appear. The name of the general loop will be used as the default name for the project file.

Anytime the configuration changes, do not forget to save it.

Save As

Use this option in the File menu to save the current configuration a file name different:

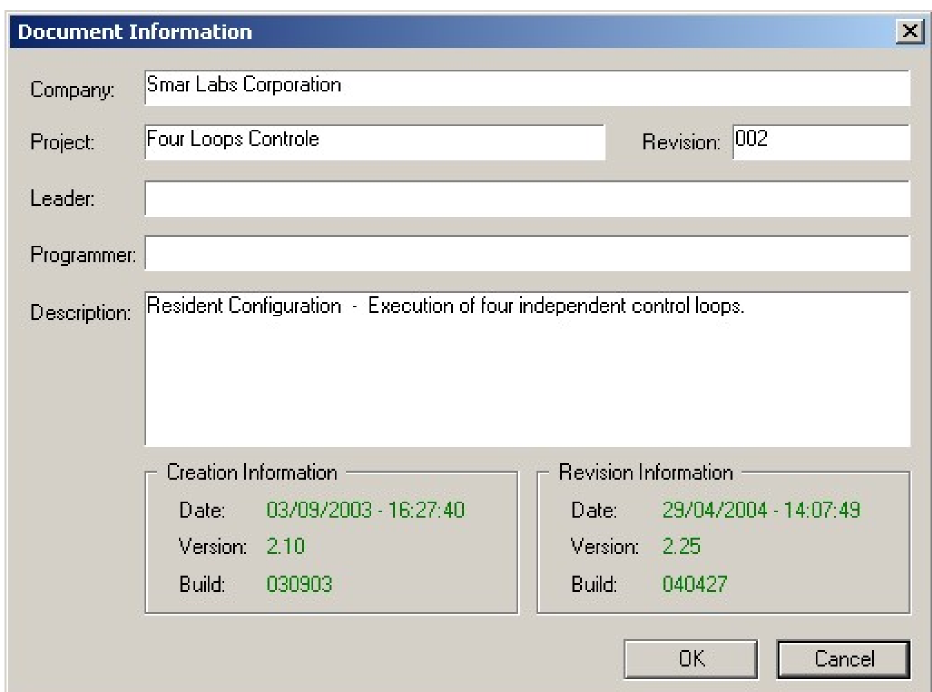
1. Go to the File menu and click in Save As. The Save As dialog box appears.
2. Select a folder to save the file.
3. Enter the filename in the File Name box.
4. Click Save to finish.

A message will appear alerting the user that the loop is in general a different name of the file. Click OK to confirm the file name change and the loop G name will be updated.

Document Information

The *Document Information* dialog box displays the information related to the configuration file, such as a description of the configuration or the number of the revision.

1. Go to the *File* menu and click *Document Info*. The *Document Information* dialog box will open.
2. Edit the desired text fields.
3. Click *Ok* to save the changes.



The following options are available in the *Document Information* box:

- Company Name: show the information about the Company.
- Project Name: Show the project name.
- Leader: Show the name of the leader.
- Programmer: Show the name of the programmer.
- Description: Show a brief description about the configuration.
- Creation Information: Show the date when the project was created and the version of the software used to create the project file.
- Revision Information: Show the date when the project was last saved and the version of the software used to review the project file.

Importing a project file

It is possible to import a configuration project from a previous version of **CONF600 Plus**. Go to the *File* menu and click *Import*. The *Import* dialog box will open:

1. Select the folder that contains the project file to be opened.
2. Click the project file icon or type its name in the *File Name* box.
3. Click *Open* to finish this task.

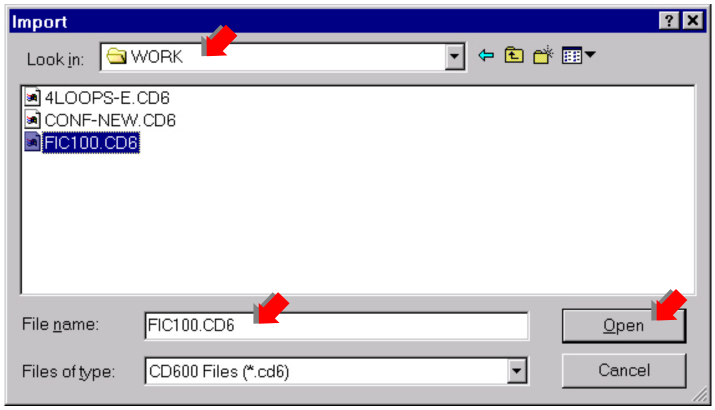


Figure 11.3 - Importing a Project File

When the user imports a configuration from a previous version of the **CONF600 Plus**, the blocks and the parameter values are added to the *Block List*. The controller does not save the graphical representation of the configuration. It will be necessary to drag the blocks to the drawing area and redraw the strategy for each loop of the configuration. See section ***Dragging blocks to the drawing area*** for further details.

Exporting the configuration

To save the configuration for a PDA file format, go to *File* and click *Export to PDA*. The configuration will be saved in two different files: one file contains the block list and the other contains the parameterization.

Printing documents

To print the report about the configuration project, go to the *File* menu and click *Print*.

Shortcut:

Toolbar: 

Keyboard: Ctrl + P

The *Selection* dialog box will open:

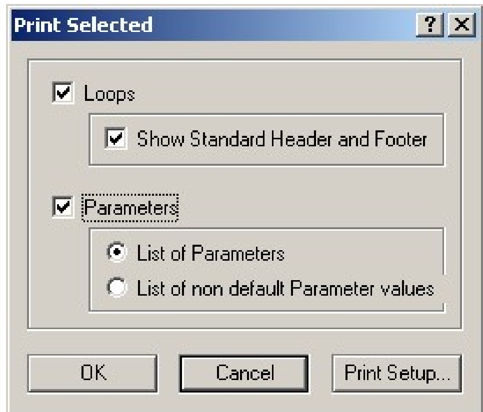


Figure 11.4 - Print Options

The following options are available in this dialog box:

- **Loops:** if this option is selected, all of the loops from the configuration project will be printed.
- **Show Standard Header and Footer**: select this option to print the standard header and footer in each page. The header contains the name of the project file, the loop name, date, time and page number.
- **Parameters:** if this option is selected, a report with all of the blocks and parameters of the configuration will be printed. There are two other options:
- **List of Parameters:** select this option to print a report with all parameters and their values, from the loops that were edited in the project file.
- **List of Changed Parameters:** select this option to print a report with only the parameters and the values that were changed compared to the default block values, from the loops that were edited in the project file.

Print configuration

To open the *Print Setup* dialog box, go to the *File* menu and click *Print Setup*.

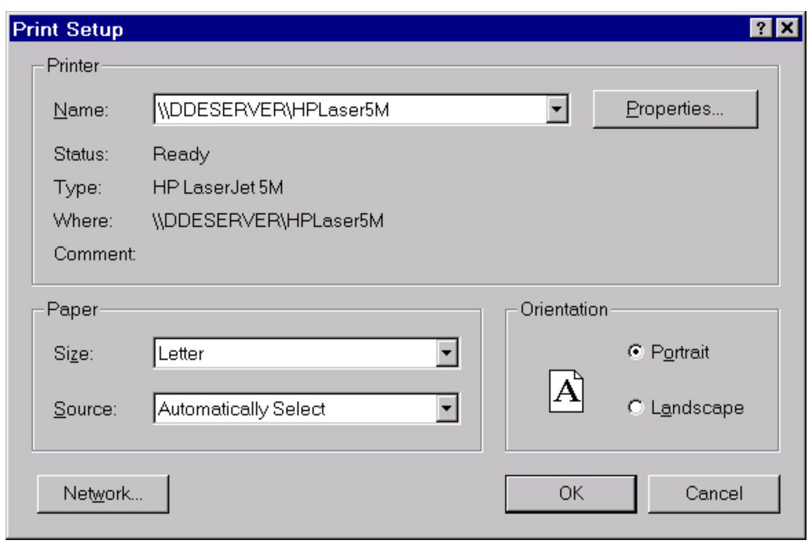


Figure 11.5 - Print Setup Dialog Box

Paper:
Select the size of the paper or envelope to be used in the Size box.

Select the paper source in the Source box. Different printer models support different paper sources, such as the upper tray, envelope feed, and manual feed.

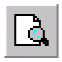
Orientation: select the page orientation and how the document is positioned on the page.

Click the button Properties to configure the printer options.

Print Preview

This option allows the user to view the report before printing it. Go to the *File* menu and click *Print Preview*.

<u>Shortcut:</u>

Toolbar: 

Select the print options, click *Ok* and the *Preview* window will open:

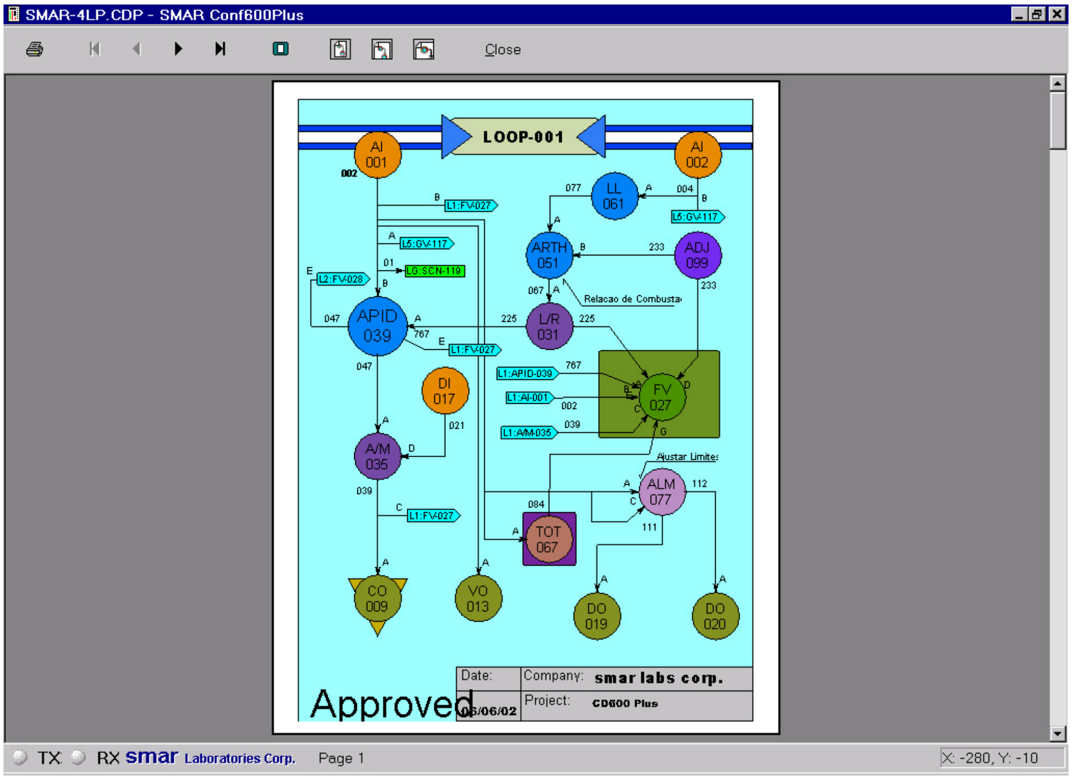
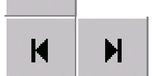
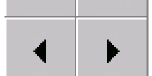
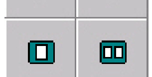
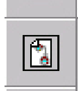
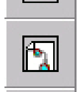
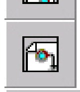


Figure 11.6 - Print Preview Window

The Preview window has its own toolbar. The table below briefly describes the buttons:

	Click this button to print the document.
	Click the button to view the first/last page.
	Click the button to view the previous/next page.
	Click the button to view one or two pages at the same time.
	Click this button to view the entire page on the screen.
	Click this button to increase the zoom and view the page width size.
	Click this button to increase the zoom and view half of the loop page on the screen.
Close	Click this button to close the *Print Preview* window and return to the configuration project window.

CONF600 PLUS INTERFACE

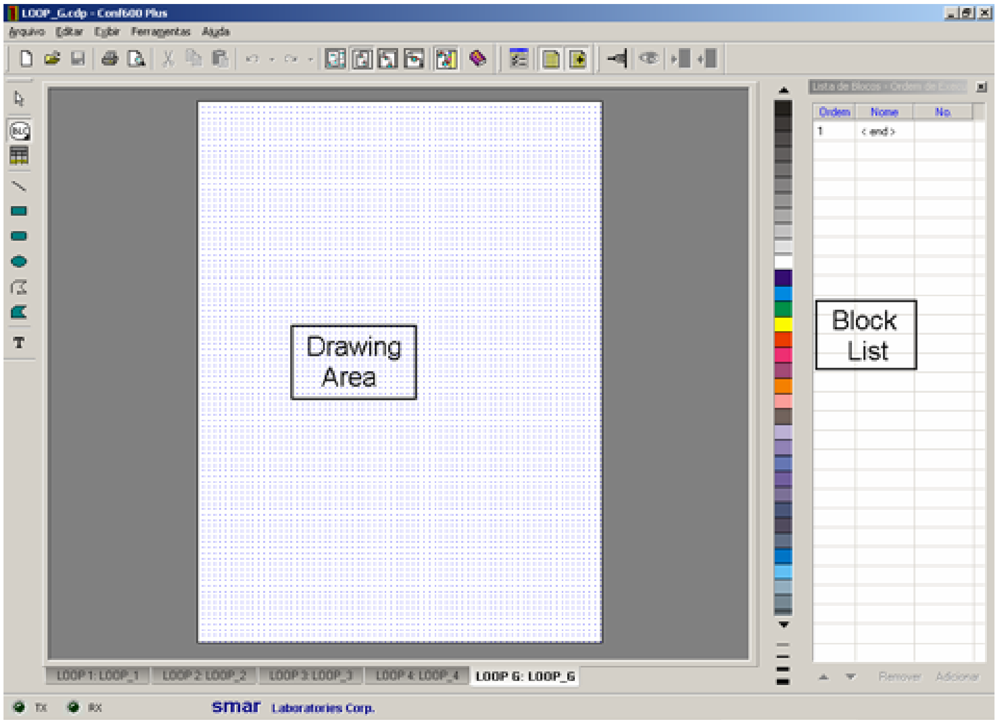


Figure 12.1 - CONF600 Plus Interface

Naming loops

The configuration project can be divided into 4 loops. To change the loop name.

1. Double-click the loop tab.

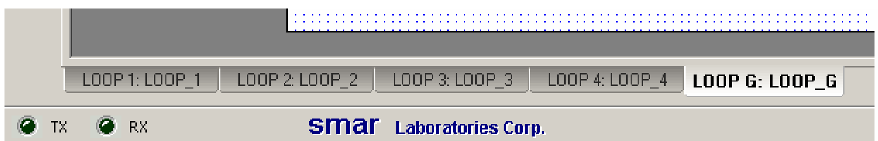


Figure 12.2 - Changing the Loop Name

2. The *Loop Name* dialog box will open:

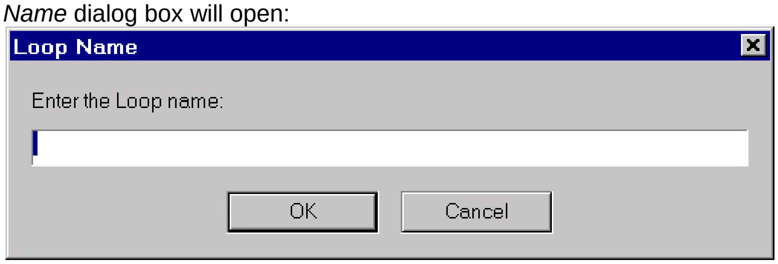


Figure 12.3 - Loop Name Dialog Box

3. Type the new name, 8 digits maximum.
4. Click *OK* to close this dialog box and return to the working area.

To change the name of the loop again, right-click on the loop tab and the dialog box will open with the current name of the loop. Type the new name and click *Ok*.

Main toolbar

To activate the *Main* toolbar, go to the *View* menu and click the option *Toolbar*. The *Main* toolbar is displayed on the working area by default.

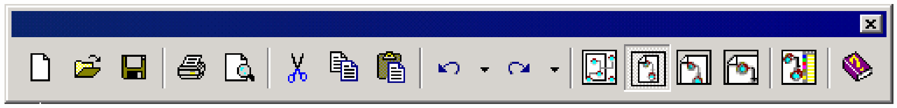


Figure 12.4 - Main Toolbar

The table below describes the buttons functionality:

Creates a new project.

Open an existing project file.

Save the project file.

Prints the configuration project.

Opens the *Print Preview* window.

Remove the selection and copy it to the Clipboard.

Copy the selection to the Clipboard.

Paste the contents from the Clipboard into the drawing area.

Undo changes up to the last save. To undo two or more actions at a time, click the down arrow then select the actions to be undone.

Redo the action executed by the undo command up to the last save. To redo two or more actions at a time, click the down arrow then select the actions to be redone.

Displays the entire loop page on the screen.

Displays the loop page width on the screen.

Displays half of the loop page width on the screen.

Shows/Hides the *Block List*.

Opens the Online dialog box.

Opens the Online help application.

Drawing toolbar

To activate the *Drawing* toolbar, go to the *View* menu, select *Tool Boxes* and click the option *Drawing*. The *Drawing* toolbar is displayed on the working area by default.

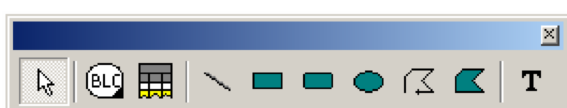


Figure 12.5 - Drawing Toolbar

These options are also available from the *Tool menu* > *Draw Tools*.
The table below describes the buttons functionality:

Draw Tool	Toolbar	Description
Select		Selects an object for further operations.
Node		Draws a node graphic on the drawing area.
Block List		Insert a graphical representation of the *Block List* in the drawing area, corresponding to the loop.
Line		Draws straight lines.
Rectangle		Draws straight rectangles.
Round Rectangle		Draws straight rounded rectangles.
Ellipse		Draws ellipses.
Polyline		Draws lines and polylines.
Polygon		Draws polygons.
Text		Inserts text strings.

Ordering toolbar

To activate the *Ordering* toolbar, go to the *View* menu, select *Tool Boxes* and click the option *Ordering*.

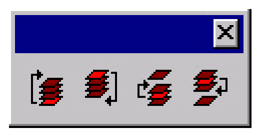


Figure 12.6 - Ordering Toolbar

These options are also available from the *Tool menu* > *Ordering*.
The table below describes the buttons functionality:

Draw Tool	Toolbar	Description
To Front		Move the selected object to the front of the stacking order.
To Back		Move the selected object to the back of the stacking order.
Forward One		Move the selected object one step forward to the front of the stacking order.
Backward One		Move the selected object one step toward the back of the stacking order.

Alignment toolbar

To activate the *Alignment* toolbar, go to the *View* menu, select *Tool Boxes* and click the option *Alignment*.

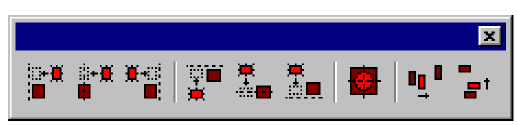
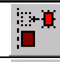
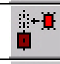
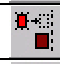
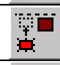
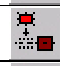
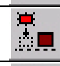
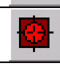
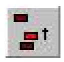


Figure 12.7 - Alignment Toolbar

These options are also available from the *Tool menu* > *Alignment*.
The table below describes the buttons functionality:

Draw Tool	Toolbar	Description
Left		Align the left side of the selected objects vertically.
Horizontal Center		Align the horizontal center of the selected objects vertically.
Right		Align the right side of the selected objects vertically.
Top		Align the top of the selected objects horizontally.
Vertical Center		Align the vertical center of the selected objects horizontally.
Bottom		Align the bottom of the selected objects horizontally.
Center All		Align the center of the selected objects.
Equal Horizontal Spacing		Distribute the selected objects horizontally, so there is equal horizontal distance between the edges of all the objects. This button works only for three or more objects.
Equal Vertical Spacing		Distribute the selected objects vertically, so there is equal vertical distance between the edges of all the objects. This button works only for three or more objects.

Color palette

To activate the *Color Palette*, go to the *View* menu, select *Tool Boxes* and click the option *Color Palette*. The *Color Palette* is displayed on the working area by default.

Figure 12.8 - Color Palette

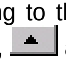
There are over 90 color options, according to the user's display configuration. To view all of the colors, click the arrows on the color palette,  and .
To change the fill color of an object, first select the object then click on the color desired at the palette.
To change the line color of an object, first select the object, then right click on the color desired at the palette.
To change the line thickness of an object, select the object then click on one of the options:

Figure 12.9 - Line Thickness

Document properties

To configure the document properties, go to the *View* menu and click *Properties*.
The *Properties* dialog box will open. The user can set several document attributes, such as the background color, the default for line thickness for the objects, default fill color for the objects, default font size for the text string.
At the *General* tab:

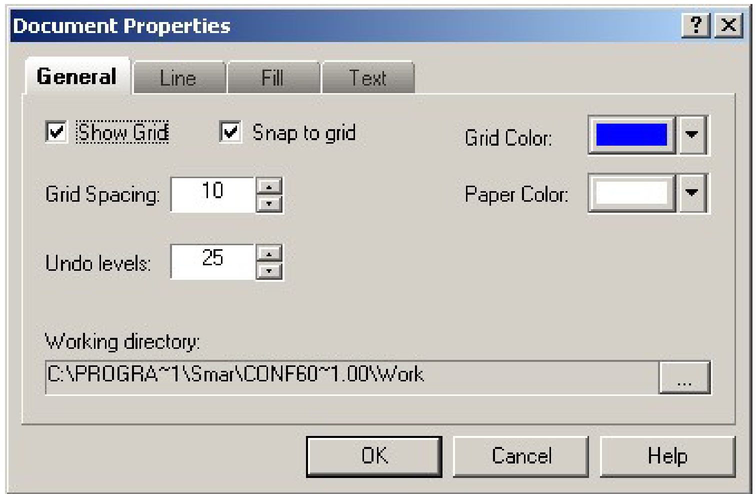


Figure 12.10 - Document Properties: General

Option	Description
Show Grid	Select this option to display the grid lines on the drawing area.
Snap to Grid	If this option is selected, objects will be drawn on the line grid. Otherwise, objects will float on the drawing area.
Grid Spacing	Set the grid line spacing.
Paper Color	Set the paper background color.
Grid Color	Set the grid lines color.
Undo levels	Set the number of changes to that can be undone. (Maximum 100 changes)
Working Directory	Select the deault directory to be used after the upload to check if the configuration file exists.

At the *Line Attributes* tab:

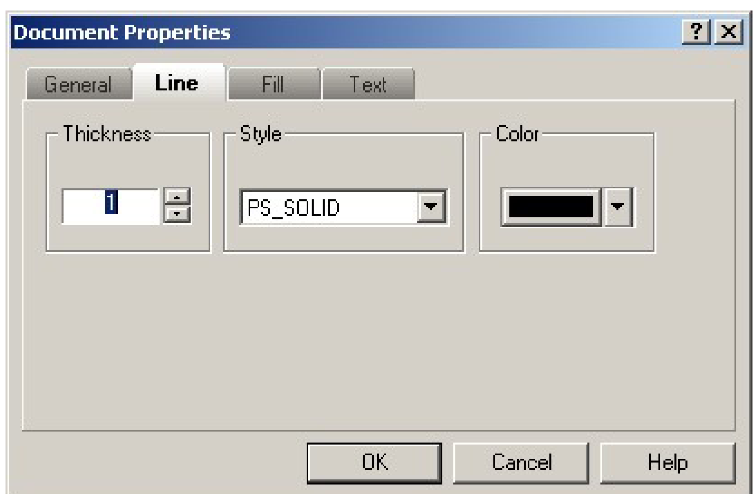


Figure 12.11 - Document Properties: Line Attributes

Option	Description
Thickness	Set the line thickness of the objects.
Style	Set the line style of the objects: solid, dashed, dot, dash-dot, etc.
Color	Set the line color of the objects.

At the *Fill Attributes* tab:

Figure 12.12 - Document Properties: Fill Attributes

Option	Description
Fill	Set the fill format: hollow, solid or hatched.
Style	Set the fill style: horizontal, vertical, diagonal, etc.
Color	Set the fill color of the objects.

At the *Text Attributes* tab:

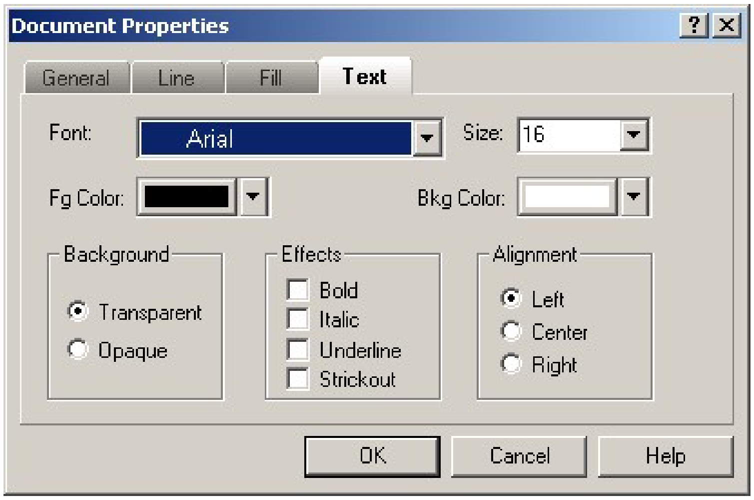


Figure 12.13 - Document Properties: Text Attributes

Option	Description
Font	Set the text font.
Size	Set the text font size.
Color	Set the font color.
Background Color	Set the background font color.
Background	Select between the transparent or opaque background.
Effects	Set the effects to be applied to the text: bold, italic, underline or strikeout.
Alignment	Set the text alignment: to the left, to the right or center.

Object properties

To set the object properties, click the object to select it. Then right click on the object to open the popup menu and select *Properties*.

The *Properties* dialog box will open. See the previous section, ***Document properties***, for further details about the object properties.

Document Properties Toolbar

Click each button to see information on the use:

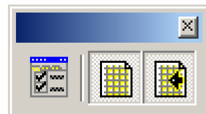
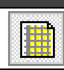
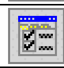


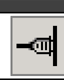
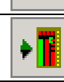
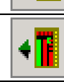
Figure 12.14 - Document Properties

Toolbar	Description
	Open the Properties dialog box to configure the document properties. See the Document Properties section for details.
	Select this option to show grid lines of the drawing area.
	If this option is selected the objects will be drawn at the grid line. Otherwise, the objects floating in the drawing area.

Communications Toolbar

Click each button to see information on the use:

Figure 12.15 – Communications Toolbar

Communication Tools	Toolbar	Description
Online		Open the dialog box Online
Monitor		Read the device parameters values and shows the links values in the design.
Update		Update the information configuration loop of device.
Upload		Click this button to start the device information upload for the configuration design.

Selecting the language

The user can change the interface language of the **CONF600 Plus** with no need to re-start the application.
On the *Tool* menu, select the target language: English, Portuguese or Chinese.

Converting the configuration list to graphics

It is possible to transfer the configuration from the PDA to the **CONF600 Plus** and then converting the configuration list to graphics.

First, download the configuration from the PDA to the controller, and then use the **CONF600 Plus** to upload the configuration from the controller to the PC. To upload the configuration list, open the *Online* dialog box, select the controller by its information address and click the *Upload* button. See the section *Uploading the device configuration* for further details.

The values of the block parameters and the links between the blocks will be uploaded from the controller to the *Block List*.

The controller does not save the graphical representation of the configuration. It will be necessary to drag the blocks to the drawing area.

Look Edition

Go to the *Edit* menu and click *Lock Edition*. When this option is selected with the check mark, , the user will not be able to edit the drawing area and the project configuration.

RESIDENT CONFIGURATION

The **CD600 Plus** leaves the factory with a resident configuration that performs a Four Loop Control. This configuration handles most of the applications normally used in process control.
Smar provides to the user a project file with the graphical representation of the resident configuration. The file is named **SMAR-4LP.cdp** and it is located at the **CONF600 Plus** installation directory ("C:\Program Files\Smar\Conf600 Plus\Work\").
The main features of the resident configuration are:

- Execution of four independent control loops.
- Each loop is implemented with an Advanced PID function block.
- Each loop may have Local Adjustment Set Point or Remote Set Point for ratio control. The ratio constant can be adjusted at the front panel of the **CD600 Plus**.
- Loops 1 and 2 have a lead-lag dynamic compensator for feed-forward control.
- Each loop has two alarms for the Process Variable (any type, any level) and one deviation alarm with time-out.
- Each loop has forced manual input.

The following figure shows the graphical representation for the loops of the resident configuration.

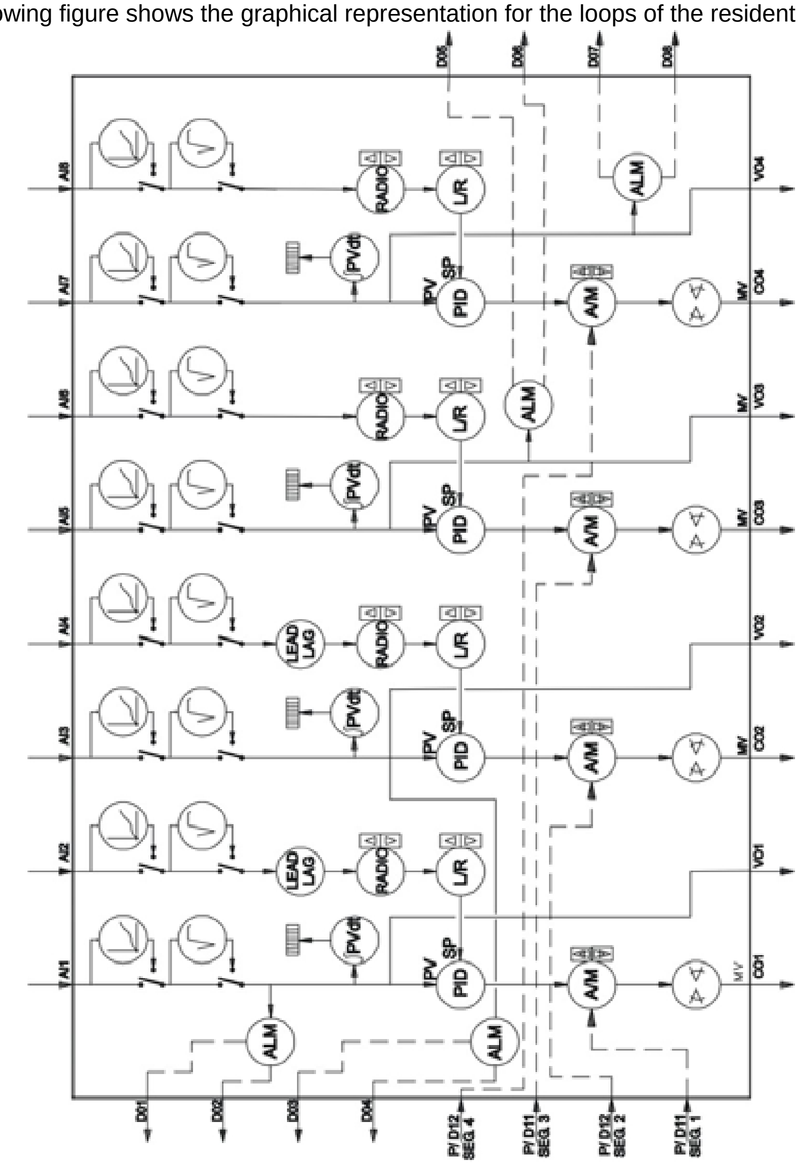


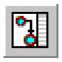
Figure 13.1 - CD600 Plus Resident Configuration

PROJECT CONFIGURATION

Activating the Block List

Go to the *Tool* menu and click on *Block List* to open the *Block List* window.

Shortcut:

Toolbar: 

Keyboard: F12

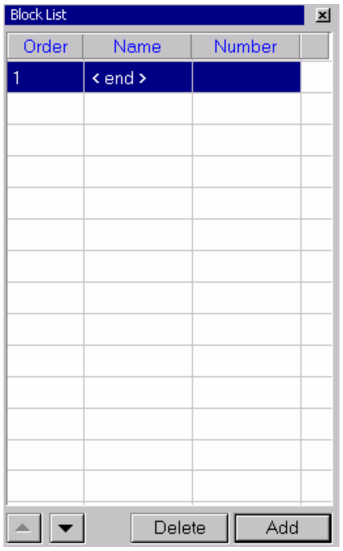
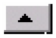


Figure 14.1 - Block List Window

The *Block List* defines the execution order of the blocks in the configuration. To change the execution order of the blocks, select the desired block and click the button  to move the block one position up in the list, or click the button  to move the block one position down in the list.

Adding blocks to the block list

To add a new block to the list, click the button *Add*. The *Block* dialog box will open:

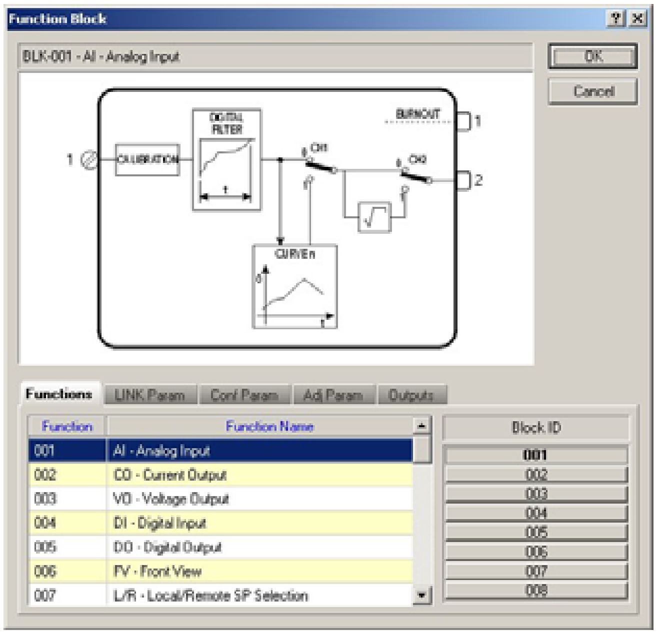


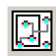
Figure 14.2 - Adding a New Block

1. At the *Functions* tab, select the block by its function name.
2. Select the block ID from the list at the right side of the dialog box.
3. Configure the block parameters, double-clicking the cell corresponding to the parameter and type the new value.

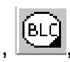
a) At the *LINK Parameters* tab, configure the linking parameters of the block.
b) At the CONF Parameters tab, configure the characterization parameters of the block.\
c) At the ADJ Parameters tab, configure the adjustment parameters of the block.

4. At the Outputs tab, the user can change the tag that identifies the output parameters of the block in the project configuration. Double-click the cell corresponding to the parameter and type the new tag for parameter.
5. Click *OK* to conclude this task and return to the *Block List*.

Repeat this procedure to add blocks to the loop. There is one *Block List* for each loop tab in the configuration project.

The graphical representation of each block will be automatically added to the drawing area. Click the button *Zoom to Objects*, , if the blocks are not showing.

Adding blocks to the drawing area

To add a new block to the configuration, select the *Node* tool, , and click the drawing area. The *Block* dialog box will open:

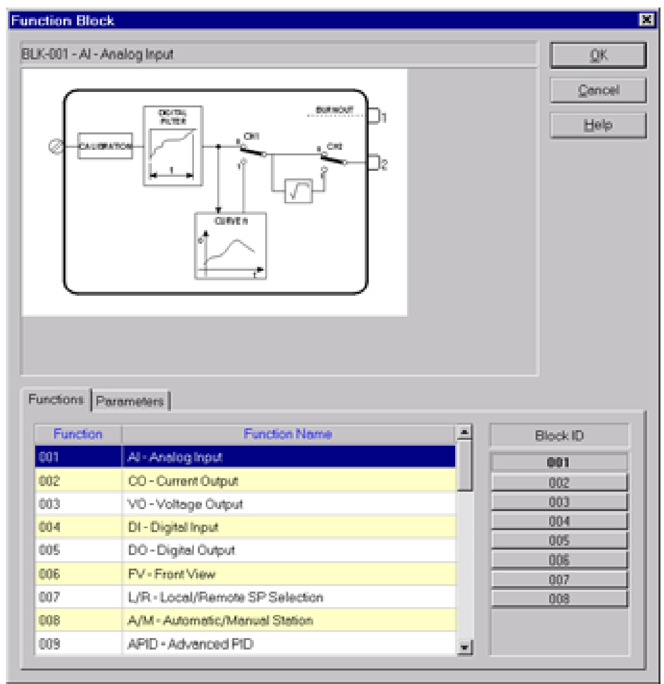


Figure 14.3 - Adding a New Block

1. At the *Function* tab, select the block by its function name.
2. Select the block ID from the list at the right side of the dialog box.
3. Configure the block parameters, double-clicking the cell corresponding to the parameter and type the new value.

a) At the *LINK Parameters* tab, configure the linking parameters of the block.
b) At the CONF Parameters tab, configure the characterization parameters of the block.
c) At the ADJ Parameters tab, configure the adjustment parameters of the block.
4. At the Outputs tab, the user can change the tag that identifies the output parameters of the block in the project configuration. Double-click the cell corresponding to the parameter and type the new tag for parameter.
5. Click *OK* to conclude this task and return to the drawing area.

Repeat this procedure to add new blocks.
The new block will be added to the *Block List* corresponding to the configuration loop.

Dragging blocks on the drawing area

To draw a block node at the drawing area from the *Block List* of that loop, select the block from the list, clicking on it and dragging it on the drawing area.

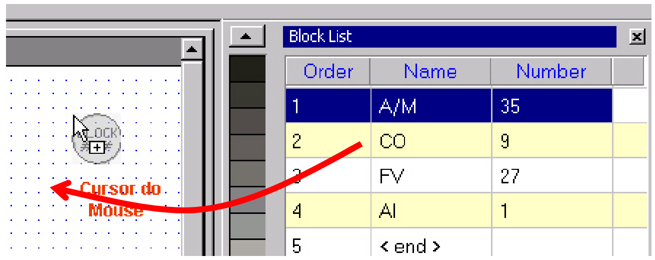


Figure 14.4 - Dragging a Block to the Drawing Area

The block selected will be drawn at the drawing area:

Figure 14.1 - Block

In case this block has links to other blocks that have already been dragged to the drawing area, these links will also be drawn.
The figure below shows an example of a configuration loop after the blocks have been dragged to the drawing area and the links have been redrawn:

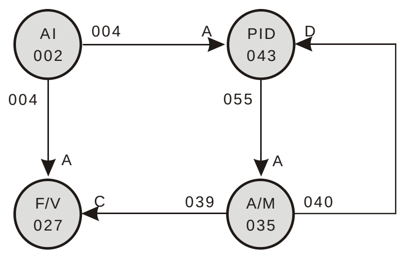
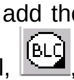


Figure 14.6 - Dragging Blocks to the Drawing Area

Adding the communication block

To add the communication block to the configuration, click the *General Loop* tab, select the *Node* tool, , and click the drawing area at the position desired to place the block. The *Block* dialog box will open:

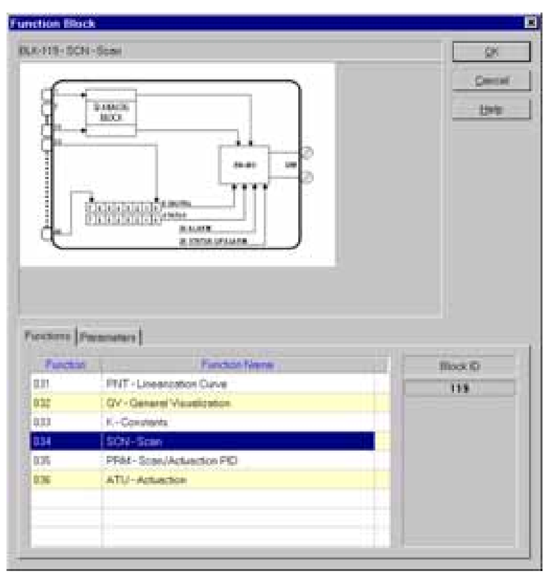


Figure 14.7 - Adding the Communication Block

1. At the *Function* tab, select the block **SCN**, **ID 119**.
2. At the *Parameters* tab, set the values for the block parameters.
3. Configure the block parameters, double-clicking the cell corresponding to the parameter and type the new value.

d) At the *LINK Parameters* tab, configure the linking parameters of the block.
e) At the CONF Parameters tab, configure the characterization parameters of the block.
f) At the ADJ Parameters tab, configure the adjustment parameters of the block.
4. Click *OK* to conclude this task and return to the drawing area.

The communication block will be drawn at the drawing area and added to the *Block List* of the *General Loop*.
Only one communication block can be added to each configuration project, and it will always be added to the *General Loop*.

Changing block parameters

To change the values of the block parameters, double-click the block on the *Block List*. Or select the block at the drawing area, right click it to activate the popup menu, and then select *Edit Params*.
The *Block* dialog box will open.

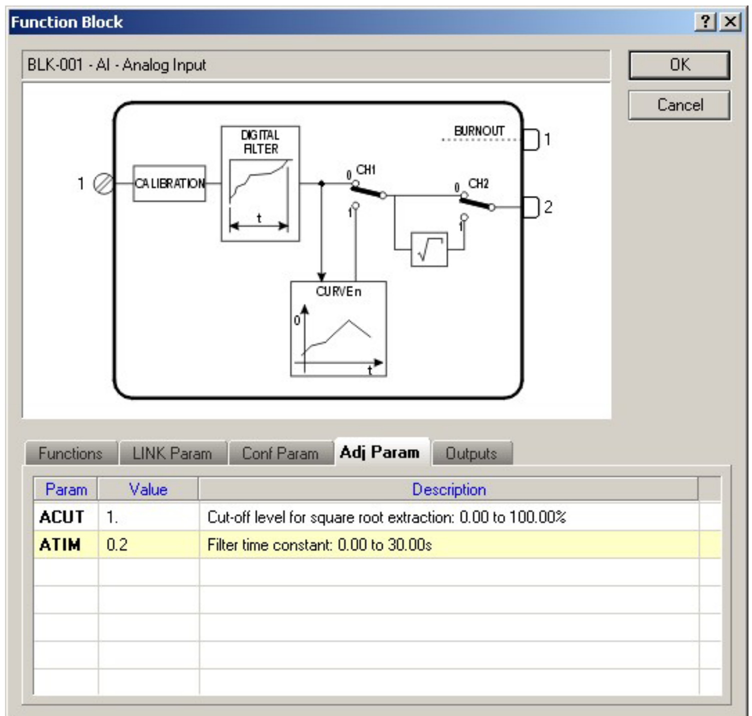


Figure 14.8 - Changing Block Parameters Values

To edit the values, double-click the value field at the line of the parameter to be edited.
The field becomes enabled for editing, the range of possible values for the parameter selected appears at the bottom of the *Block* dialog box, and a brief description about the parameter appears as well.
Type the new value and press *Enter* on the keyboard.
Once the user finishes editing the parameters, click *Ok* to accept changes and return to the drawing area.

Deleting blocks

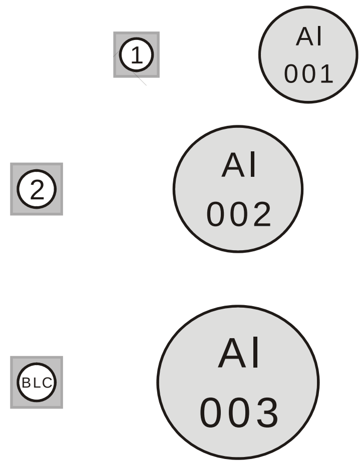
To delete a block from the *Block List*, select this block from the list and click *Delete*.
To delete the block node from the drawing area, select the block and press *Del* on the keyboard.

When a block is removed from the *Block List*, it is also removed from the drawing area, and vice-versa.

Changing the block format

There are 3 default sizes for a block node at the drawing area:

Icon **Graphic**



BLOCK SIZE 1

BLOCO SIZE 2

BLOCK SIZE 3 (default format)

To select the block size, click the right lower corner of the *Node* tool, , and the submenu will open:

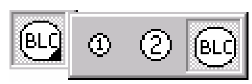


Figure 14.9 - Block Format Menu

Select the block size desired and click the drawing area to add the block.

To change the block size after adding it to the drawing area, click the *Selection* tool, , select the block to be changed and right click it to open the popup menu:

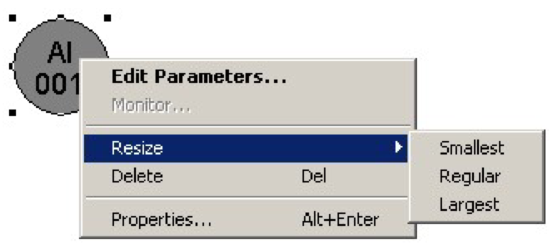


Figure 14.10 - Changing the Block Size

Point the mouse to the *Resize* option and click the block size.

Section 15

LINKING BLOCKS

Creating a direct link

A direct link connects blocks from the same configuration loop.

Select the *Node* tool, . Note that the mouse cursor changes when placed on the block node. Click on the block and the *Link* menu will open. See the following diagram:

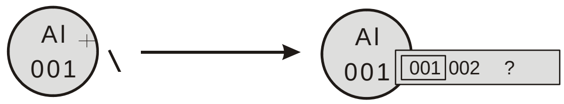


Figure15.1 - Select the Output Parameter

The block menu presents the parameters available for the link and the help button, , that opens the *Block* dialog box and the user can select graphically the output parameter.
See the example below of the AI block with the output 001 selected, signed in blue:

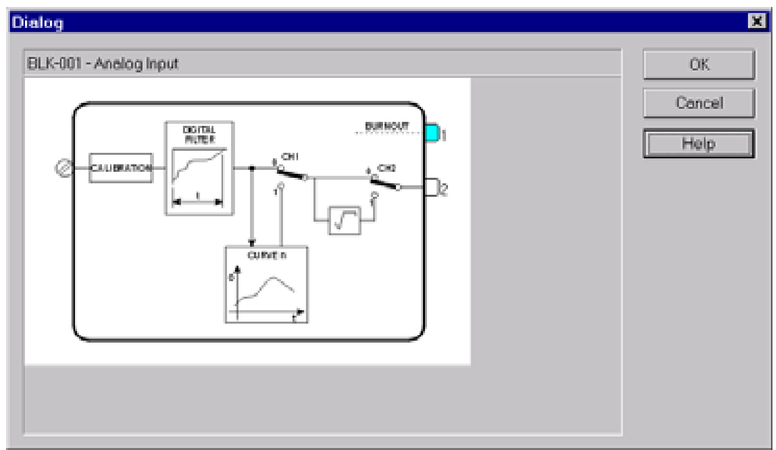


Figure 15.2 - Select the Output Parameter Graphically

Once the output parameter is selected, drag the mouse on the block that will be connected to the first one and draw the link line, then click on the second block to open the *Link* menu. See the following diagram:

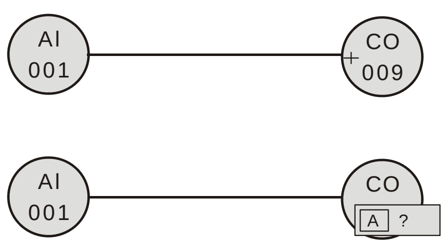


Figure 15.3 - Select the Input Parameter

The *Link* menu presents the parameters available for the link and the help button, , that opens the *Block* dialog box and the user can select graphically the input parameter. See the example below the DO block with the input C selected, signed in blue:

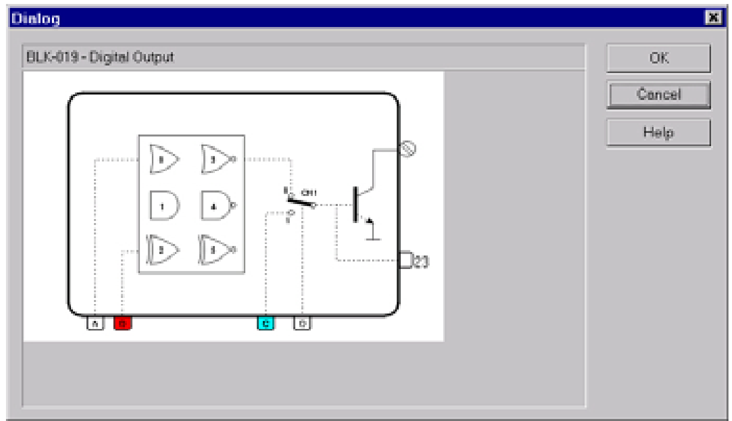


Figure 15.4 - Select the Input Parameter Graphically

If the block already has a link to one of its input parameters, this parameter will be signed in red and will not be available for another link, as the figure above shows.

Once the input and output parameters are selected, the link will be drawn as in the figure below.

Figure 15.5 - Linking Blocks

If the user clicks on a block that has no output/input parameter during the linking procedure, the link will be canceled.

To cancel the link, click the *Close* button, , at the right upper corner of the *Link* menu.

Creating a link with interruption

A link with interruption connects blocks from different loops in the same configuration project, or blocks in the same loop but there is an interruption on the line draw.

Select the *Node* tool, , click on the block to open the *Link* menu and select the output parameter, as described in the previous section.
Once the output parameter has been selected, drag the mouse onto the drawing area and right-click the area to open the popup menu, as the following diagram shows:

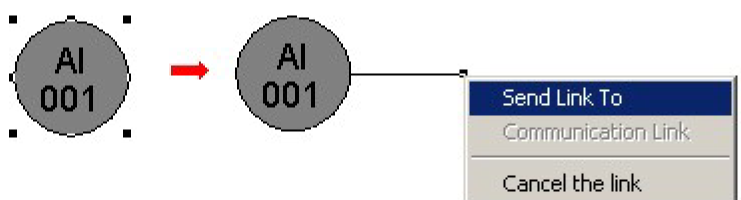


Figure 15.6 - Creating a Link with Interruption

Select the option *Link To* from the menu. The link line will be interrupted and an arrow will be drawn at the end to indicate that the link line continues in another position.

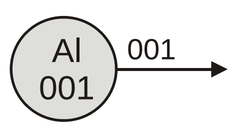


Figure 15.7 - Link with Interruption

To end the link, click the drawing area where the second block is located, whether it is on the same loop or in another loop, and the arrow indicating the link continuity will appear. Click the second block and select the input parameter.

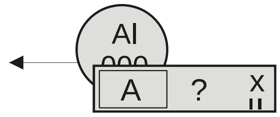


Figure 15.8 - Finalizing the Link with Interruption

To select a block placed on another loop, click the loop tab. Remember that it is only possible to click the loop tab after selecting the loop with interruption, that is, after clicking the option *Link To* from the popup menu that interrupts the line drawing.

Once the output and input parameters have been selected, the link with interruption will be drawn with the information about the blocks connected.

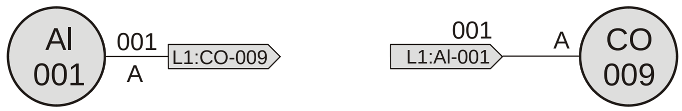


Figure 15.9 - Example of a Link with Interruption

To cancel the link, click the *Close* button, , at the right upper corner of the *Link* menu, select the option *Cancel Link* from the popup menu, or right-click the drawing area.

Figure 15.10 - Popup Menu

Creating a communication link

To create a communication link it is necessary to add the communication block to the *General Loop*. For further details see section ***Adding the communication block***.
The communication link is created from any block output parameter to the Block 119 of the *General Loop*.

Select the *Node* tool, , click the block to open the *Link* menu and select the output parameter. Drag the mouse then right click on the drawing area to open the popup menu, as indicated below:

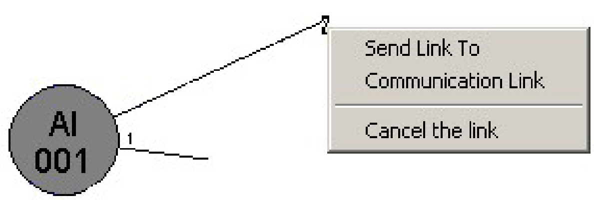


Figure 15.11 - Creating a Communication Link

Select the option *Comm Link* from the menu. The menu with the input parameters available will open. Select the input parameter. See the example below:

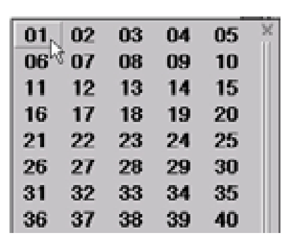


Figure 15.12 - Selecting Input 01 from the Communication Block

The link will be created for the communication block at the *General Loop*, showing the information about the link between the blocks.

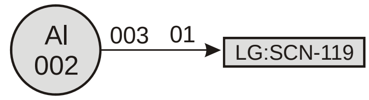


Figure 15.13 - Communication Link

To cancel the link, click the *Close* button, , at the right upper corner of the *Link* menu, select the option *Cancel Link* from the popup menu, or right-click the drawing area.

Editing the link properties

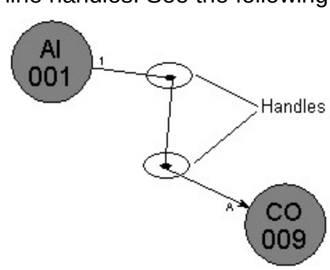
To change the link line properties click the *Select* tool, , select the link line. Press *Alt* + *Enter* on your keyboard or right-click the link to open the menu and click option *Properties*.

The *Properties* dialog box appears. The user can set the line attributes and text attributes of link.

Options	Description
	Line Palette
Thickness	Adjust the line thickness of objects.
Style	Adjusts the objects lines style: solid, dotted, dash-dot, etc.
Color	Adjusts the line color of objects.
	Text Palette
Font	Adjust the text font.
Size	Adjust the font size of text.
Font color	Adjust the font color.
Color shading	Adjusts the shading color of font
Background	Set the screen background as transparent or opaque.
Effects	Set the effects to be applied to the text: bold, italic, underline and strikethrough.
Alignment	Sets the text alignment: left, right or center.

Redrawing a link

The link line can be redrawn using line handles. See the following figure



To create a new handle, click on the link line. A "line break" will be inserted on the line. To remove a handle, right click the "line break" of the link line and it will be deleted.

To redraw a link line, place the cursor on the handle and it will change to a cross. Click and hold the mouse button pressed while dragging the handle to the desired position. To draw a straight horizontal or vertical line from the reference point of the handle press and hold the CTRL key while dragging the handle.

Removing a link

To remove a link from a block, click the *Select* tool, , select the link to be removed and press *Del* on your keyboard. Or right click on the link to open the popup menu and click the option *Delete*, as indicated below:

Figure 15.14 - Popup Menu

The link will be removed from the configuration.

COMMUNICATION

The data to be sent or received by the **CD600 Plus** is defined by the communication blocks **BLK119**, **BLK120** and **BLK121**.
These blocks should be allocated in the *Loop G* of the configuration, each one with a specific function:

- **BLK119** (**SCAN**) - All data required by the communication bus are available in this block. The block contains: analog and/or digital outputs from any functional block used in a configuration, alarm limits and status, digital inputs and outputs, status of L/R and A/M selectors and totalizations.
- **BLK120** (**PID**) - The values of Proportional Gain (KP), Integral Time Constant (TR), Derivative Time (TD) and Bias (B) of the PID Controller blocks can be read and changed by the communication bus with this block.
- **BLK121** (**ACTUATION**) - This block is used to actuate the controller's commands, such as L/R and A/M selectors and to change values such as SP, manual output and registers of the controller. It changes the alarm limits and generation of analog and discrete variables.

Checking the controller

To check the **CD600 Plus** identification address:

1. Press the <ACK> key at the front panel of the **CD600 Plus** and hold for a few seconds until the display message changes.
2. Press the <ACK> and the <DSP> keys together, the display will show the Identification Address of the **CD600 Plus**.
3. Use the keys <Δ> and <∇> on the front panel of the controller to change the numerical value of the display. The value “1” means that the controller accepts the communication with the PDA only. Values from “2” and “30” are the programmed controller addresses in the serial communication network.
4. Click the <LP> key to return to normal operation.

Configuring the communication

To configure the communication, go to the *Tool* menu and click *Comm Settings*. The *Communication Settings* dialog box will open:

<u>Shortcut:</u>
Keyboard: F10

To configure the remote communication via Ethernet, it will be necessary to configure the serial port of the ENET-710 module. Refer to the ENET-710 User’s Manual for further information to configure the module.

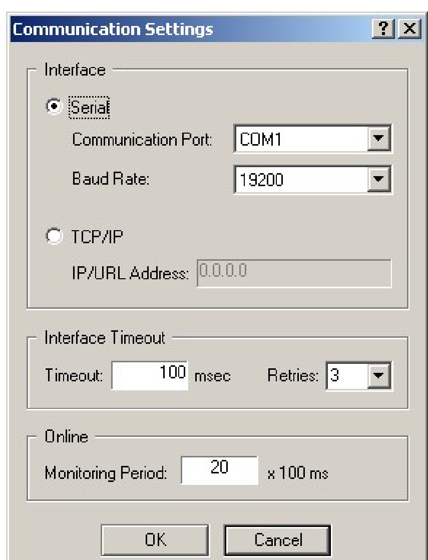
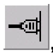


Figure 16.1 - Communication Settings Dialog Box

- At the *Communication Port*, select the serial port that is connected to the **CD600 Plus**.
- At the *Network Baud Rate*, select network communication speed.
- At the *IP/URL Address*, type the IP Address or the URL of the computer connected to the **CD600 Plus**.
- At the *Interface Timeout*, select the timeout when trying to communicate with the interface.
- At the *Retries*, select the number of attempts to connect to the communication interface.
- At the *Monitoring Period,* set the period, in seconds, for the refreshing time of the variables under supervision. The minimum period is 100 ms and the maximum is 5000 ms.

Click *Ok* to close this dialog box and return to the drawing area.

Initializing the Communication

To initialize the communication, go to the *Tool* menu and click *Online*. Or click the button *Online*, , on the main toolbar. The *Online* dialog box will open:

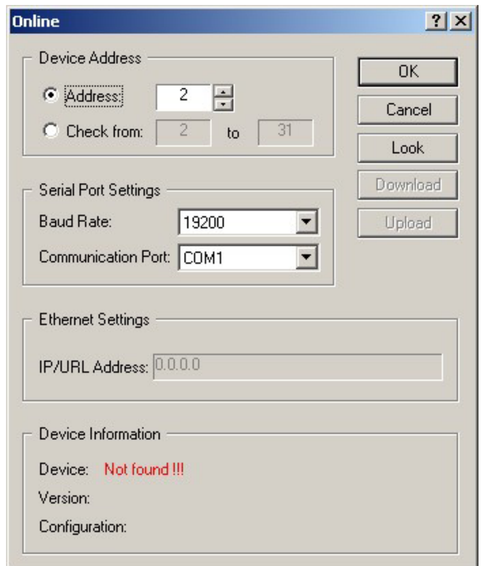


Figura 16.2 – Online Dialog Box

If the **CD600 Plus** address is known, select the address number on the *Address* box. Anyway, choose the option *Check from* and type the possible range of values, and the application will search for the equipment's address.

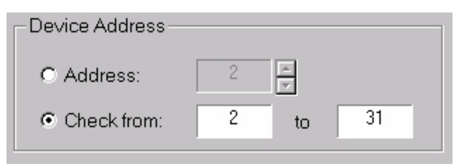


Figura 16.3– Selecting Possible Address Values

On the *Online* dialog box, the user can also configure the serial ports, as well as the network baud rate and the communication ports:

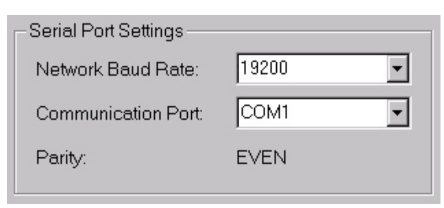


Figure 16.4- Serial Port Settings

Click the button *Look* to search the device. In case the user chooses to search the device from a range of possible values, this search will return a list of devices available for communication. Select the device desired then click *Ok*, as indicated below:

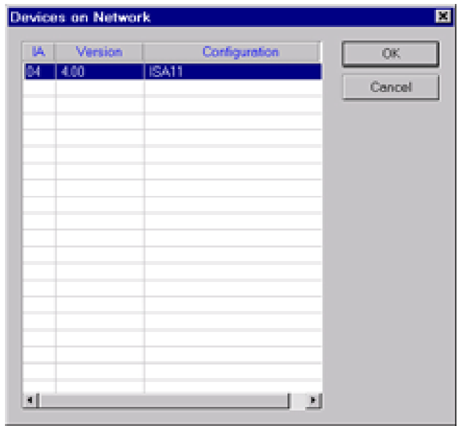
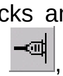


Figure 16.5- Selecting the Device

The *Online* dialog box reports the information about the device selected for the communication.

Figure 16.6- Information about the Device Selected

Uploading the device configuration

To upload the blocks and parameters values from the device, first open the *Online* dialog box, clicking the button, , and follow the instructions described in the previous section to locate the device desired.
Once the device is selected, click the button *Upload* at the *Block* dialog box to load the configuration from the device to the *Block List*. The message below will appear to indicate that the configuration was uploaded with success:

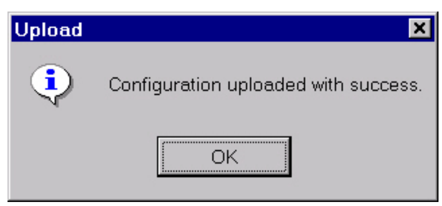


Figure 16.7- Upload Complete

If there is a configuration project open, a message box will appear:
- Click *Save and Download* to save the current configuration then execute the download.
- Click *Only Download* to execute the download without saving.
- Click *Cancel* to abort the download

Click *Ok* to close this dialog box and then close the *Online* dialog box. Another message will prompt asking the user whether the configuration uploaded is to be used on the project file or the user will discard the information and keep the current block configuration.

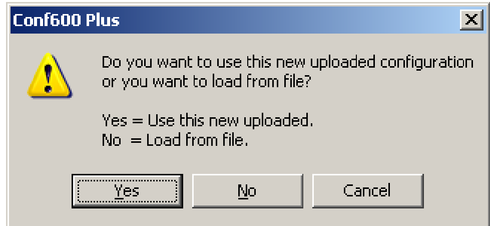
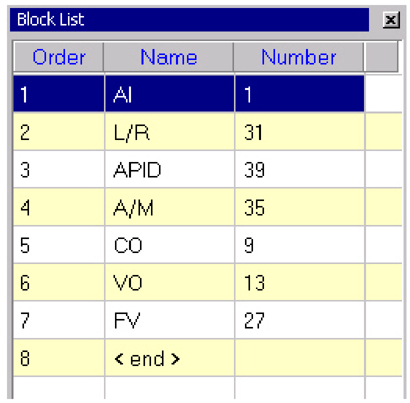


Figure 16.8- Confirm Upload Dialog Box

At the **CONF600 Plus** main window, if the user uploaded the device configuration the *Block List* will show the blocks uploaded from the device and added to the configuration project. See the example below:

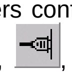

Block List

Order	Name	Number
1	AI	1
2	L/R	31
3	APID	39
4	A/M	35
5	CO	9
6	VO	13
7	FV	27
8	< end >	

Figure 16.9- Uploaded Configuration Example

The values of the block parameters and the links between the blocks are also uploaded from the device, but it will be necessary to drag the blocks from the list to the drawing area and draw the configuration strategy.

Downloading the configuration to the device

To download the blocks and parameters configured in the project file to the device, first open the *Online* dialog box, clicking the button, , and follow the instructions described in the section ***Initializing the communication*** to locate the device desired. Then click the button *Download* at the *Block* dialog box to download the configuration to the controller.

If there is a configuration project open, a message box will appear:
- Click *Save and Download* to save the current configuration then execute the download.
- Click *Only Download* to execute the download without saving.
- Click *Cancel* to abort the download.

Showing communication values

Open the *Online* dialog box, clicking the button , and follow the instructions described in the section ***Initializing the communication*** to locate the device desired. Then click the button *Go Online* at the *Block* dialog box to read the parameter values from the device and show all of the values of the links in the drawing area.

The *Online* button will be selected indicating the parameters are being monitored. Click the button again to stop monitoring.

Monitoring the parameters of a block

Before monitoring the values of the parameters for a specific block, check if the ID of the **CD600 Plus** is configured properly. Click the button *Online*, , on the main toolbar to open the *Online* dialog box. The *Online* dialog box should report the information about the device selected for the communication, as indicated in the figure:

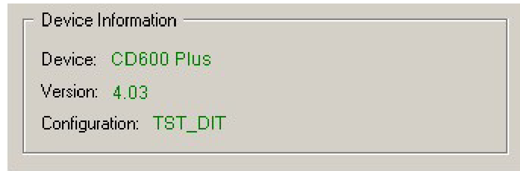


Figure 16.10 - Information on the selected CD600 Plus

See *Initializing Communication* section for details.

Select the block to be monitored, then right-click to open the menu. Click on *Monitor*. The *Block Monitor* dialog box will open:

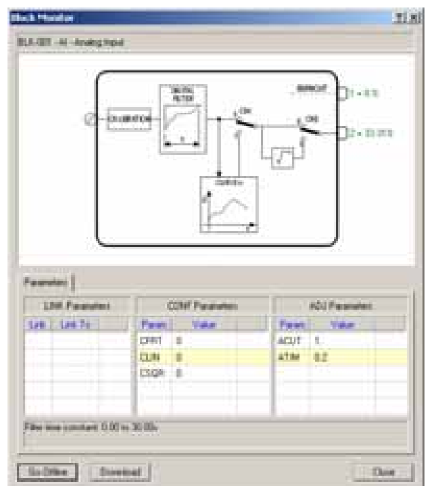


Figure 16.11 - Block Monitor Dialog Box

The values of the parameters will be displayed. Double-click the value field to edit a parameter.

Click the button *Go Offline* to stop monitoring the parameters.

If changes have been made to the parameters, it is possible to download the new values to the controller clicking the *Download* button.

Click *Close* to exit this dialog box.

Updating the configuration

If the project configuration is updated in the online operation mode, such as adding a new block or editing a parameter, the user can update this information in the controller instead of executing the download for the entire configuration.

Go to *Tool* menu and click *Update* to update all loops of the configuration in the device.

<u>Shortcut:</u>
Keyboard: Ctrl + F8

Section 17

CALIBRATION

The **CD600 Plus** is factory calibrated according to procedures complying with the ISO9000 Standards. If a new calibration is required, it can be easily done through the **CONF600 Plus**.

First, check the **CD600 Plus** identification address. Press the <ACK> key at the front panel of the **CD600 Plus** and hold for a few seconds until the display message changes. Then press the <ACK> and the <DSP> keys together, the panel display will show the Identification Address of the **CD600 Plus**. The user can change the numerical value of the display with the keys <Δ> or <∇>. The value "1" means that the controller accepts communication with the Hand-Held Terminal only. Values from "2" up to "30" are the programmed controller addresses in the serial communication network. Click the <LP> key to return to normal operation.

The table below displays the input and output parameters available for the **CD600 Plus** calibration.

AI – Auto								
	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8
0V	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1V	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3V	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
5V	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000

AI – Manual								
	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8
0V	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1V	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3V	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
5V	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000

CO 0-20mA				
	CO1	CO2	CO3	CO4
0%	0.000	0.0p00	0.000	0.000
100%	20.000	20.000	20.000	20.000

CO 4-20mA				
	CO1	CO2	CO3	CO4
0%	4.000	4.000	4.000	4.000
100%	20.000	20.000	20.000	20.000

VO 0-5V				
	VO1	VO2	VO3	VO4
0%	0.000	0.000	0.000	0.000
100%	5.000	5.000	5.000	5.000

VO 1-5V				
	VO1	VO2	VO3	VO4
0%	1.000	1.000	1.000	1.000
100%	5.000	5.000	5.000	5.000

Analog Input

The analog inputs are 0-5V voltage inputs. To convert the voltage inputs into 0-20mA current inputs, connect the 250 Ω shunt resistor to the terminal.

To calibrate an analog input **J** (J = AI1 to AI8), follow these steps:

a) Check if the input to be calibrated will work as current or voltage input. If it will work as a current input, it is recommended to use the same shunt resistor that will be used during operation;
b) Connect the voltage or current generator with indicator to the terminals corresponding to the **J** input;
c) Select the output from the **J** analog input block to be displayed on the controller. Be sure that the square root extraction and linearization function are not activated;
d) Connect the computer to the controller through the ICS2.0-1 interface;
e) Go to the *Tool* menu and click *Calibration* to open the *Calibration* dialog box. Select the device address using the Identification Address value and click the button *Look* to locate the device:

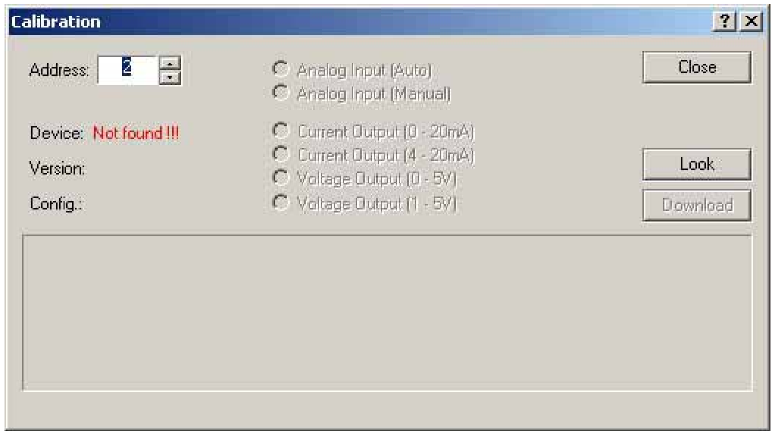


Figure 17.1 - Calibration Dialog Box

The device selected will be displayed:

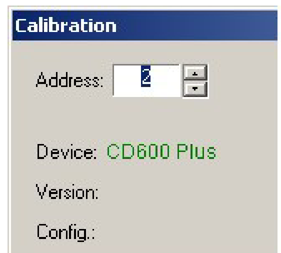


Figure 17.2 - Selected Device

The controller has two options: *Automatic* and *Manual*. The *Automatic* mode is faster while the *Manual* mode allows the user to read the parameters during calibration.

Analog Input Calibration - Automatic Mode

a) Select the option ***Analog Input (Auto)*** in the *Calibration* dialog box.

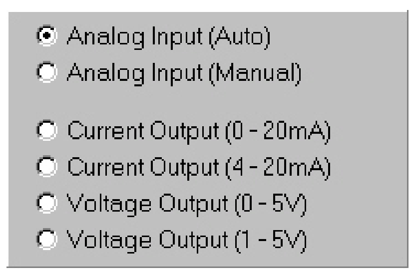


Figure 17.3 - Analog Input - Automatic Calibration

b) Select the input to be calibrated, from AI1 to AI8. The cell's background color will change to red.

The user can select all the inputs to be calibrated together.

c) Apply 0V or 0mA with the voltage/current generator and select the 0V header cell at the table.

d) Apply 1V or 4mA with the voltage/current generator and select the 1V header cell at the table.

e) Apply 3V or 12mA with the voltage/current generator and select the 3V header cell at the table.

f) Apply 5V or 20mA with the voltage/current generator and select the 5V header cell at the table.

Repeat steps ***c*** to ***f*** for the inputs to be calibrated, if the user hasn't selected all of the inputs to be calibrated at the same time.

Analog Input Calibration - Manual Mode

This option enables the user to read and record, eventually, the calibration parameters. This mode is not fast and straightforward as the *Automatic* mode, but it is safer.

a) Select the option ***Analog Input (Manual)*** in the *Calibration* dialog box.

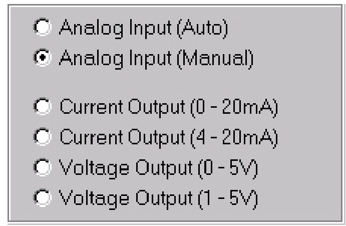


Figure 17.4 - Analog Input - Manual Calibration

b) A dialog box will open asking the user if the default configuration is to be opened. Click *Ok* to open this configuration or *Cancel* to start a new calibration.
c) Double-click the value field to be edited and the field becomes enabled for editing. At the 0V cell type the new value **0** and press *Enter* on the keyboard.
d) Repeat step c for the 1V, 3V, and 5V cells.

Once the values for the parameters have changed, the *Download* button will be enabled. This means that the default values haven't been downloaded to the CD600 Plus.

e) After editing the values, click the button *Download* at the *Calibration* dialog box to download the new values to the device. The *Download* message box will appear to indicate the calibration was downloaded with success:

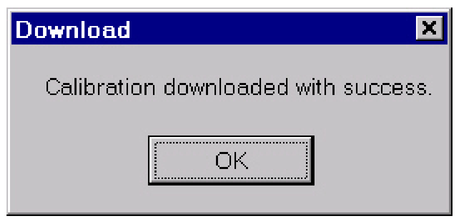


Figure 17.5 - Calibrating the Device

After downloading the values to the CD600 Plus, the *Download* button will be disabled, which means that the default values have been downloaded to the controller.

f) At the **CD600 Plus** front panel, select the analog input using the <LP> key.
g) For each analog input, repeat these steps execute for the **AI1**:
   i. Apply 0V or 0mA with the voltage/current generator to the AI1.

   ii. Read the AI1 value indicated in the **CD600 Plus** front display.

Press the <DSP> key at the CD600 Plus front panel to view the input values.

   iii. At the *Calibration* dialog box, double-click the value field to be modified that corresponds to 0V and type the AI1 value read from the display.
   iv. Press *Enter* on the keyboard and the new value has been edited. Repeat these steps for 1V or 4mA, 3V or 12mA, 5V or 20mA.

h) To select another input, connect the voltage/current generator to this input and repeat steps ***i*** to ***iv*** to calibrate all inputs.
i) After editing the values, click the button *Download* at the *Calibration* dialog box to download the new values to the device. The *Download* message box will appear to indicate the calibration was downloaded with success:

Figure 17.6 - Calibrating the Device

Current Output

The current output can be 4-20 mA (live zero) or 0-20 mA (dead zero). Selection is made in the blocks 009 to 012.

Connect a current indicator (mA) to the output to be calibrated and select the output to be adjusted on the front panel. The program used in the controller has the current output 1 (BLK009) driven by the A/M station of Loop 1. It is possible to adjust the current output with the controller in Loop 1 and in Manual mode.

a) Select the option ***Current Output*** (***0-20 mA*** or ***4-20 mA***) in the *Calibration* dialog box.
b) A dialog box will open asking the user if the default configuration is to be opened. Click *Ok* to open this configuration or *Cancel* to start a new calibration.
c) Click the output cells to apply the default values.
d) Click the *Download* button.
e) At the **CD600 Plus** front panel, select the outputs using the <LP> key.
f) Set the output values to 0% using the <∇> key at the front panel and verify the reading at the current indicator (that should be connected to the corresponding output at the **CD600 Plus** terminal). If the value read is not 0, or 4 mA according to the option selected, type the new value at the output field in the *Calibration* dialog box:
    i. Double-click the value field to be edited, corresponding to 0%.
    ii. Type the value read from the current indicator.
    iii. Press *Enter* to confirm the new value.
g) Set the output values to 100% using the <∆> key at the front panel and verify the reading at the current indicator. If the value read is not 20mA, type the new value at the output field in the Calibration dialog box:
    i. Double-click the value field to be edited, corresponding to 100%.
    ii. Type the value read from the current indicator.
    iii. Press *Enter* to confirm the new value.
h) After editing the values, click the button Download at the Calibration dialog box to download the new values to the device. The Download message box will appear to indicate the calibration was downloaded with success.

Voltage Output

The voltage output is calibrated like the current output. The only difference is that a voltage meter will be connected to the output instead of a current meter.

a) Select the option ***Voltage Output*** (***0-5 V*** or ***1-5 V***) in the *Calibration* dialog box.
b) A dialog box will open asking the user if the default configuration is to be opened. Click Ok to open this configuration or Cancel to start a new calibration.
c) Click the output cells to apply the default values.
d) Click the Download button.
e) At the CD600 Plus front panel, select the outputs using the <LP> key.
f)
g) Set the output values to 0% using the <∇> key at the front panel and verify the reading at the voltage meter (that should be connected to the corresponding output at the CD600 Plus terminal). If the value read is not 0V, or 1V according to the option selected, type the new value at the output field in the Calibration dialog box:
    i. Double-click the value field to be edited, corresponding to 0%.
    ii. Type the value read from the voltage meter.
    iii. Press *Enter* to confirm the new value.
h) Set the output values to 100% using the <∆> key at the front panel and verify the reading at the voltage meter. If the value read is not 5V, type the new value at the output field in the Calibration dialog box:
    i. Double-click the value field to be edited, corresponding to 100%.
    ii. Type the value read from the voltage meter.
    iii. Press *Enter* to confirm the new value.
i) After editing the values, click the button Download at the Calibration dialog box to download the new values to the device. The Download message box will appear to indicate the calibration was downloaded with success.

CONF600 Plus Tutorial

The figure below presents a simple example of a strategy control that will be implemented in the **CD600 Plus**.

The focus will be on a project where Fluid A and Fluid B mix in a 4 to 1 proportion. Consider that the transmitter at Fluid A measures 100% of flow at 80Kg/s while transmitter at Fluid B measures 100% at 20Kg/s. A PID function block combined with other function blocks will be used to implement the control logic.

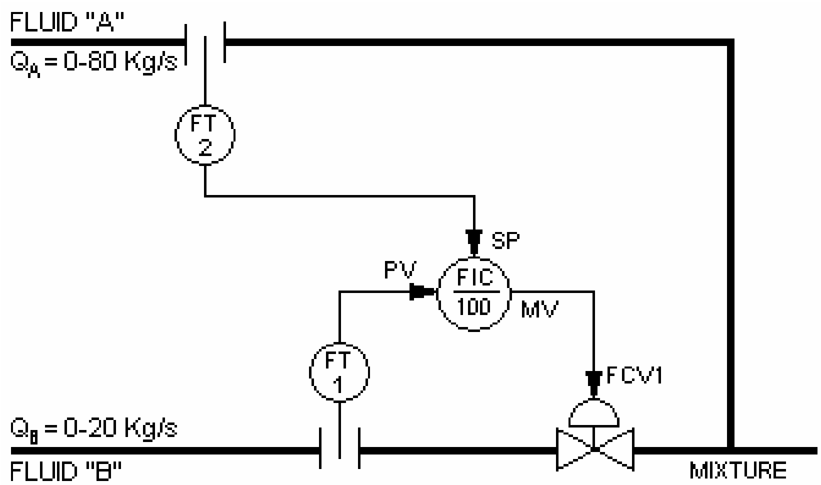


Figure 18.1 - Desired Control Loop

The following figure shows what will be the final look of the strategy control implementation. Notice that *Function Blocks* are represented with circles with an identification mnemonic (AI for Analog Input, A/M for Auto-Manual Switch, etc.) and a unique number that represent its instance. *Function Block* outputs are shown as numbers while inputs are represented by letters. A terminal may represent a physical input or output.

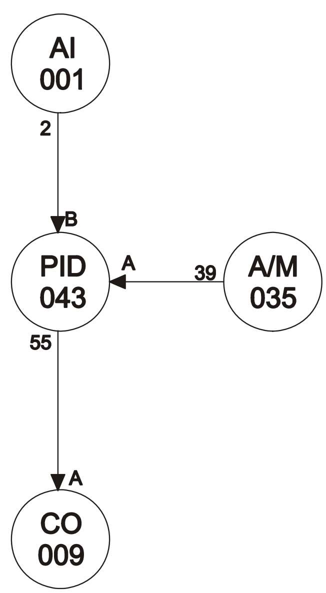


Figure 18.2 - Strategy Control

Starting the Configurator

To start **CONF600 Plus**, select the *Start menu > Programs > Smar > CONF600 Plus > CONF600 Plus*.

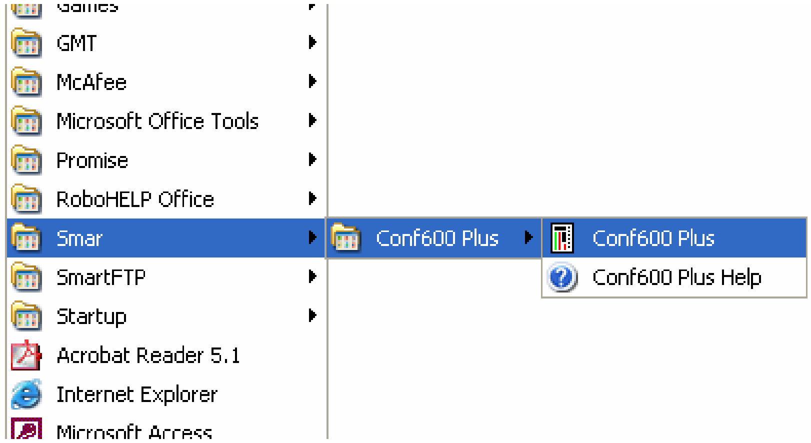
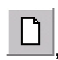


Figure 18.3 - Starting the CONF600 Plus

Creating a New Configuration

Click the *New* button, , on the main toolbar. A new project window will open. There are 5 tabs at the bottom of the page representing the loops:

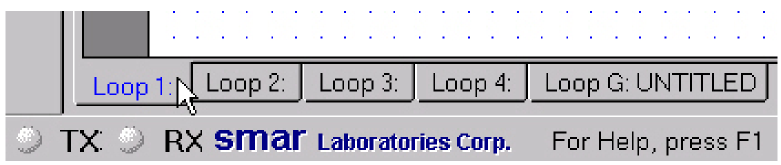


Figure 18.4 - Loop Tabs

To name the configuration project, right-click on the *Loop G* tab. The *Loop Name* dialog box will open. Type the name "Sample" in the text box (the name is limited to 8 characters). It means that the configuration project will be saved with this name. Click *Ok* to conclude this task.

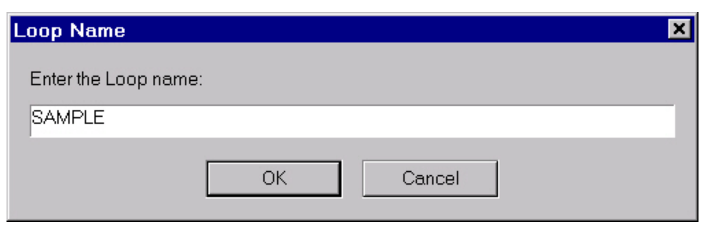


Figure 18.5 - Loop Name Dialog Box

Building the Strategy

Adding blocks

1. Right-click the *Loop 1* tab and type the name "Mix A.B" at the *Loop Name* dialog box. Click *Ok* to return to the working area.
2. Select the *Node* tool, , on the *Drawing* toolbar.
3. Move the cursor onto the working area. The mouse cursor will turn into a circle. Click the drawing area to place a new *Function Block* and the *Block* dialog box will open.

4. Select the **Analog Input** block. Make sure to select the **001** from the *Block ID* list.

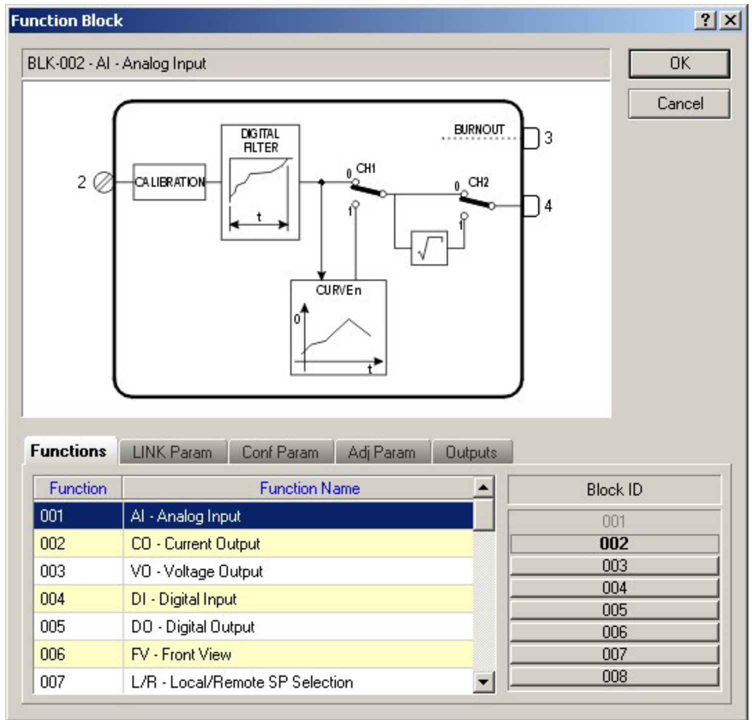


Figure 18.6 - Function Block Dialog Box

5. Click Ok. The AI block will be drawn.
6. Place the cursor right below the AI block and click the drawing area to add another block.
7. Select the Simple PID block. Make sure to select the 043 from the Block ID list.
8. Click Ok to return to the working area.
9. Now repeat the process described in the steps 2 to 5 to add the blocks listed in the table below:

Function Block	Block ID
AI (Analog Input)	002
CO (Current Output)	009
FV (Front View)	027
A/M (Automatic/Manual Station)	035

The drawing area should look similar to the figure below:

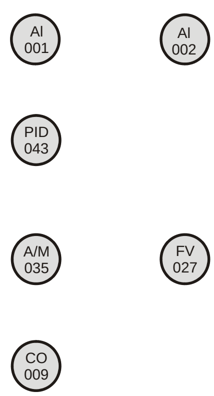
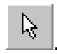


Figure 18.7 - Drawing Area

Moving blocks

Follow these steps to move blocks and arrange them on the drawing area:

1. Click the *Select* tool, .
2. Click on the *Function Block* to select it.
3. Click and hold the mouse button pressed while dragging the block node to the desired position.

Linking Function Blocks

1. Select the *Node* tool, , on the *Drawing* toolbar, and place the cursor on the AI (001) function block. The mouse cursor changes when placed on the block node. Click on the block and the *Link* menu will open.

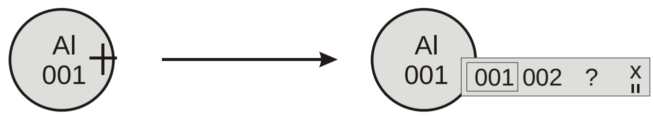


Figure 18.8 - Link Menu

2. Click the *Help* button, , to open the *Block* dialog box.
3. Click the output **2** and its color will change to light blue.

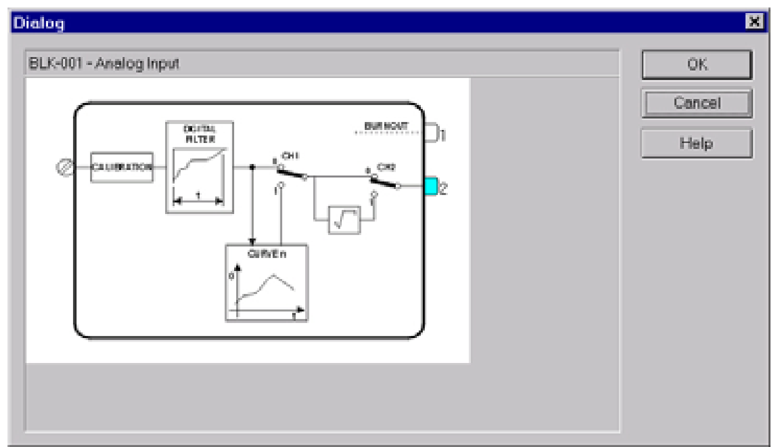
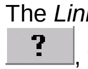


Figure 18.9 - Select Output Parameter

4. Click *Ok* to return to the working area.
5. A "rubber band" is connected to the cursor. Place the cursor on the PID (043) block, and click this node.
6. The *Link* menu will open presenting the input parameters available. Click the *Help* button, , to open the *Block* dialog box.
7. Click the input **B** and its color will change to light blue.

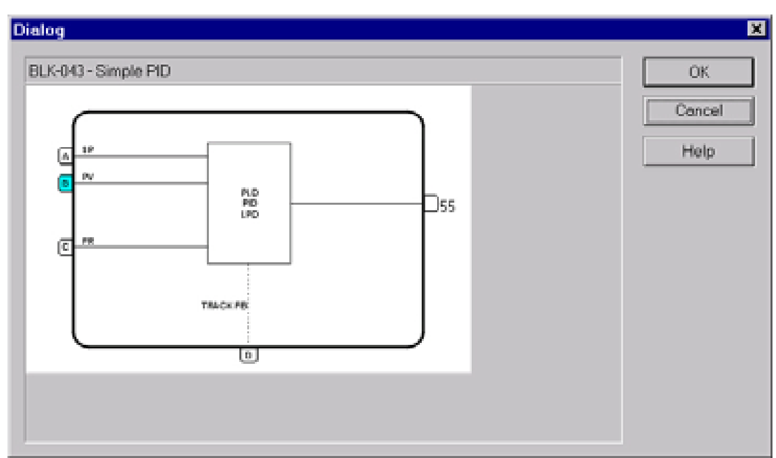


Figure 18.10 - Select Input Parameter

8. Click *Ok* to conclude this task and return to the working area.
9. The configuration should look similar to the figure below.

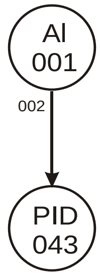


Figure 18.11 - Linking Blocks

Creating all links

1. Select the *Node* tool, , on the *Drawing* toolbar, and place the cursor on the AI (002) block. Click on the block and the *Link* menu will open.
2. Select the output **4** and drag the cursor to the FV (027) block.
3. Click on the block node and select the input **A** from the *Link* menu.
4. Repeat step 1 and select the output **4** again.
5. Drag the cursor down to the PID (043) block.
6. Click on the block node and select the input **A** from the *Link* menu.
7. Repeat these steps until all links have been made according to the figure below:

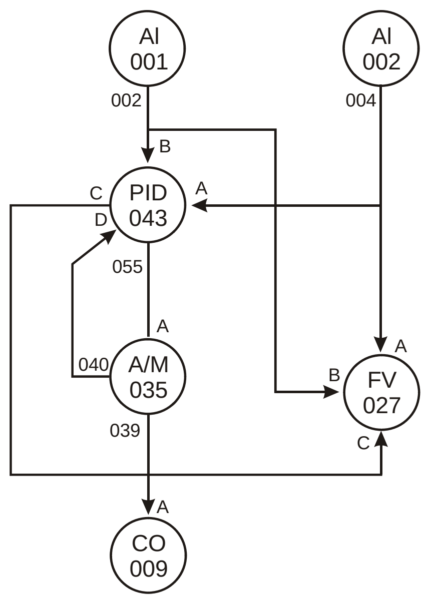
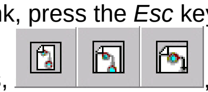


Figure 18.12 - Complete Strategy Control

Notes:

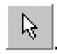
- Each mouse-click adds a “line break” to the link line. To remove a line break, right-click on it.
- To quit drawing the link, press the *Esc* key on the keyboard.
- Use the zoom buttons, , on the main toolbar, to increase or decrease the zoom on the drawing area.

Redrawing links

1. Click the *Select* tool, .
2. Place the cursor on the line break of the link to be redrawn and it will change to a cross.
3. Click and hold the mouse button pressed while dragging the handle to the desired position.

To draw a straight horizontal or vertical line from the reference point of the handle, press and hold the CTRL key while dragging the handle.

Checking the Environment

1. Click the *Select* tool, .
2. Select the PID (043) block then right-click it to open the popup menu.
3. Select the option *Edit Params*. The *Block* dialog box will open. There are 3 classes of parameters: LINK parameters, CONF parameters and ADJ parameters, starting with L, C and A respectively. All parameters are at the default values, except for the LINK parameters.

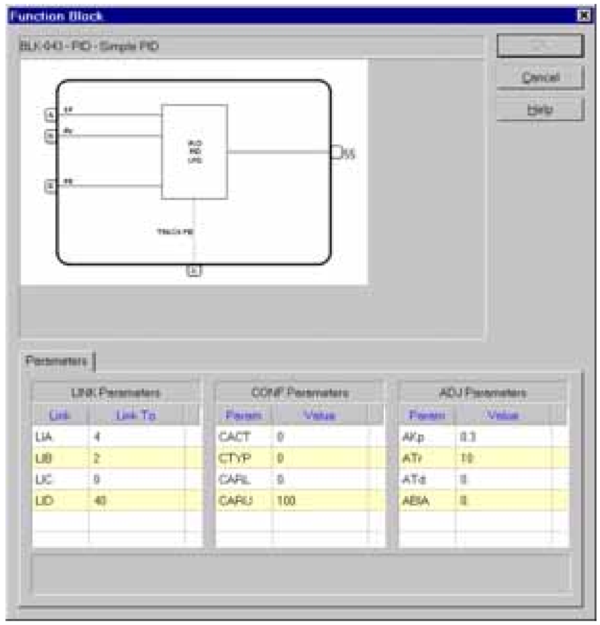


Figure 18.13 - Checking Block Parameters

4. Close the dialog box and return to the configuration project.

Changing Parameter Values

Based on the sample project presented at the beginning of this appendix, it will be necessary to change some of the parameter values for proper operation. The parameters to be edited are displayed in table below:

Function Block	Parameter	Description	Default Value	New Value
PID (043)	AKp	Proportional Gain	0.30	1.20
PID (043)	ATr	Reset Time (min/repetition)	10.00	2.00
AI (001)	CSQR	Square Root	0.00	1.00

Changing parameter values of the PID (043) block

1. Click the *Select* tool, .
2. Select the PID (043) block, then right-click it to open the popup menu.
3. Select the option *Edit Params*. The *Block* dialog box will open.
4. Double-click the value field of the AKp parameter in the *ADJ Parameters* column. The field becomes enabled for editing.
5. Type the new value **1.20** and press *Enter* on the keyboard.
6. Double-click the value field of the ATr parameter in the *ADJ Parameters* column.
7. Type the new value **2.00** and press *Enter*.
8. Click OK to accept changes and return to the working area.

Changing parameter values of the AI (001) block

1. Click the *Select* tool, .
2. Select the AI (001) block then right-click it to open the popup menu.
3. Select the option *Edit Parameters*. The *Block* dialog box will open.
4. Double-click the value field of the CSQR parameter in the *CONF Parameters* column.
5. Type the new value **1.00** and press *Enter*.
6. Click OK to accept changes and return to the working area.

QUICK GUIDE OF INSTALLATION

This appendix is a summary for the user to install the CD600 Plus. It assumes that the user has a previous knowledge about it.

This appendix informs:
- Which tools and equipments are necessary to install it;
- How to install it (electrically and mechanically);

Tools and Equipments necessary for the Installation

The items necessary for the installation are:
- Screwdriver;
- Cables for power supply;
- Cables for I/O signals;
- Cables for communication;
- ICS 2.0P interface for serial communication or ENET-710 for Ethernet.

Procedures

Check the content of the CD600 PLUS packing (See section 9 – Installation, in the CD600 Plus Manual)

Check:
- The model that matches the ordering code;
- The equipment did not have any damage during transportation;
- The CD600 Plus manual, CD with configuration software and fixing clip to attach the controller to the panel is inside the packing box according to the ordering code.

If some item of the code is not included, contact Smar Equipamentos Industriais Ltda.

Mechanical Installation of the Controller

The figure 1 shows the CD600 Plus inserted in the panel cut-out (front view of the panel).

Figure 1 – CD600 PLUS partially inserted in the panel cut-out.

Figure 2 shows the screwdriver and the fixing clip bolt of the CD600 Plus (back view of the panel)

Figure 2 – Screwdriver on the CD600 Plus fixing clip bolt

The figure 3 shows the lower and upper fixing clip inserted in the opening of the CD600 housing to attach it to the panel.

Figure 3 – CD600 Plus Fixing clip

Figure 4 shows the correct way to tie the cables on the CD600 Plus back part, so that access to the shunt resistors is not obstructed.

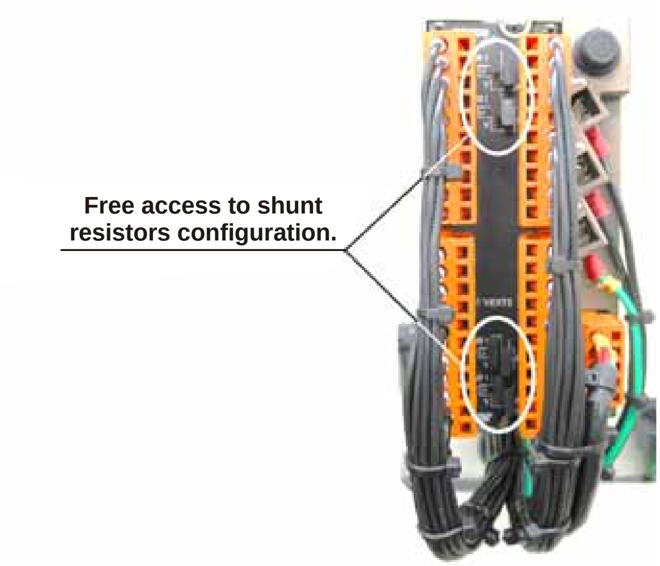
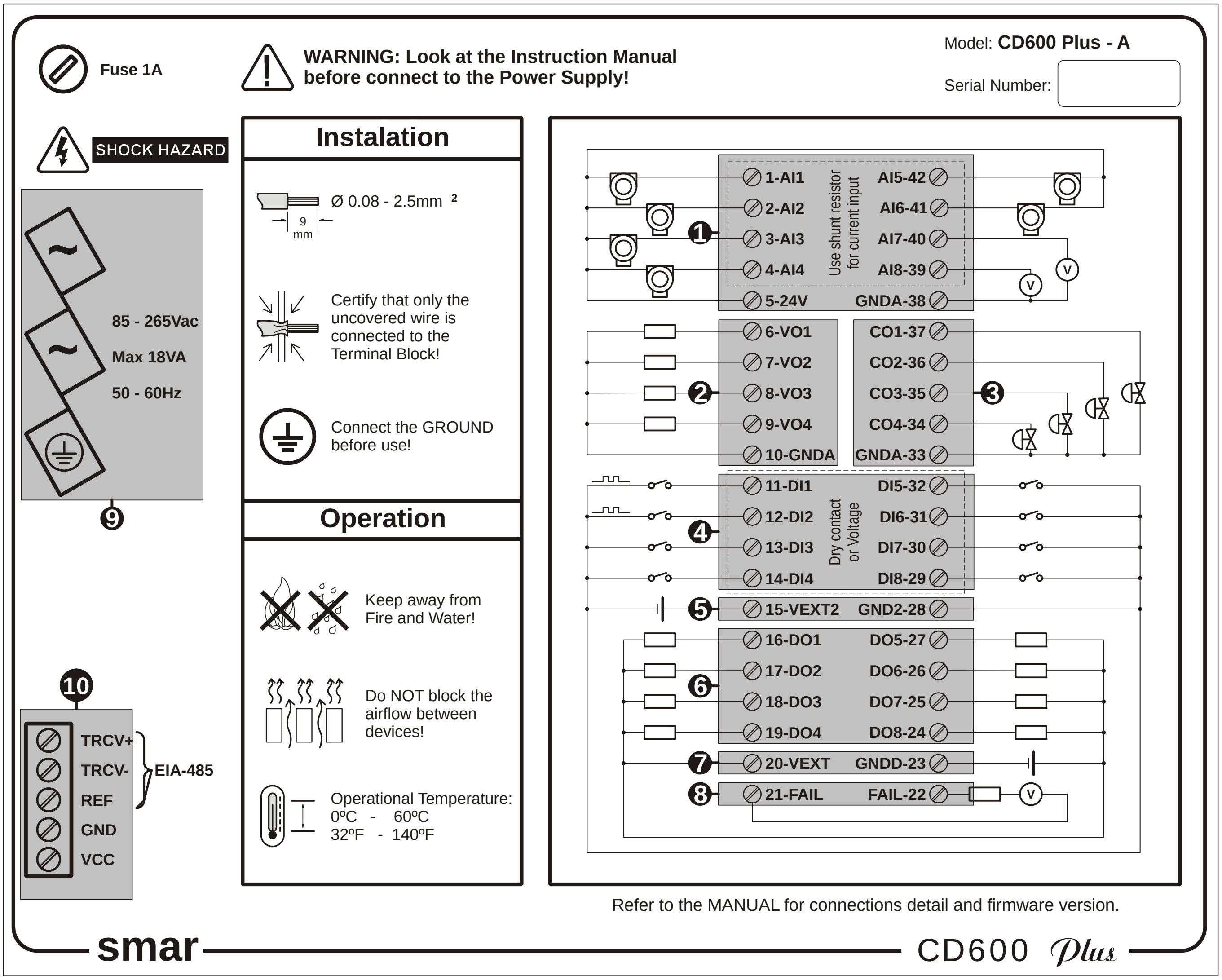


Figure 4 – Correct way to tie the terminal block cables.

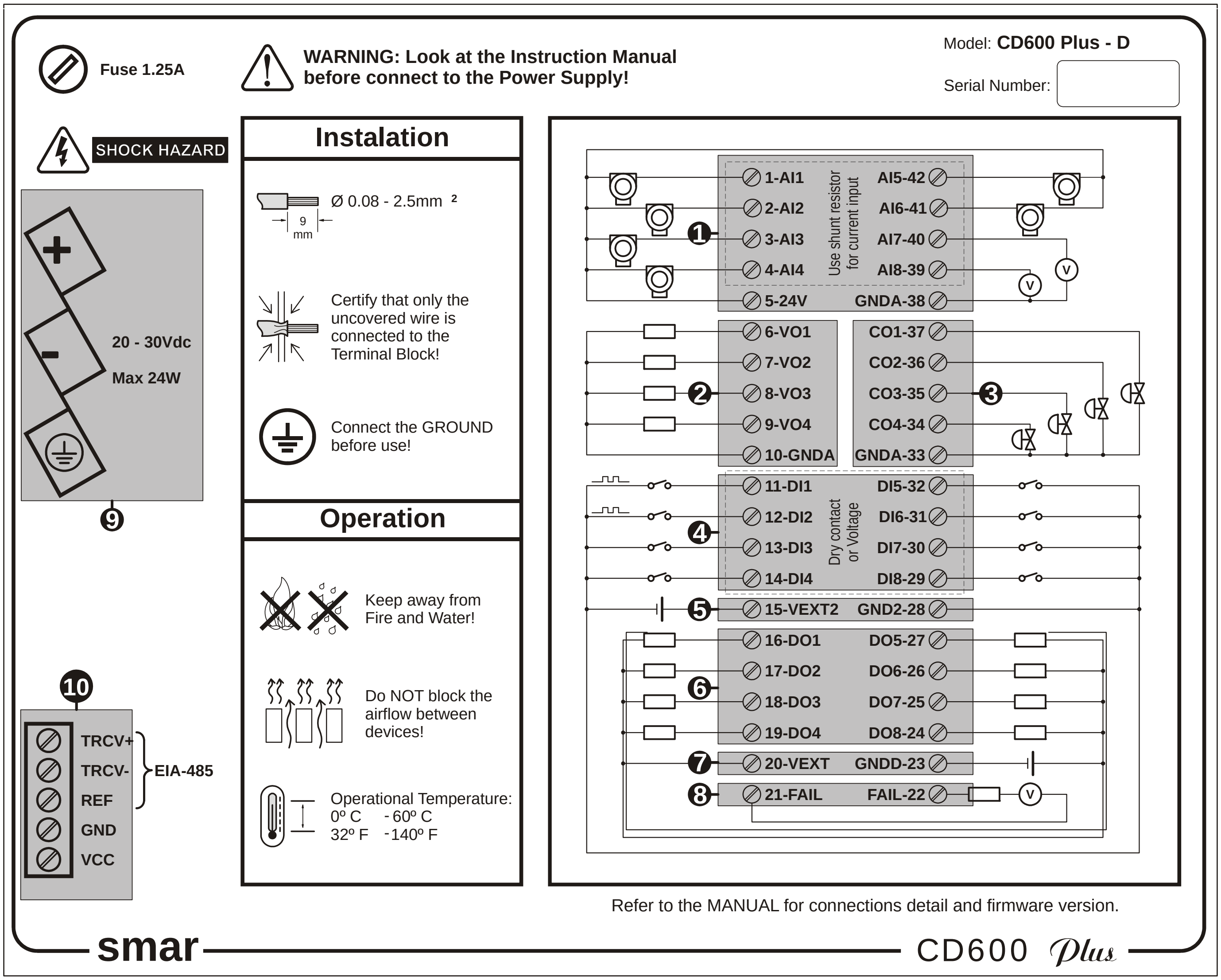
Electrical Installation of the controller

Figure 5 and 6 show the labels attached to the CD600 Plus side, AC and DC model, respectively. See through theirs legend the terminals meanings.



LEGEND	
❶ – Analog Input.	❻ – Digital output.
❷ – Voltage analog output.	❼ – External power supply for digital output.
❸ – Current analog output.	❽ – Fail.
❹ – Digital input.	❾ – Power supply terminals.
❺ – External power supply for digital input.	❿ – EIA – 485 – Communication.

Figure 5 – Side label with the terminal block diagram for the CD600 Plus AC model.



LEGEND	
❶ – Analog Input.	❻ – Digital output.
❷ – Voltage analog output.	❼ – External power supply for digital output..
❸ – Current analog output.	❽ – Fail.
❹ – Digital input.	❾ – Power supply terminals.
❺ – External power supply for digital input.	❿ – EIA – 485 – Communication.

Figure 6 – Side label with the terminal block diagram for the CD600 Plus DC model.

To insert the connection wire for Input/Output and terminal block communication, follow the steps below:

1 – Insert the screwdriver in the rectangular cavity of the terminal blocks. (Do not force the screwdriver in the block side, because it can damage it).

2 – Rotate the screwdriver at a 90º angle. The cavity for the wire insertion will open.

3 – Insert the uncovered part of the wire in the cavity and rotate the screwdriver again in the opposite direction to press the wire in the cavity.

NOTE
To guarantee the electrical contact insert only the uncovered wire in the cavity.

See figure 7

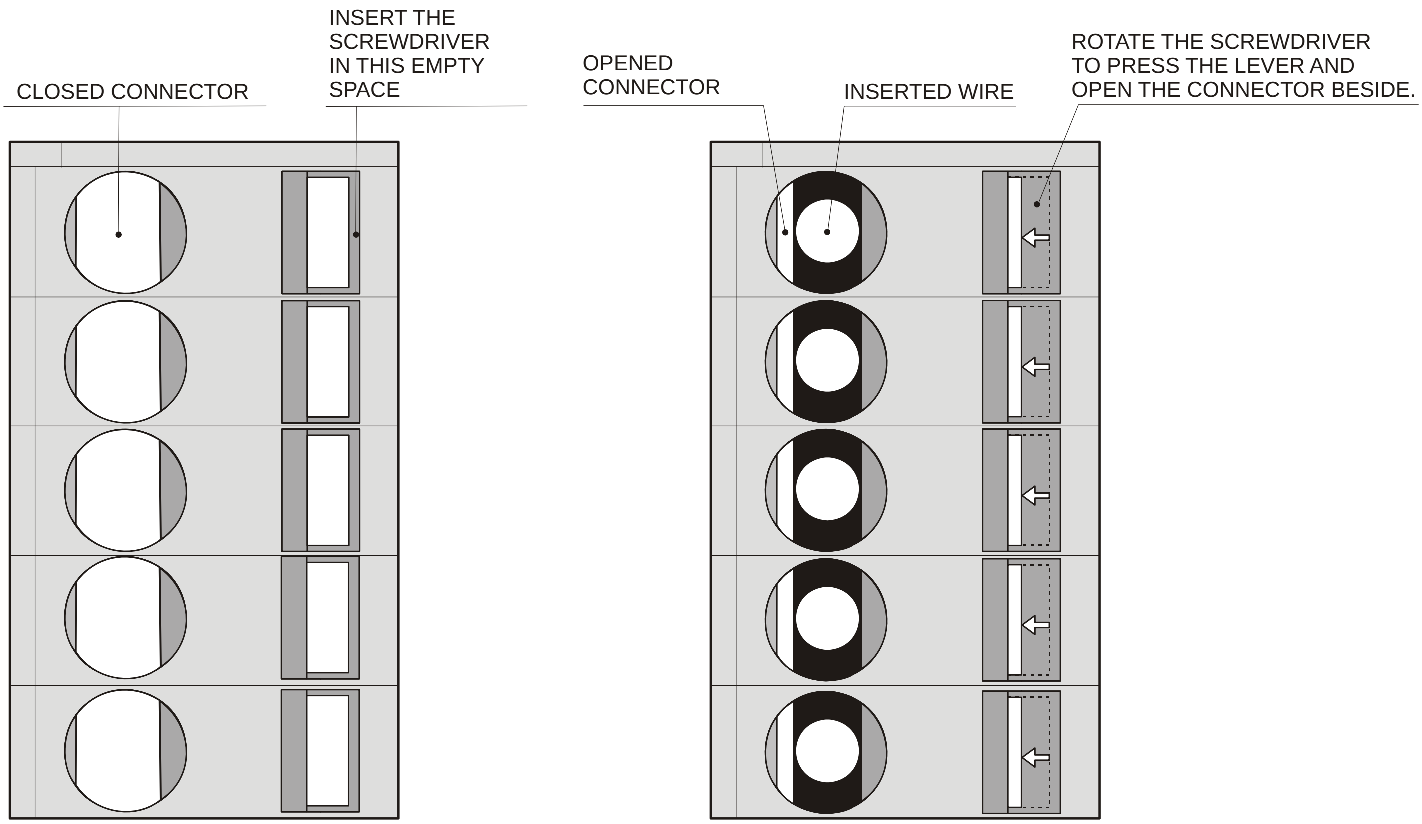


Figure 7 – CD600 Plus terminal block with its closed and open terminals.

ATTENTION
Connect the housing ground before supplying the equipment..

Control strategy configuration

Consult the CONF600 in the user manual for installing the configuration software.

NOTE
CD600 Plus is factory-configured to work with 4 loops. See in the CD600 Plus manual for more information about this subject.

Establishing the communication between the controller and the computer

1 – Using the computer serial gate

Connect the ICS 2.0P interface in the identified terminal in the label of the CD600 Plus with the specific cable. (See the ICS 2.0P manual for more details). Figure 8 shows the connections of the cable with the equipments.

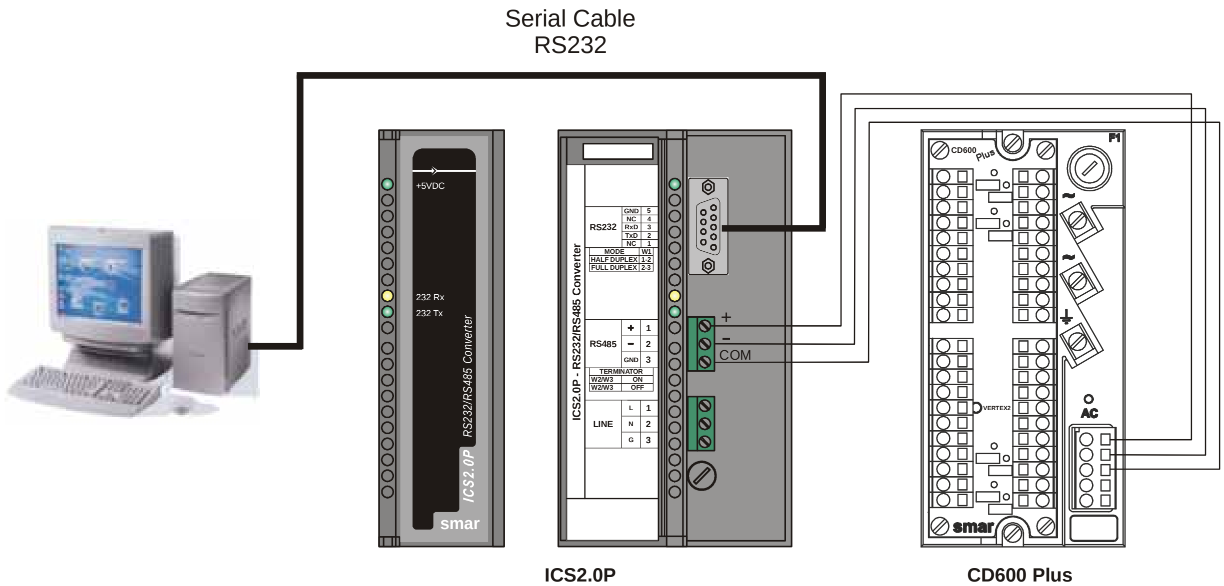


Figure 8 – CD600 Plus Wiring diagram with ICS2.0 interface.

2 – Using Ethernet connection

To establish an Ethernet connection, connect the ENET-710 interface in the RS485 terminal of the CD600 Plus. See figure 9. Refers to the ENET-710 manual for more details.

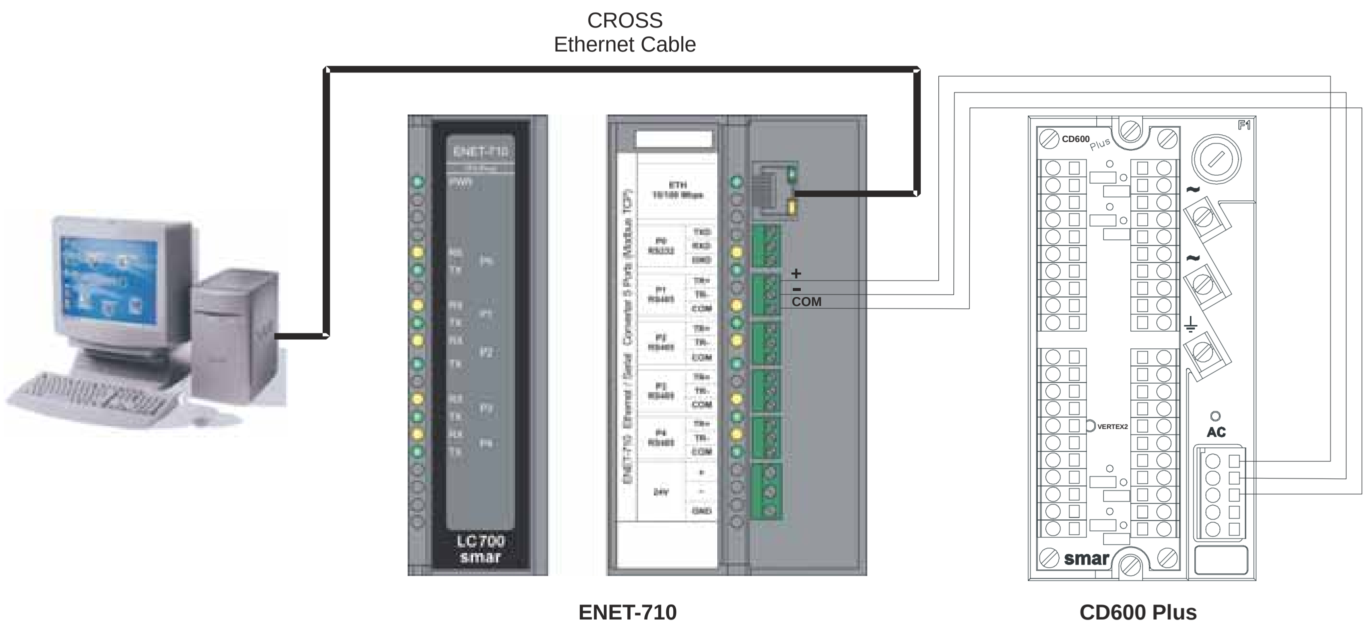


Figure 9 - CD600 PLUS wiring diagram with an ENET-710 interface

Refers to the communication section of the CD600 Plus user manual for more details about the communication blocks configuration.

Appendix B

Returning Materials

Should it become necessary to return the device and/or configurator to SMAR, simply contact our office, informing the defective instrument serial number, and return it to our factory.

In order to speed up analysis and solution of the problem, the defective item should be returned with a description of the failure observed, with as much details as possible. Other information concerning the instrument operation, such as service and process conditions, is also helpful.

Instruments returned or to be revised outside the guarantee term should be accompanied by a purchase order or a quote request.

smar

FSR – SERVICE REQUEST FORM

CD600 – Multi-loop Contoller

Proposal Nº:

COMPANY INFORMATION

Company: ____________________
Unit: ____________________
Invoice: ____________________

COMMERCIAL CONTACT

Full Name: ____________________
Phone: ________ ____________________ ________ ____________________ **Fax:** ____________________
E-mail: ____________________

TECHNICAL CONTACT

Full Name: ____________________
Phone: ________ ____________________ ________ ____________________ **Extension:** ____________________
E-mail: ____________________

EQUIPMENT DATA

Model: ____________________
Serial Number: ____________________

PROCESS DATA

Process Type (Ex. boiler control)**:** ____________________
Operation Time: ____________________
Failure Date: ____________________

FAILURE DESCRIPTON

(Please, describe the failure, if it is repetitive, how it reproduces, etc.)

____
____
____
____

OBSERVATIONS

____
____
____
____

USER INFORMATION

Company: ____________________
Contact: ____________________
Section: ____________________
Title: ____________________ **Signature:** ____________________
Phone: ________ ____________________ ________ ____________________ **Extension:** ____________________
E-mail: ____________________ **Date:** ______/ ______/ __________

For warranty or non-warranty repair, please contact your representative.
Further information about address and contacts can be found on **www.smar.com/contactus.asp.**