A Guide to Ordering
a Control Module

This is a detailed ***"Parameter Table."*** It is an expanded form of a ***"Truth Table."*** It should contain all the factors that define or set the system of operation of your process control automation. Please use this as a guide for ordering your control module. The succeeding pages explain how to fill up this table.

An ***"Ordering Guide Example"*** is provided in another downloadable document. You can modify this table to suit your requirements. On page 3 is a section where you can provide additional information about your process requirements.

To spare you the trouble, just describe your process on page three (3) and we will work on this table for you. When we return this document to you for approval, this will serve as part of our Functional Design Specification.

Parameter Table for I/Os							
INPUT	TYPE	STATE	TIMER	CONDITION 1	CONDITION 2	OUTPUT	STATE

The following table should contain all peripherals that are to be connected to the controller pins. These can be ***operation buttons, switches, and sensors, in the case of inputs,*** and ***relays, motor controllers, actuators, pumps, lights, etc., in the case of outputs.*** The input and output entries being on the same row ***does not necessarily mean*** that the input controls the output in that row. The table is laid out this way only for convenience.

INPUT	DESCRIPTION		OUTPUT	DESCRIPTION

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INPUTS
There are two classes of INPUT signals: Digital and Analog. For our purposes here, we will name our DIGITAL INPUTS D1, D2, D3, and so forth. For ANALOG INPUTS we will name them A1, A2, A3, and so forth.

OUTPUTS
We are considering two kinds of OUTPUT signals: Digital and PWM. PWM is a way of digitally encoding analog signal levels. They are used for controlling motors, servos, and actuators for speed and positioning. We will name our DIGITAL OUTPUTS DO1, DO2, DO3, and so forth. For PWM OUTPUTS we will name them AO1, AO2, AO3, and so forth.

TYPES OF INPUT SOURCE
There are four (4) types of ***Digital Input Sources*** to consider: ***Buttons, Switches, Sensors,*** and ***Internal.*** For purposes of nomenclature, we will use the following:

1. Switch - SW
2. Button - BT
3. Sensor – SN
4. Internal – INT (This type of input is generated by program algorithm for control.)

STATE (INPUT)
Digital Input States can only be ***"1" or "0,"*** meaning the input is ***energized or not-energized,*** respectively. Some *input States* may be energized only for a very short period as with those connected to a button. In this case, the contact allowing the flow of current to reach the *Input Pin* is temporary, only during the short duration when the button is pressed.
Analog Inputs detect varying current or voltage. Sensors that provide a range of values, e.g., pressure or temperature sensors connect to analog pins. The microcontroller converts the incoming data into digital form that can be processed by the CPU.

TIMER
A timer can be implemented after a change in an input state. For example, if it is required that a pump continuous to run for a given period before being turned off.

CONDITION
A condition is an added parameter that influences an action. It could be the state of a process within a program or the condition of another ***Input Pin.*** For example, - "If D1 = 1" meaning, if D1 is (also) energized. Or to put it in plain language, ***"if the drain valve is also open,"*** for example.

OUTPUT
The OUTPUT PIN that receives the resultant control signal of the step in the program/sequence.

STATE (OUTPUT)
The resultant State of the ***OUTPUT PIN*** for the step in the program/sequence. If this were a "Digital Output" the state can only be "1" or "0," meaning the output is energized or not-energized. If it were a ***"PWM (Analog simulated) OUTPUT,"*** the value of the control parameter.

On the field below, provide further details of the requirements of your automation process. Please refer to the downloadable ***"Ordering Guide Example"*** for guidance.

For Further Reading -

There are two different classes of control signals processed by digital *input pins.* These are:

1. *Latched signals* – retained signals provided by switches or sensors. A switch that is in the "ON" position will provide a retained "***high-level (energized) state"*** to an *input pin*, while in the "OFF" position will provide a retained ***"0" voltage or "low level state."***
   A sensor will provide a retained signal depending on the state of the switching mechanism. This signal (state) can vary depending on the function of the sensor and the status/condition it is monitoring. For example, a liquid level sensor may provide a retained ***energized state*** to an input pin if the set level triggers or closes the mechanical contact in the sensor. Such a configuration is classified as ***"NO"*** to designate Normally Open when the sensor is not activated, and the contact is made only on activation/triggering of the sensor, i.e., when the level is attained. On the other hand, the sensor may also break open a contact at such condition (triggered or level attained) depending on the configuration of the switch. Such a configuration is classified as ***"NC"*** to designate Normally Closed when the sensor is not activated, and the contact is broken (open) only on activation/triggering of the sensor.
2. *Momentary signals* – signals that are at ***"high"*** state only momentarily, as in the case of signals provided by push buttons, trip switches, counters, etc. Momentary signals on ***input pins*** can provide latched control on equipment connected to an ***output pin.*** This output control is handled in the control unit's program. Momentary signals are used to ***toggle states*** in a program. This toggling of states allows for a single ***input pin*** to be used to turn *on* or *off* equipment connected to the controller.

Input Signal Processing

Input signals can directly control outputs on a controller, but this is not usually the case. If it were so, there would be no need to pass the signal through the controller but directly to the controlled equipment, such as in a light switch. When the switch is on current flows to the light, or load, and it is turned on. When the switch is off no current flows and the light is off.

Input signals are used by the controller in its program algorithms. The way the signal is treated in a controller program depends on process requirements. For example, if a pump is required to turn off two (2) minutes after the level in a container reaches a certain point, a delay of two minutes can be implemented after the state of the level sensor pin changes from low to high, in the case of a normally open sensor switch, before turning off the ***output pin*** that drives the pump. This type of signal processing is called a ***delay timer.***

Input signals can also be used with counters. For example, in case there is a need to perform another operation in a cycle after a level in a container has dropped a certain number of times. In this case the input signal serves both the purpose of counting the number of times the level dropped and operating the pump.

Very often, input signals are used to toggle states in a controller's program. This allows for a single button connected to an *input pin* to perform several functions depending on the state the program is in. The duration during which an *input pin* is energized can also be used to manipulate the controller program. A long press could be used to tell the program to do something different as opposed to what it should in case of just a short press.

Analog Input Pins

An *Analog Input Pin* converts a voltage level into a digital value that can be processed by a controller's computer. There are a multitude of sensors used in process applications. Flow meters, temperature, pressure, and level sensors are just some. These instruments usually calculate parameters converting them into volt units. A controller's analog input pin converts the 0 – 5-, or 0-24-volt range, depending on a controller's rated capacity, into a digital value between ***0 and n,*** a data range which can be converted by the controller's microprocessor into digital data and can be processed by the CPU for incorporating into program algorithms.