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- Understand
- Select
- Program
- Update

Logic Controllers made easy

A straight forward guide to unleash the full power of Crouzet's Logic Controller

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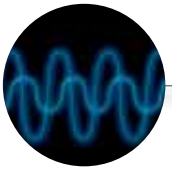


Why use a Logic Controller

Relays are a mature widely used technology, but today's Logic Controllers can easily replace them and even PLCs (Programmable Logic Controllers) in some machine control applications. And they can save both space and dollars.

Often relays have a multiple of I/O configurations and need to be used with a variety of other devices to provide equipment and system control. Logic Controllers have the ability to be pre-programmed to perform certain tasks at specific selected times and intervals. All that might seem a bit confusing, but it's as easy as the steps contained in this guide.

Today's control devices are all about saving space, time and money. Logic Controllers can be programmed by technicians via push buttons or simple PC programming software.

Most PLCs still require licensed software and always need a person skilled in PLC programming.

We created this guide because if your application is straightforward, then providing the proper controls should be easy and flexible as well.

About us

Crouzet Control Technologies

Widely recognised for over 50 years as the specialist in electromechanical, electronic technology and software engineering, Crouzet Control Technologies' experience in time management, physical and mechanical values has resulted in an extensive automation components offer that includes logic controlllers, timers, control relays, counters, ratemeters, machine sfety equipement, and temperature controllers

Simple to use, Crouzet products are easy to program and install.

Custom Sensors & Technologies (CST) is a specialist in sensing, control a motion products.

Through its brands, BEI Kimco, BEI Sensors, BEI PSSC, Crouzet, Crydom, Kavlico, Newall and Systron Donner, CST offers customizable, reliable and efficient components for mission-critical systems in Aerospace & Defence, Transportation, Energy & Infrastructures, Commercial & Industrial OEMs, Medical, Food and Beverage and Building Management markets.

Focused on premium value offers and committed to excellence, CST, with more than 4300 employees worldwide and sales of 571M US in 2010, is the dependable and adaptable partner for the most demanding customers.

Introduction

The evolution of Logic Controllers

Until recently, OEMs (original equipment manufacturers) and engineers were forced to choose between simple hardwired controls or internally developed and designed custom controllers for their products. But operating systems come in different sizes and with different degrees of complexity.

Often, hardwired or PLC control choices can raise the cost of controls for less complex systems to unjustifiable levels. Today we have an alternative – Logic Controllers take up a lot less rack space, can incorporate a variety of control components, help simplify system design, offer simple programming commands based on hardwired principles and also offer communication for control.

Logic Controllers have been applied in a variety of industries and are helping create applications that previously were cost, technology or size prohibited. They are suited to compact, stand-alone, low-complexity applications. For example, Logic Controllers incorporate hardwired timers, counters and cube relays in applications ranging from HVAC controls to irrigation and water handling, green energy conservation and control of machinery in manufacturing.

However, because they are relatively new, applying Logic Controllers may seem confusing. For example, you might ask “Will I need to know Ladder Logic?” “Can I expand the system once in place or add components to the control scheme?” “Are there things that I can’t do with Logic Controllers?” and so on. The decision to invest in an alternative control system can be daunting.

This guide will help you turn your compact and moderate sized control systems into an affordable, reliable and flexible solution.

About this guide

In this book you’ll learn the types and functions of Logic Controllers. You’ll also learn how they work, as well as how and where to apply them. You’ll learn that programming Logic Controllers doesn’t require a trained programmer. You’ll learn that Logic Controllers can save you money and time in installation, operation and maintenance of your control system. Finally, the guide will tell you what you need to know to make a confident decision when selecting Logic Controllers.

How this guide is organized

This document guides you through the six areas that you need to understand Logic Controllers. If the concept is new to you, you might be interested in everything. If you are a veteran of the control wars, you can select the sections that interest you most. It will be useful to readers at all levels.

Part I provides an explanation of how Logic Controllers work, and the different types (and functions) that are available. Part II offers guidance on how to select the correct Logic Controller for your application. It also provides examples of applications where Logic Controllers are already

successfully being applied, as well as other application areas for you to consider. Remember, Logic Controllers are continually evolving and adding new features – you may discover uses that you never considered.

Part III discusses about the role of Logic Controllers in control and offers applications where Logic Controllers can help you save initial investment and operating dollars, and also improve your system performance.

Part IV shows you how easy it can be to create your control system by programming the Logic Controllers to fit your application. It also tells you about low cost ways to get to know and feel comfortable with Logic Controllers if you are just beginning to know about them.

Part V offers you useful tips, as well as a simple method to make your selection or even find help if you need it. Follow its five points and you will realize a successful start in the application of Logic Controllers.

If you want the jargon, the glossary presents a common-sense description of the terminology used in control systems. And if you still have any questions contact : **www.crouzet.com**

How they work

Understanding how Logic Controllers work

Forget individual components, such as rotary timers, cube relays, counters and contactors – or complex and expensive PLCs. Logic Controllers can meet your control needs in a variety of compact, stand-alone and low-complexity applications.

It is generally accepted that there are 5 good reasons to choose a Logic Controllers when comparing with hard wired, individual components:

1	**Number of Components**
	Because Logic Controllers come with common control functions built-in – you don't need separate devices for timing, counting, etc. One Logic Controller can replace multiple timers, counters and cube relays. In turn that reduces the number of required components as well as system cost.
2	**Enclosure Size**
	A Logic Controller takes up a lot less space than all of the devices just mentioned. You can reduce the size of the electrical enclosure, cut the installation footprint on any controller equipment, and free up space.
3	**Engineering and Configuration Effort**
	Logic Controllers simplify design and configuration. Rather than figure out where to place and wire multiple devices, you only do this once. Simple programming commands based on hardwired principles eliminates the need for an engineer or trained programmer to configure the system.
4	**Manufacturing and Installation Cost**
	Installing, wiring and testing a Logic Controller take less time than wired controllers. Fewer steps and fewer connections mean fewer possible points of failure. Assembly and testing of a hardwired system requires wiring between individual devices, increasing material and labor costs.
5	**Maintenance and Modification Support**
	Logic Controllers reduce the time for control system commissioning and maintenance. A Logic Controller provides alarm messages and I/O status, often eliminating the need for a multi-meter or logic probe used to maintain hardwired controls. Customizing to meet changing needs requires programming changes, but no additional devices

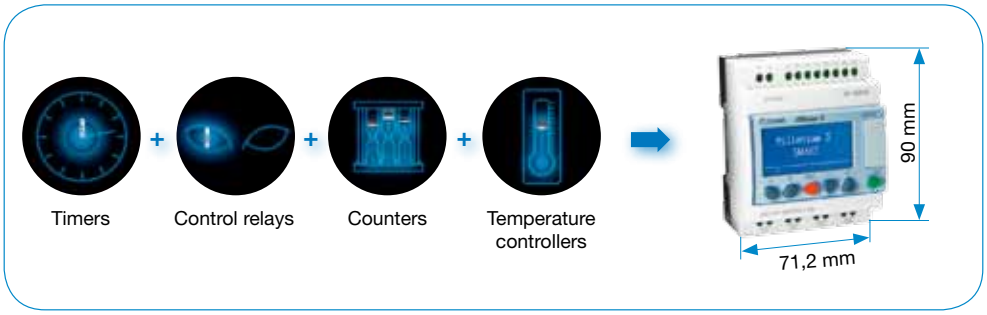


Fig. 1 – Advantages of a Logic Controller –
level or temperature control, impulse relays can be internal functions saving space and wiring

What is a Logic Controller?

A Logic Controller is a compact electronic device included in the Nano-PLC family. It can be used to control and monitor a set of conditions according to the state of the sensors, the passing of time and the program created using software. Logic Controllers can be pre-programmed to perform certain tasks (time, count, detect, display, communicate or process) and at specific and selected times and intervals. Logic Controllers use either relays or solid state outputs to control operations.

XD26 Smart

The basics

Logic Controllers are compact Programmable Logic Controllers (PLC) with built-in timers, counters, and compare function blocs, only they are easier to program (graphical software) – making them easier to install and use. In many ways, they are applied much like the hardwired controls they replace.

We can represent Logic Controllers schematically as follows :

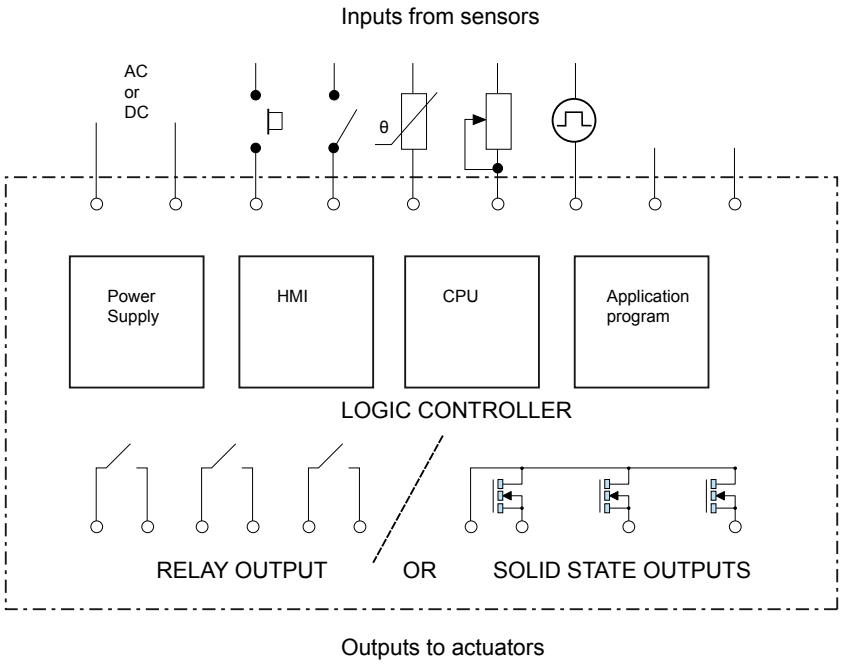


Fig. 2 – Typical Logic Controller architecture

Types and functions of Logic Controllers

Logic Controllers can be used to automate devices requiring 10 to 50 inputs/outputs. They are appropriate for nearly all control and regulation applications, and they are suited to projects containing up to 700 function blocks. Inputs can be analog or digital. A Logic Controller also can contain a number of internal functions including: level control, counters, timers, impulse relays, and temperature controllers. Outputs can be in the form of relays or solid-state transistors.

Logic Controllers work with devices including remote displays, touch panels, signal converters, analog pressure transmitters, temperature probes, temperature sensors, modem communications, pH and ORP probes, and power supplies. They also work in conjunction with devices that include indicating lights, pushbuttons, sensors, and limit switches.

But there are other specific options that you need to be aware of in order to select the correct Logic Controller. For example, Logic Controllers (Fig. 3) generally are available in two ranges:

- Compact for simple automation applications,
- Expandable for higher performance (larger number of digital or analog I/O) or for access to networks (Ethernet or Modbus).

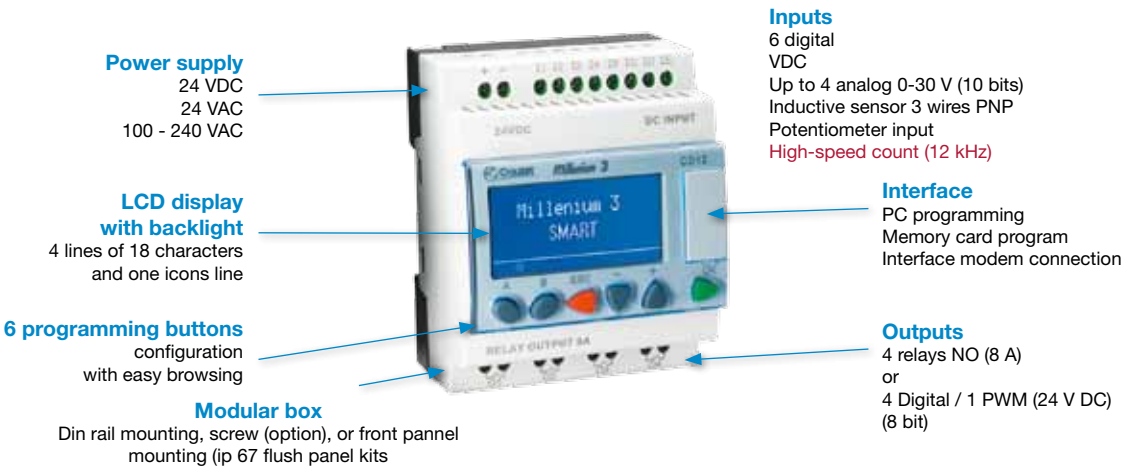


Fig. 3 – Expandable Logic Controller

Next, you need to decide if you need more than one Logic Controller. Often, it is possible to connect several Logic Controllers for applications that need more control capability. Then you need to consider if you need dedicated and even custom function blocks. The types of function blocks available include:

- Timer Function Blocks
- Counter Function Blocks
- Display Function Blocks
- Analog Inputs and Gain Blocks
- Compare Function Blocks
- Calculation function blocks

Finally, as the application becomes more involved, you might need to add relay, communication, or analog extensions.

How to specify Logic Controllers

To specify a Logic Controller, you only need to follow these basic steps:

1. **Number of inputs**
   (8 or 12 on base, 6 or 16 on expandable modules, plus 6 on sandwich extension, plus 4 or 6 or 8 on final extension)
2. **Number of outputs**
   (4 or 8 on base, 4 or 10 on expandable modules, plus 4 on sandwich extension, plus 2 or 4 or 6 on final extension)
3. **Type of input signals to be processed**
   (digital AC or DC, frequency, analog voltage range, current)
4. **Type of output signals needed**
   (digital AC or DC, voltage, current, switching frequency, relay or transistor, PWM, analog voltage range)
5. **Network connection and type**
   Number 3., 4. and 5. define the supply voltage
   (DC digital, analog input and PWM or analog output signals are only availible in the DC range, networks only with 24VDC)
   In connection with number 1. and 2. these criteria define the base or expandable modules and extensions to be ordered.
6. **Accessories**
   (power supply, program transfer via Bluetooth, modem interface, remote screens, etc., ...)

Selection for some applications may require the evaluation of additional factors:

- Type of contacts – normally open, normally closed, (double-throw)
- Current rating of contacts – compact relays switch a few amperes, large contactors are rated for over 50 amperes, alternating or direct current
- Voltage rating of contacts – typical control relays rated 300 VAC or 600 VAC, automotive types to 50 VDC, special high-voltage relays to about 15,000 V
- Switching time – where high speed (transistor output) is required

Depending on these requirements there might be a need to use external contactors or solid state relays.

A standard or base unit can internally provide counting, timing, comparison, display, sin/cos, and more. If you need more than just a basic unit, expansion modules generally are available. These units can provide additional I/O, communications capability. In many cases, several different expansion modules may be added to a single Logic Controller as needed. Application-specific extensions can provide capabilities like water quality management.

Some manufacturers also can provide dedicated functions for: pump switching, PID regulation, movement, solar tracking, pressure, level, flow, and so on.

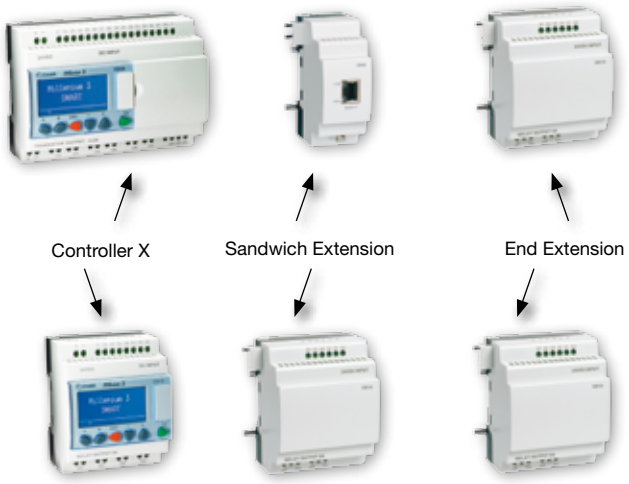


Fig. 4 – Extension units can provide digital/analog I/O, Modbus/Ethernet communication

Where Logic Controllers work

Logic Controllers can provide the best control solution where traditional relay based control is inadequate and Smart Controllers (PLCs) are too complex and costly to consider.

Logic Controllers are used in applications such as heating/air conditioning, access control, lighting applications, heat pumps, water and air treatment, waste treatment, lifting and handling, medical equipment and pump management.

They are designed for use in automation for commercial & industrial sectors, domestic and building controls providing the ideal solution for lighting, energy management, industrial control, watering, pump control, HVAC and home automation. Let's take a look at a few specific examples.

Logic Controller applications

Water Treatment

Requirements:

- Purification of polluted water (dissolved salts, sludge, bacteria, viruses, etc.) using reverse osmosis. The filtration process requires monitoring of temperature, pressure and conductivity upstream/downstream to guarantee optimum filtration.
- Automatic management of the reverse osmosis unit requires:

  Calendar-based, automatic and manual operating mode, management of alarms, etc.

  Preventive management of filter maintenance in your installation.

The solution:

- Logic Controller to manage circulation pumps, monitor levels, pressure and temperature of treated water (up to ~40°C) and monitor outlet water conductivity via an analog conductivity probe.

Advantages:

- The same device controls physical filtration and chemical treatment.
- Simple, straightforward programming.
- Other automation requirements controlled by additional functions of the Logic Controller.

HVAC

Requirements:

- Manage room temperature in residential buildings, halls and offices.
- Control return temperature in refrigeration or heating circuits (regulation).
- Monitor humidity levels.
- Monitor operating time, switching and power increase in compressors to optimize energy consumption and wear..

The solution:

- Logic Controller with a dedicated software function block to manage and switch between two and four compressors.
- Control relay to control phase sequence on power-up and ensure compressors start in the right direction.
- Timer (anti-short cycle) to limit the number of starts/hour.

Advantages:

- Simultaneous control of compressors fans and pumps.
- An integral panel-mounted remote display/keyboard provides interface to display failure modes and configure the AC system.
- Lower service costs with compressor monitoring.
- Optimized compressor service life through circular switching, etc.
- Option of remote management (temperature, operating mode) and traceability/ log (energy calculation) via the Web.
- Optimize the energy bill for dual energy systems (conventional and renewable energy).

Greenhouses

- In greenhouses, the Logic Controller centralizes the management of the automatic watering system. Programming options optimize water consumption and provide direct control over opening the solenoid valves under 24 VDC.

Compressor management for cold storage chambers

- Larger cold storage chambers may have several compressors. These compressor sets need to be managed on several counts :
- Progressive start-up, to prevent drawing too much current.
- Using a different compressor for start-up to avoid excessive wear.
- Controlling the number of compressors in operation at any one time in relation to the demand for cooling

Managing geothermal heating

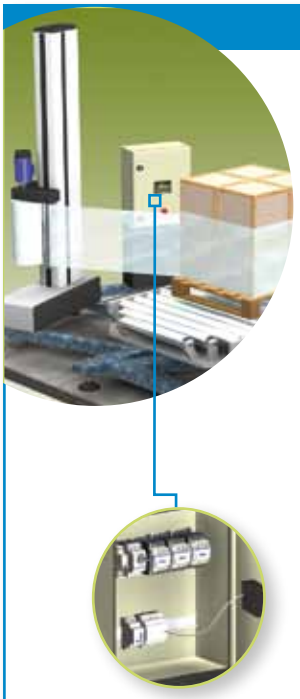
- Geothermal heating consists in collecting energy contained in the ground (Heat Pump) and using it for heating or cooling. It can save 75% of the energy relative to other heating systems. The components are similar to those in a refrigerator: a coolant, a pressure reducer, an evaporator, a compressor.

Processing the air in air conditioning

- The concept is a cooling tower chilling a water circuit. It is used in air conditioning systems or to cool medium- or large-scale climatic installations in industrial processes, industrial premises and large tertiary activities.

Smart Applications for Logic Controllers

Logic Controllers continue to evolve and add capabilities. That means that new uses become possible on a regular basis. Units are available that offer hundreds of pre-programmed function blocks: I/O, logic, calculation, application-specific functions, control, human-machine interface and more. Logic Controllers have advantages over PLCs, including real-time control and monitoring. Another important advantage is that relays fail to a predictable state on power loss, making them ideal for many safety-system applications. Here are a few examples that may get you thinking in a new direction.



Compact Industrial Machines/Packaging

All compact industrial machines have different automation requirements.
One Logic Controller can be adapted to almost any automation need.

Requirements:

- Checking paper or plastic film for proper unwinding (breakage, damage, end of roll) and that the correct length of film is taken up by controlling the appropriate motor.
- Cut the film or paper at the end of a cycle: control cutting by motor or cylinder.
- Ensure that plastic bags (various sizes) are perfectly sealed before filling with air or other gases by controlling the temperature and duration of sealing.
- Achieve ideal operating conditions: unwinding speed, rotational speed, etc.

The solution:

- Logic Controller:
  - Rapid input to detect zero speed, indicating the end of a roll or broken film.
  - Manages operating cycles (winding time, unwinding time, packaging height reached for stretch wrapping machine).
- Remote display/keypad displays parameters, faults and alarms on control panel.
- Temperature controller monitors heating temperature to control sealing cycle times

Advantages:

- Full automation of machine cycles.
- Alarms in case of faults or lack of paper.
- Counting of the number of operations for the purposes of preventive maintenance.

Access Control

Safety and a constant quest for energy savings demand optimum access management: internal doors, fire doors, air locks, automatic barriers, sectional flexible doors, car park access ramps, loading ramps, etc.

- Detect the presence of personnel or vehicles.
- Control opening and closing of doors after a delay or on presence detection.
- Count the number of operations for the purpose of preventive maintenance.
- Control different opening modes (automatic/manual/semi-automatic).
- Configure the cycle times depending on door models.
- Control the opening height.

The solution:

- Logic Controller to:
  - Define the different opening modes (time-based, calendar-based, etc.),
  - Modify the detection parameters (distance, etc.),
  - Control the door opening/closing times and position,
  - Count cycles,
  - Fault alerts via alarms,
  - Manage several traffic directions (directional/bi-directional control),
  - Check that cells and contactor operate correctly to authorize door lowering.

Advantages:

- Easy to install in the electrical panel in the compact, extendable or bare board versions.
- Checks that the sensors (photo-electric or magnetic cells) operate correctly before each lift/lower operation.
- Cycle counting enables management of preventive maintenance.
- Flexibility in use compared with the printed circuit board solution.
- Full autonomy for the user

Logic Controllers in automation system

Relays might seem to be a fading technology for all but the most basic control applications, especially when we consider the almost continuous advances in PLCs. In reality, relays (especially Logic Controllers) are adding capabilities and making significant advances into control areas formerly occupied by PLCs (Fig. 5).

According to industry analysts and some end-users, today's relays and Logic Controllers can offer advantages over PLCs (see Table 1) in two main categories. Traditional relay functions such as voltage conversion, current amplification and electrical isolation fall into the first category.

The second category includes control functions for which relays are a better alternative in terms of cost, performance and ease of use. A single Logic Controller can provide relay, timer, counter, and time switch functions internally. End users also say that Logic Controllers can offer higher A/D input resolution and accuracies for resistive temperature detector measurement than low-cost PLCs.

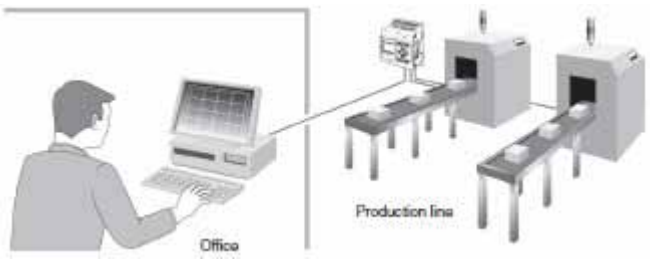


Fig. 5 – Logic Controller in a Network

Let's look in more detail at instances and applications where relays and Logic Controllers can be a better solution than even low-end PLCs.

We know that higher control complexity favors PLCs, but the simplicity and somewhat limited capability of Logic Controllers means Logic Controllers can be programmed by technicians. Depending on the I/O contained in the device, this can be accomplished via pushbuttons PC programming software. Most PLCs still require licensed software and always need a person skilled in PLC (ladder logic) programming.

In control applications, other control advantages of Logic Controllers over PLCs often are price-related. Many Logic Controllers have local displays and LEDs that display input faults, relay status and the process variable. Logic Controllers with greater I/O capability generally are programmed via a PC, but may use a display extension (add-on unit). PLCs nearly always need an added-cost HMI along with software to accomplish the same tasks. For many applications, just a few I/O points require high-speed monitoring and control. For many mid-sized applications, instead of buying an expensive PLC with high-speed capabilities, it's often more cost-effective (see Fig. 6) to combine a low-cost PLC with a high-speed Logic Controller.

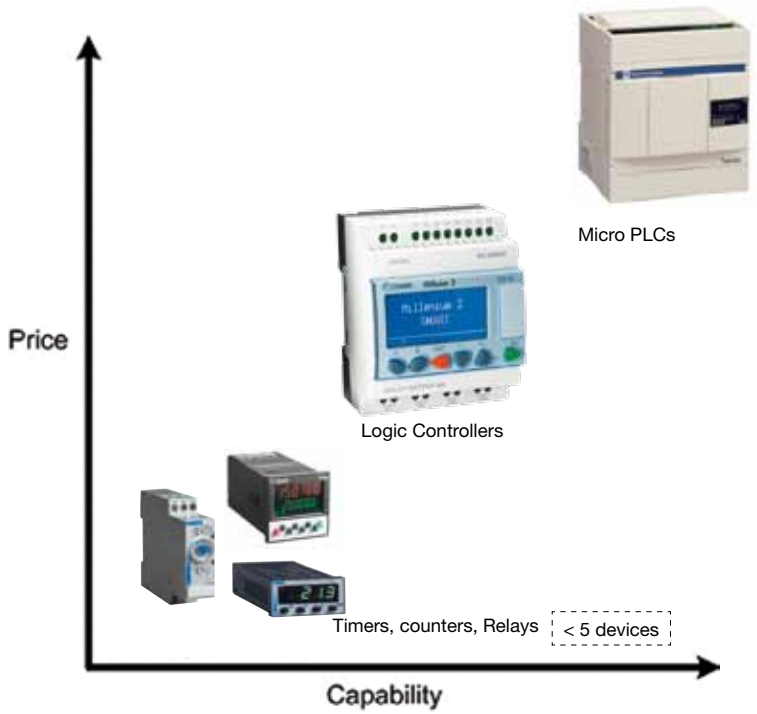


Fig. 6 – Price and performance – relays, Logic Controllers and PLCs

Table 1: Logic Controller advantages over PLCs

1. Economical
2. Simpler
3. Smaller
4. Easier replacement

Calculate the Cost Advantages

The total cost of any control system depends on a number of fixed and variable costs. Simple hardwired controls such as start/stop inputs, run lights, timers or counters and loads may have lower fixed product costs in a compact system. For example the wiring costs alone can be significantly higher.

However, in larger systems the fixed component costs, interconnect wiring costs and electrical enclosure costs increase significantly.

According to independant cost analysis studies Logic Controllers have slightly higher initial capital investment for software, programming cable and memory, but allow significant cost savings or wiring, enclosure size and reliability when compared with simple hardwired controls.

Notes

Simple and straight forward

OK, we said that programming Logic Controllers is simple and straight forward. Now it's time to prove it. Actually, with many Logic Controllers, programming can be accomplished using either the more involved ladder logic, or the intuitive Function Block Diagram (FBD) approach. For this guide, we will focus on the simpler to follow FBD approach.

If you are worried about needing to have a deep understanding of programming when using FBD, fear not! Colored icons and virtual wiring will help you create the control circuit. If you don't understand how a function block is used, help associated with each function block is available at the click of a button.

Getting started in simple programming

➜ Creating an Application

To create an application, once the software has been installed/downloaded (Fig. 7), all you generally need to do is follow these five steps: Identify the Logic Controller being used, select any extension units, select the programming language (ladder logic or function block diagram), then edit the program, and finally write the program to the Logic Controller.

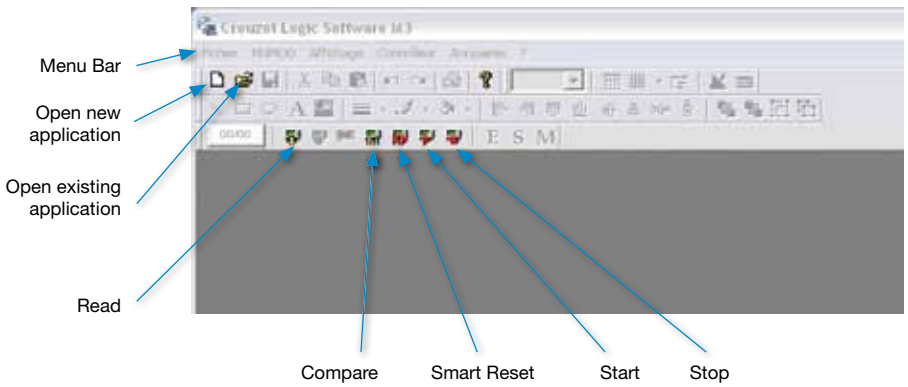


Fig.7 – Creating the application

➜ Logic Controller Selection

As mentioned earlier, programming software usually is available for downloading from the manufacturer's Web site. You will need to identify the specific Logic Controller being used. With the software provided by many manufacturers, that will automatically list the operating voltage.

Unless you already understand ladder logic, a flexible Logic Controller offers the option of programming intuitively via function block diagrams. With function blocks, you do not need any particular knowledge of programming. You can teach yourself while the software helps to direct them. For quick, simple programming, the software should provide access to a variety of dedicated application specific functions such as: pump switching, PID regulation, movement, pressure, level and flow.

➜ Extension Selection

Once the programming software is running, identify the extension units being used (Fig. 8) – digital/analog I/O (the number and type of inputs and outputs), and Modbus/Ethernet communication (STN Modem, GSM Modem, Web Server, Bluetooth, etc.). Basic functions, like counting, timing, comparison and display, generally are available as well.

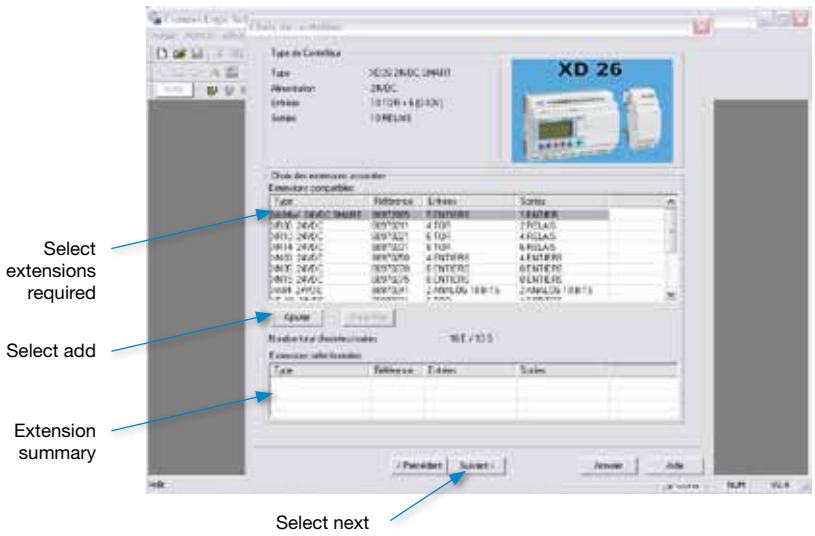


Fig. 8 – Selecting extension units

➜ Programming Language Selection

Next you should choose whether you want to program the device using ladder logic, or function block diagram (FBD) / Grafcet Sequential Flow Chart (SFC). (Fig. 9).

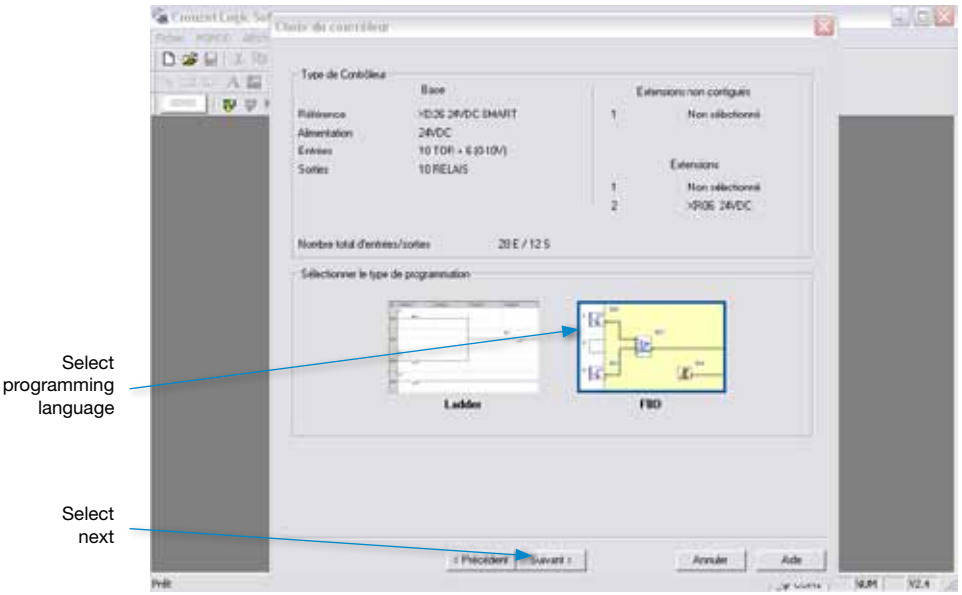


Fig. 9 – Selecting the programming language

➜ Editing the Program

Editing can be performed on either new or existing applications. When you select a new application, a new screen should open. You should be presented with a Menu Bar, an assortment of Display and Drawing Tools, Slot Memory Status, Function Block Menus, Inputs and Outputs. For quick, simple programming, the Millenium 3 software provides access to dedicated application specific functions such as: pump switching, PID regulation, movement, pressure, level and flow.

Another level of security is the fool-proofing principle: when the slightest data entry error is made, it flags the incorrect item in red. You can correct any obvious errors before proceeding. Also, you can check your installation as you go along at each stage of programming. Optional program password protection (several levels) or customized protection (FBD key) may also be available.

The Logic Controller should allow you to debug your application in realistic conditions

- View the machine operation on your PC in real time
- Offer optimized user interface (Bar chart)
- Modify parameters defined via the human-machine interface (keypad)
- Progressive debugging, validating each part of the application.

➜ Writing to the Controller

Before you can write a program to the Logic Controller you'll first need to set the controller to STOP mode. When the program is successfully downloaded, you will need to set the controller to Start mode

Function Blocks Explained

The basic function block types available include:

- Input blocks: IN
- Output blocks: OUT
- Standard functions: Function Block Diagram (FBD)
- Special function blocks FBD_C
- Sequential Flow Chart functions (Fig. 10)
- Logic function blocks (Fig. 11)

Designation	Symbol	Description
INIT STEP **(Initial step)**		Initial step of a chart.
RESET-INIT **(Reset initial step)**		Initial step of a chart with initialization of the step by a command.
STEP **(Step)**		Step which transmits an order to another function.
DIV AND 2 **(Divergence in AND)**		Transition from one or two steps to two steps.
CONV AND 2 **(Convergence in AND)**		Transition from two simultaneous steps to one step.
DIV OR 2 **(Divergence in OR)**		Transition from one step to one or two steps.
CONV OR 2 **(Convergence in OR)**		Transition from one to four steps to a single step.

Fig. 10 – Sequential Flow Chart

Function	Symbol	Description	Number of inputs	Input type
NOT		If the input is inactive or not connected, the output is active. If the input is active, the output is inactive.	**1**	**Digital**
AND		If all inputs are active, the output is active. If at least one input is inactive, the output is inactive.	**4**	**Digital**
OR		If a least one input is active, the output is active. If all inputs are inactive or not connected, the output is inactive.	**4**	**Digital**
NOT AND		If a least one input is inactive, the output is active. If all inputs are active or not connected, the output is inactive.	**4**	**Digital**
NOT OR		If all inputs are inactive or not connected, the output is active. If a least one input is active, the output is inactive.	**4**	**Digital**
EXCLUSIVE OR		If one input is inactive and the other input is active or not connected, the output is active. If both inputs are active or inactive or not connected, the output is inactive.	**2**	**Digital**

Fig. 11 – Typical Logic Function Blocks

Programming Example

Application: Temperature Control in a Room

Description of Customer Needs:

Controlling the room temperature (heating or cooling) as well as displaying the relative humidity.

How the application works:

The ambient room temperature is controlled in heat mode by a heating element and in cold mode by a fan.

A temperature sensor and a humidity sensor are used to measure room conditions.

The Solution:

- Programmable Logic Controller (with analog inputs).
- Accessories:
  - o Ambient Temperature Sensor (0-10 VDC)
  - o Relative Humidity Sensor (0-10 VDC)

  A switch can be used to turn the controller ON and OFF and another switch can be used for selecting between Heating and Cooling mode.

  The screen can display the controller's mode, the ambient temperature, the setpoint and the humidity. The setpoint can be adjusted using the front panel keys.

The Programming Steps:

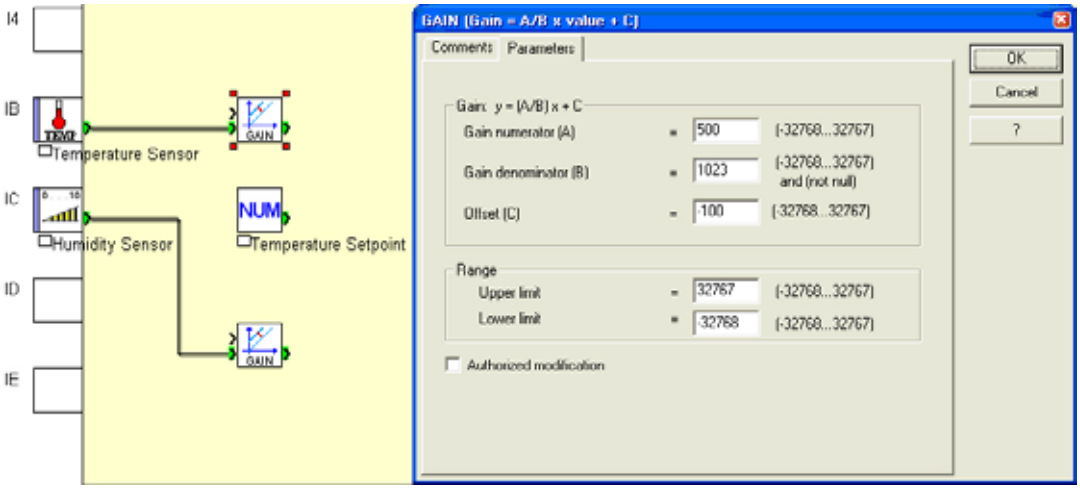
1. Assign the Inputs and the Outputs:

INPUTS		OUTPUTS	
I1	ON/OFF Switch	O1	Heating Resistor
I2	Mode Selection	O2	Fan
IB	Temperature Sensor (0-10 VDC)		
IC	Humidity Sensor (0-10 VDC)		

From the IN and OUT toolbars take Discrete Inputs into I1 and I2, Analog Inputs into IB and IC, and Discrete Outputs into O1 and O2. You can add comments and change the icons.

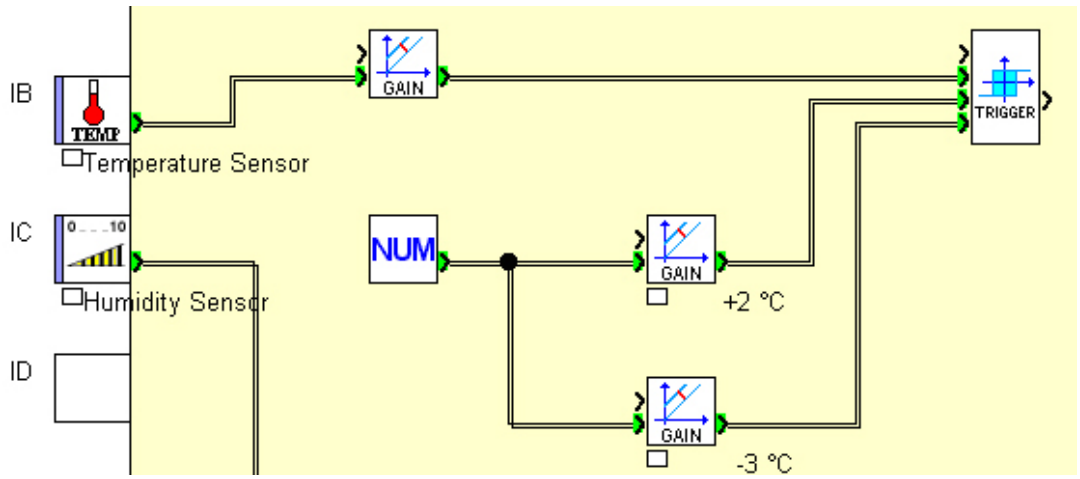
2. Scale the Analog Inputs:

Use GAIN function blocks to scale temperature and humidity sensors signals into readable values. The blocks provide an output in units multiplied by 10 (a decimal point can be used for better display precision). A NUM function block represents the Temperature Setpoint.



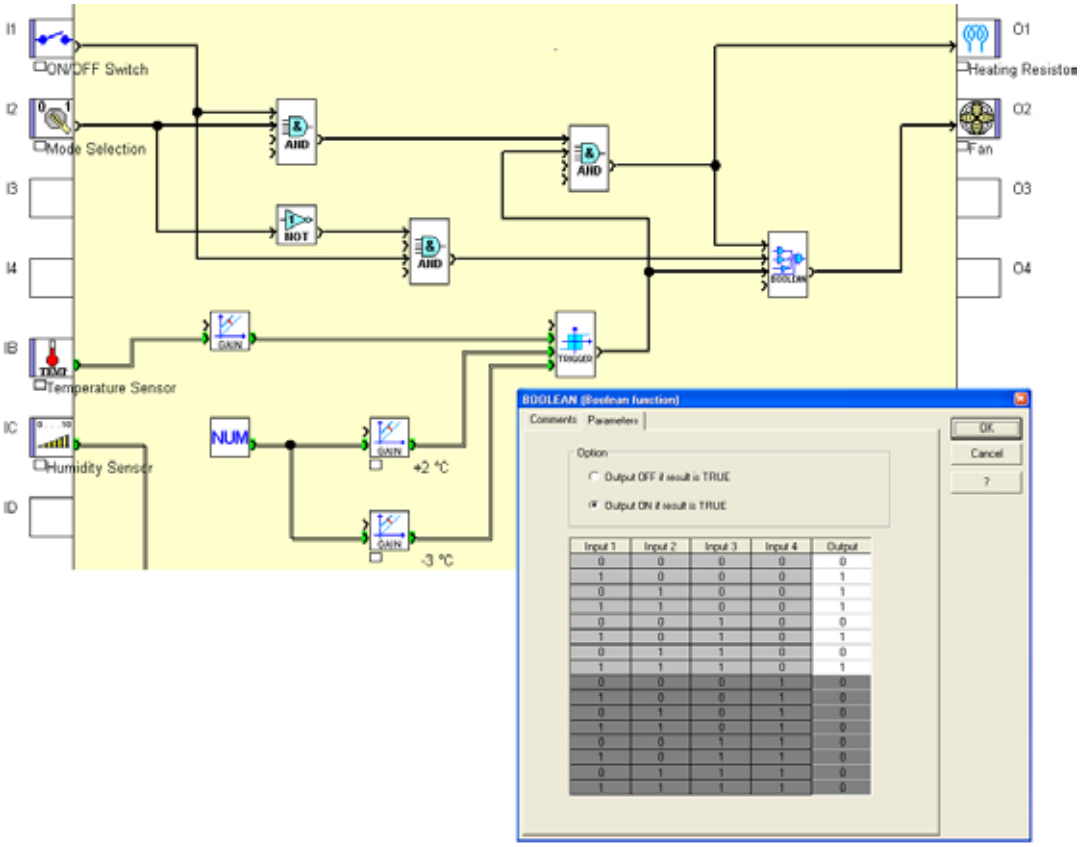
3. Define the Heating Control:

Use a TRIGGER function block to control heating taking into account a Hysteresis of +2°C from ON to OFF and -3°C from OFF to ON. GAIN function blocks provide these offsets.



4. Define the Cooling and Heating functions:

Use Logic Gates to define Cooling and Heating functions based on input switches and Heating control signal. For more complex logic decisions a BOOLEAN function block can be used. By double clicking on it, a Truth Table can be entered.

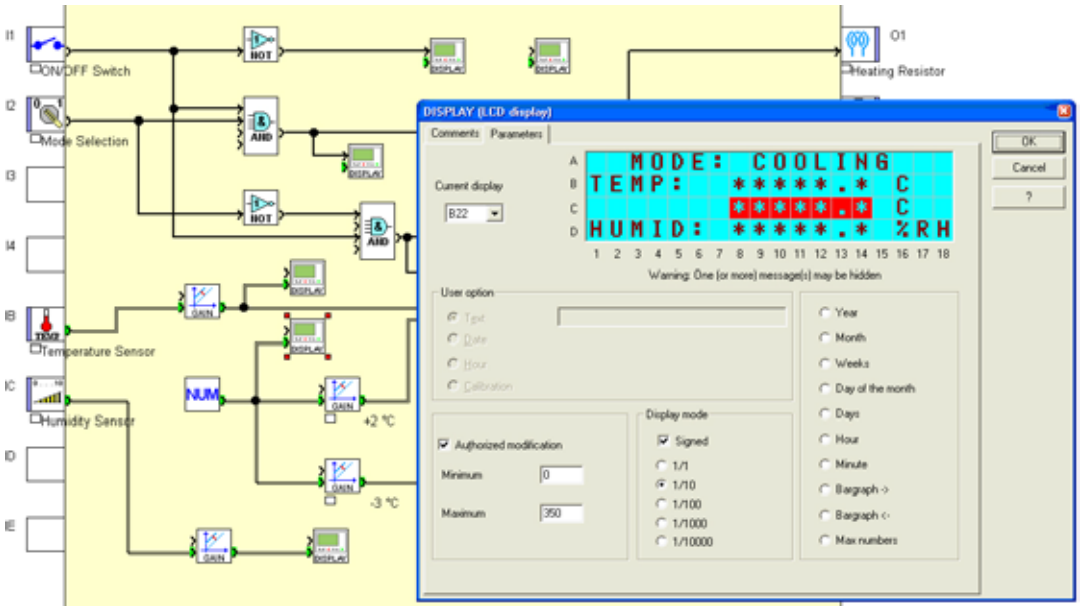


5. Displaying messages and values:

The status of the controller as well as the measured values can be displayed and modified on the controller's screen.

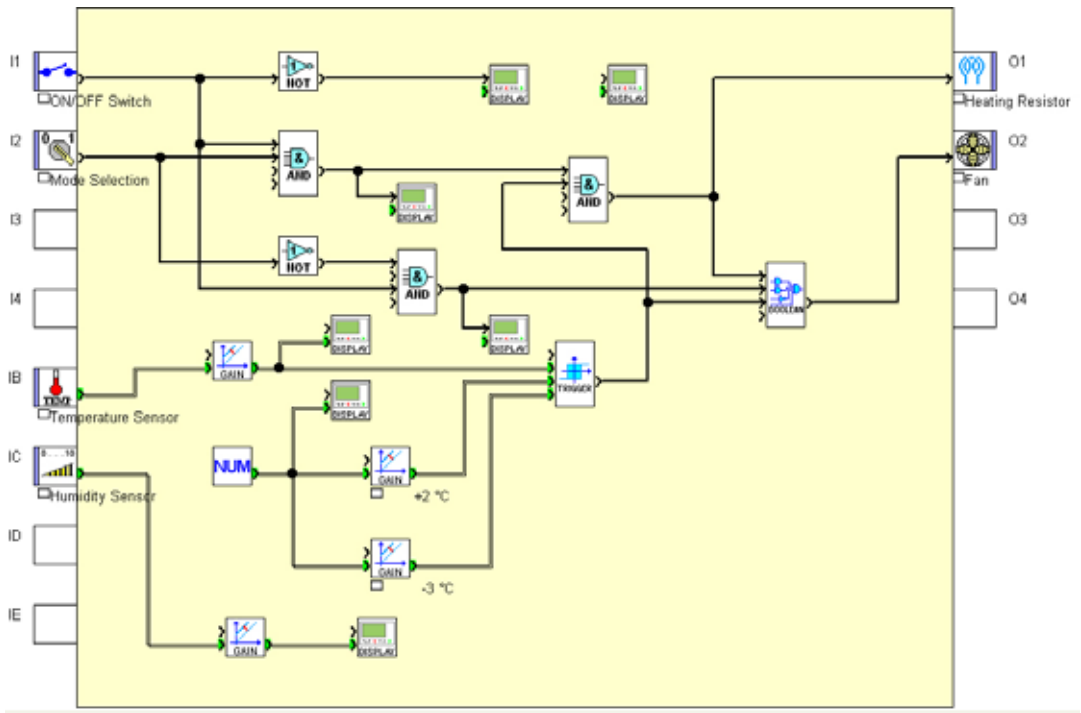
Use DISPLAY function blocks to display text and to display the values measured values and the setpoint. You have to use one DISPLAY block per each value to be displayed.

Under Display Mode select Signed and 1/10 to show a sign and to display one decimal value.

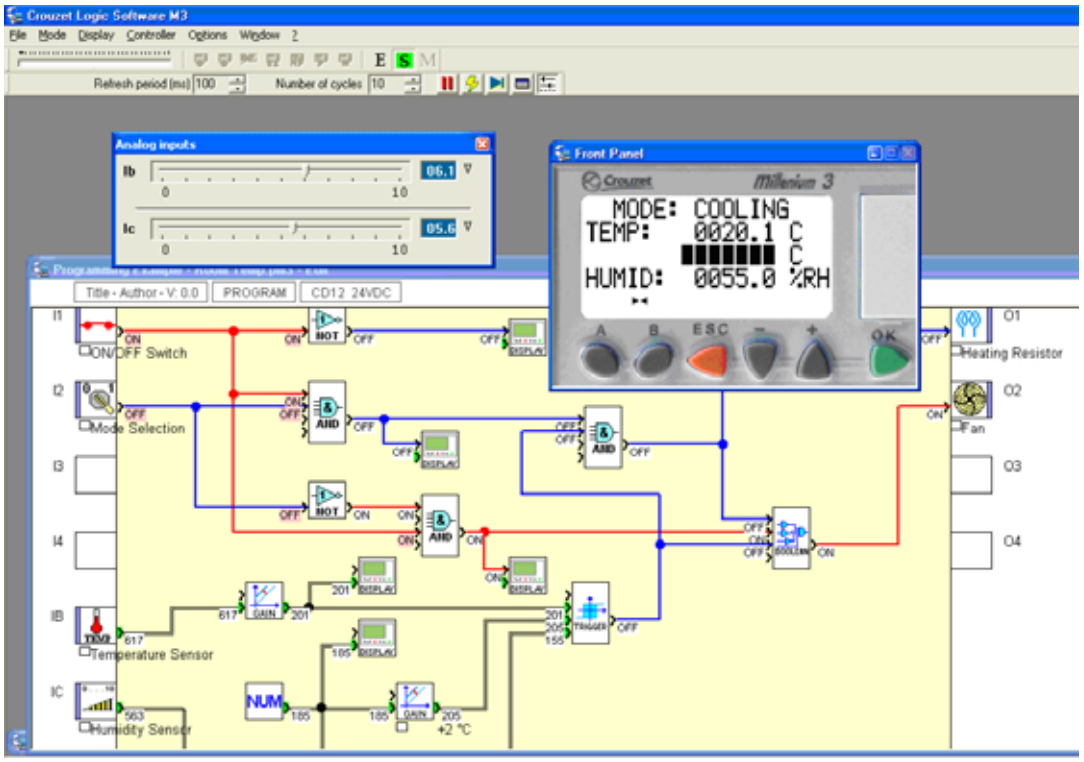


For the DISPLAY block that shows Setpoint value, select the Authorized modification option. This allows the value to be modified from the front panel using the -, +, and OK buttons.

6. This would be the final program:



7. The program can be simulated in software to verify that it works as wanted:



Further Requirements:

- Additional rooms can be controlled with a single controller (Logic Controller).
- The lighting on the room can be controlled as well (based on time of day).
- A more complex controller can be programmed using a PID function block.
- Each room's controller can communicate to a master controller via a network (an expandable unit is required).

Notes

Let's be honest, regardless of the amount of experience you have in any given area, there are specific things that you can do that either will make the process easier or harder. This section presents five areas to keep in mind when starting any project – even one of selecting and applying Logic Controllers. Application tips, what to look for, what to avoid, how to find help, and how to make the right selection can help ensure that you get started in the right direction.

Selection Advice (what to look for)

The programming software

- **Multilingual –** Languages should include English, French, Italian, German, Spanish, etc. as needed.
- **Programming** – You should have a choice between programming approaches: Ladder and FBD/Grafcet.
- **Simulation** – Make sure you can test the result of your programming in real time.
- **Downloading** – You will want to transfer your programs directly to the control modules or remotely via local wired or wireless modem solutions.
- **Supervision** – Can you view the application locally or remotely via the communication solutions.

The Logic Controller and extension/expansion units:

- **Power supply**
  12 and 24 V DC voltages
  Power supplies can range from 7.5 to 240 W
- **Sensing** – The inputs (digital, potentiometer or 10-bit analog) of the Logic Controller should be compatible with most sensors on the market: temperature sensors, pressure transmitters, level detectors, flow sensors, etc.
- **Operator dialogue** – To make it easier for the operator during parameter setting or operation Logic Controllers should have a built-in, backlit screen or a remote screen (via Modbus extension XN06).
- **Communication** – Be sure that the Logic Controller offers the option of supervising and connecting devices (PC, remote screens/keyboards, etc.) by linking Logic Controllers to field buses (Modbus, Ethernet) or via a modem: STN or GSM.
- **Actuating** – Logic controllers can be used to drive devices such as brushless motors, solenoid valves and pumps (relay, solid state or PWM outputs).

- **Adjusting** – Are there options for adjusting setpoints – an external control potentiometer on analog inputs and internal setpoints modifiable via the display.
- **Converting** – Analog extensions can acquire or provide current, voltage or temperature values and convert them to the digital signals needed by the controller.

Useful tips when applying Logic Controllers

With networked Logic Controller, you can monitor and control installations remotely and reduce maintenance costs by:

- Performing pre-diagnostics
- Avoiding unnecessary visits
- Defining priorities before responding.

On site with a mobile phone you can:

- Receive SMS alerts: If one mobile phone is unavailable, the alarm should automatically redirect to another mobile phone.
- Send commands to a remote logic module
- Interrogate the status of application components.

In the office using the manufacturer's software you can:

- Use the same functions as on your mobile phone from the comfort of a PC
- Manage the composition of your maintenance teams
- Organize alarms so that you can file, archive, sort or export them.

The rule of fives

What you should know about your supplier

There are several ways to simplify the process of selecting and implementing alternative controls such as Logic Controllers. When selecting a Logic Controller, there are several things that you also should learn about its manufacturer. For example,

- Does the manufacturer have the capability to design and deliver a range of standard and custom products?
- Does the manufacturer try to fully understand your application?
- Do they have expertise (Electrical, Electronic and Mechanical) across industry segments?
- Are they familiar with the standards that are used in your industry segment?
- Do they offer prototypes for custom hardware and software needs?
- Does the manufacturer propose technical solutions?
- What testing does the manufacturer provide for its products?
- Can they meet your delivery requirements for the Logic Controller as well as all other required components?
- Do they provide after-sale service?

Also, if your vendor is familiar with the operating environment for your installations, make sure they can optimize the materials and components used to manufacture their products and ensure your devices work to the best of their ability. Here are several types of possible adaptation at the hardware level.

Toughening

- Increased mechanical resistance: shock, vibration, sealing
- Adaptation to climatic conditions: temperature, humidity, etc
- Compliance with electrical and standards-related constraints voltage, EMC, etc

Customization

- Dedicated connections for a complete electrical function that can easily be installed
- Connection to all of the sensors used in your application

Specific configuration

- Changing the number of I/O
- Updating the I/O characteristics (input voltage, etc)
- Development of specific extensions
- Changing the polarity type (PNP/NPN)
- Fixed parameter settings

Getting help when you need it

A number of vendors offer Logic Controllers and the associated components and software, but getting service when you need should be a vital factor in your product selection. Chances are your applications may need to function in a variety of environments (temperature extremes, wet or dirty environments, environments with electrical noise, etc.). That means you'll likely need their expertise before, during and after implementing Logic Controllers.

Crouzet Control Technologies...

If you are interested by our easy to use Millenium Logic Controller do not hesitate to contact our experienced engineers who are always available to help identify the best fit solution for your specific need.

For contact information see : www.crouzet.com

A simple selection process

If you can review the following list and check the needed items, you can successfully select the correct Logic Controllers. If you have trouble deciding what you need, simply ask a logic controller vendor to assist you.

How many inputs and outputs do you need?

Inputs ..... (specify analog and digital inputs)

Outputs ..... (specify analog and digital outputs)

Will you use:

❑ **Digital Inputs**
❑ 110-230 VAC
❑ 24 VAC
❑ 12 VDC
❑ 24 VDC
❑ Encoder

Signal voltage: .....

Resolution: .....

Max. frequency: .....

❑ **Analog Inputs**
❑ 0-10 V
❑ 0-20 mA
❑ Potentiometer
❑ Temperature
❑ NTC
❑ Pt100
❑ Pt1000
❑ Thermocouple
❑ pH
❑ ORP
❑ Other.....

What type of output do you require?

❑ **Digital outputs**
❑ Relays
❑ Solid state

Voltage : .....

Max. current: .....

❑ **PWM outputs**
Frequency & current: .....
❑ **Analog outputs**
❑ 0-10 V
❑ Other.....

Do your Logic Controllers need to communicate with a network?

❑ Modbus
❑ Ethernet (Modbus TCP/IP)
❑ Other .....

Do you need to link Logic Controllers?
Quantity linked in a single application .....

Does your application require?

Direct current
❑ 24 VDC ❑ 12 VDC

Alternating current
❑ 24 VAC ❑ 100-240 VAC

Does your Logic Controller need a display (on the product)?

❑ Yes ❑ No

Do you need extension devices?

❑ Digital I/O - number of inputs and outputs: .....

❑ Analog I/O - number and type of inputs and outputs: .....

❑ Modem interface:
- ❑ GSM Modem
- ❑ STN Modem

❑ Other: .....

Do you need accessories?

❑ External display
- ❑ Touchscreen (monochrome)
- ❑ Touchscreen (color)

❑ Input signal converter – from to: .....

❑ Output signal converter – from to: .....

❑ Bluetooth wireless programming interface

❑ Power supply – max. output power: .....

❑ Other: .....

Do you have special application requirements?

Vibration: ..... Operating temperature: .....

Humidity: ..... Degree of protection: .....

Approval(s): .....

Some points to take into account:

- Type of contacts – normally open, normally closed, (double-throw)
- Current rating of contacts – compact relays switch a few amperes, large contactors are rated for over 50 amperes, alternating or direct current
- Voltage rating of contacts – typical control relays rated 300 VAC or 600 VAC, automotive types to 50 VDC, special high-voltage relays to about 15,000 V
- Switching time – where high speed (transistor output) is required

Do you need other products?

❑ Counters

❑ Timers

❑ Temperature Controllers

❑ Safety Relays

Glossary

Whether you are new to industrial controls or a seasoned veteran, we all need to keep up with the terminology being used in industry. Following is a sampling of terms used when referring to Logic Controllers. There are many more that could be listed, but your time is important and our primary goal is to provide you with enough understanding of Logic Controllers to make you both confident and capable in specifying and applying them.

Automation

Using control systems and information technology to reduce the need for human work in producing goods and services. Automation is a step beyond mechanization. Mechanization provides human operators with machinery to assist with the muscular requirements of work; automation greatly decreases the need for human sensory and mental requirements as well.

Data Acquisition (DAQ)

The process of converting real world physical condition samples into digital numeric values that can be manipulated by a computer. It typically involves the conversion of analog waveforms into digital values for processing. Components of data acquisition systems include: sensors, signal conditioning and analog-to-digital converters.

Electromechanics

Electromechanics combines the sciences of electromagnetism and mechanics. Mechanical engineering refers to the larger discipline which includes chemical engineering, and related disciplines. Electrical engineering also encompasses software engineering, computer engineering, and related fields.

Ethernet

A family of frame-based computer networking technologies for local area networks (LANs). The name came from the physical concept of the ether. It defines a number of wiring and signaling standards for the Physical Layer of the OSI networking model as well as a common addressing format and Media Access Control at the Data Link Layer. Ethernet is standardized as IEEE 802.3.

Function Block Diagram (FBD)

A Function Block Diagram is a block diagram that describes a relation between input variables and output variables. It may contain multiple relations that otherwise would have to be programmed individually. Input and output variables between blocks are connected by lines.
FBD is a language for a control such as Logic Controller, Programmable Logic Controller (PLC) or a Distributed Control System (DCS) system supported by the IEC 61131-3 standard.

Human-Machine Interface (HMI)

A user interface which makes it easy and efficient to operate a machine in the way which produces the desired result. This generally means that the operator needs to provide minimal input to achieve the desired output, and also that the machine minimizes undesired outputs to the human.

Input/Output (I/O)

Input/output, or I/O, refers to the communication between an information processing system (such as a computer), and the outside world possibly a human, or another information processing system. Inputs are the signals or data received by the system, and outputs are the signals or data sent from it.

Internet Protocol (IP)

The principal communications protocol used for routing packets across network boundaries; it is the primary protocol that establishes the Internet

Programmable Logic Controller (PLC)

A Programmable Logic Controller (PLC) is a digital computer used to automate electromechanical processes (machinery on factory assembly lines or lighting fixtures). The PLC has multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

Relay

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Modbus

A serial communications protocol published by Modicon in 1979 for use with its PLCs. It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices.

Ladder logic

A programming language that represents a program by a graphical diagram based on the circuit diagrams of relay-based logic hardware. It is primarily used to develop software for Programmable Logic Controllers (PLCs) used in industrial control applications. The name is based on the observation that programs in this language resemble ladders, with two vertical rails and a series of horizontal rungs between them. Ladder logic can be thought of as a rule-based language rather than a procedural language.

Original Equipment Manufacturer (OEM)

An Original equipment manufacturer, or OEM, manufactures products or components that are purchased by a company and retailed under the purchasing company's brand name. OEM refers to the company that originally manufactured the product.

Personal Computer (PC)

A personal computer (PC) is any general-purpose computer whose size, capabilities, and original sales price make it useful for individuals. A personal computer may be a desktop computer, a laptop, a tablet PC, or a handheld (palmtop) PC.

Glossary

Programmation Automation Controller (PAC)

A Programmable Automation Controller (PAC) is a compact controller that combines the features and capabilities of a PC-based control system with that of a typical Programmable Logic Controller (PLC). PACs are used in industrial settings for process control, data acquisition, remote monitoring, machine vision, and motion control.

Remote Terminal Unit (RTU)

An RTU or Remote Terminal Unit is a microprocessor controlled electronic device which interfaces objects in the physical world to a distributed control system or SCADA by transmitting telemetry data to the system and/or altering the state of connected objects based on control messages received from the system.

Total Cost of Ownership (TCO)

Total cost of ownership (TCO) is a financial estimate. Its purpose is to help consumers and enterprise managers determine direct and indirect costs of a product or system. It is a management accounting concept that can be used in full cost accounting or even ecological economics where it includes social costs.

Supervisory Control And Data Acquisition (SCADA)

The term SCADA usually refers to centralized systems which monitor and control entire sites, or complexes of systems spread out over large areas. Most control actions are performed automatically by Remote Terminal Units (RTUs) or by Programmable Logic Controllers (PLCs).

Notes

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