Synergy Controller General Logic Programming Features

Introduction

Tidal Engineering's Synergy Controllers, including the Synergy Micro 2, Synergy Quattro, and the ¼ DIN Synergy Nano provide state-of-the-art usability and connectivity for environmental test control and data acquisition. They combine the functionality of a chamber controller and a data logger and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards. With the flexibility afforded by their multiple communication ports; Ethernet (10/100 Base-T), GPIB/IEEE 488, and RS-232, these controllers are perfect for today's dynamic testing environments.

The Synergy Controller software currently implements more than 30 high level functions (algorithms) called primitives which are designed to drive compressors, heaters, fans, and various refrigeration and humidity control components.

In addition, starting in Version 4.0.x these controllers have a variety of general purpose programming features that can be used to implement control logic such as timers, thermostatic (On/Off) output functions, time proportioning outputs, selectors functions, Latch, and logic output (AND, OR, NAND and NOR) functions. This application describes these general purpose primitives and provides examples.

1. On/Off output functions. Up to16 Available.
2. Time proportioning outputs (PWM). Up to16 Available.
3. Selectors functions. Up to16 Available.
4. Latch functions. Up to16 Available.
5. Logic output (AND, OR, NAND and NOR) functions. Up to 32 Available

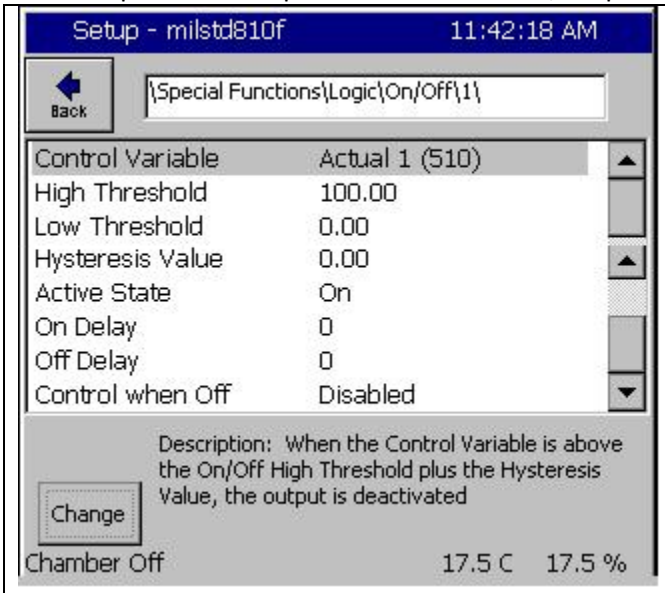
ON/OFF Thermostatic Primitive

The ON/OFF Thermostatic Primitive (referred to as On/Off primitive below) is full featured two threshold thermostatic output with programmable Activation and De-activation timers. The output is active when the source variable is within the limits defined by the High and Low Engineering Thresholds and the output is not active when the source variable is outside these thresholds. The output value of the primitive in the Active state can be set to On or Off. In addition, hysteresis can enabled around the switch-points to prevent chatter and Activation and De-Activation Delay timers are individually settable.

The functionality of the On/Off primitive in its simplest form is as follows:

When the Active State parameter is set to On (1)	When the Active State parameter is set to Off (0)
$f(x) = \begin{cases} 0, & x < Low\ Eng.Threshold \\ 0, & x > High\ Eng.Threshold \\ 1, & otherwise \end{cases}$	$f(x) = \begin{cases} 1, & x < Low\ Eng.Threshold \\ 1, & x > High\ Eng.Threshold \\ 0, & otherwise \end{cases}$

The setup folders and parameters for the On/Off primitive are as follows:



Control When Off. When this parameter is Disabled, the output of this Logic function will always be off when the chamber is off. When this parameter is Enabled, this output is still calculated and can be On even if the chamber is Off.

Control Variable parameter defines the Control variable x in the equation above. ONOFF#_SRC

High Threshold parameter defines the high threshold; when the source parameter is above this threshold, the primitive output is inactive. ONOFF#_ENGMAX

Low Threshold parameter defines the Low threshold; when the source parameter is below this threshold, the primitive output is inactive. ONOFF#_ENGMIN

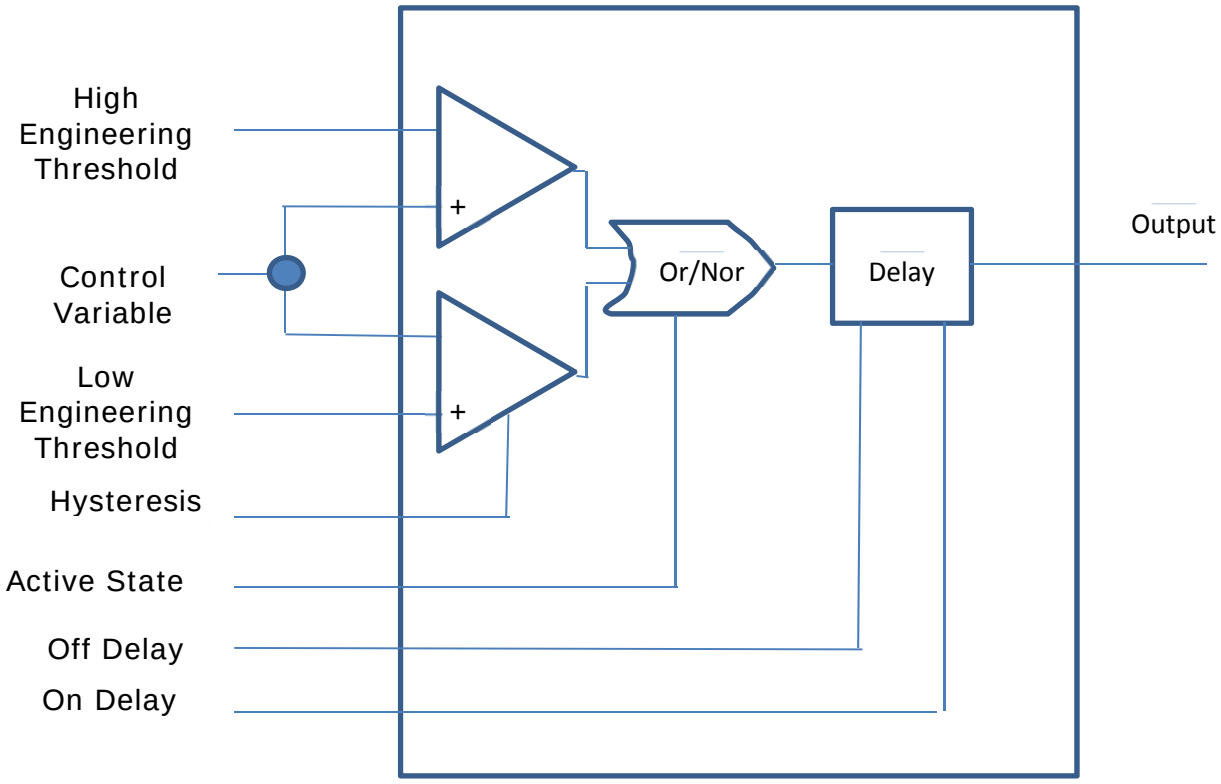
Hysteresis Value Parameter defines the switching Hysteresis. ONOFF#_HYST

Active State Parameter defines value of the output in the active state, On or Off. ONOFF#_ACTST

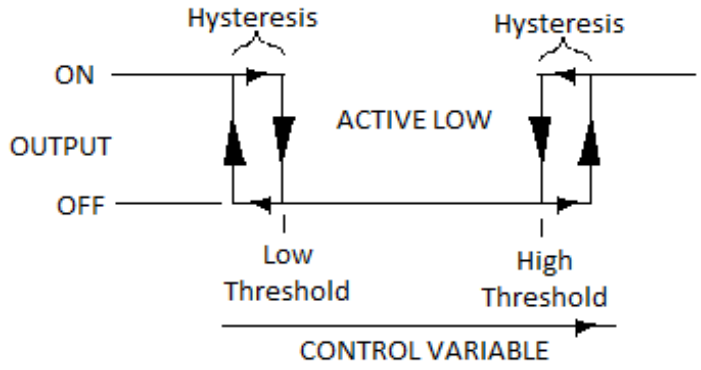
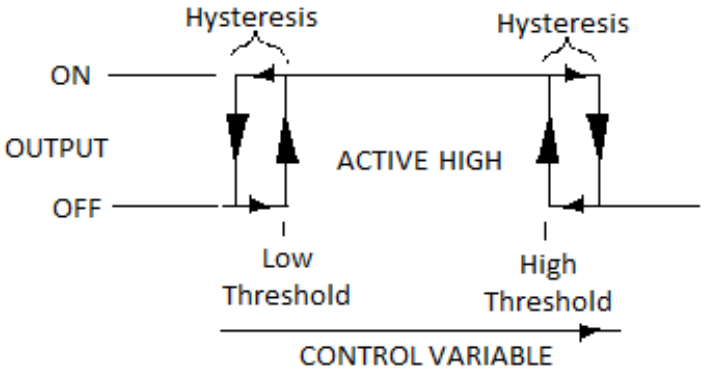
On Delay is the number of seconds of delay before the output state changes after the source parameter gets inside the threshold limits. ONOFF#_ONT

Off Delay is the number of seconds of delay before the output state changes after the source parameter goes outside the threshold limits. ONOFF#_OFFT

Block Diagram ON/OFF Primitive



The two diagrams below describe how this function operates graphically.

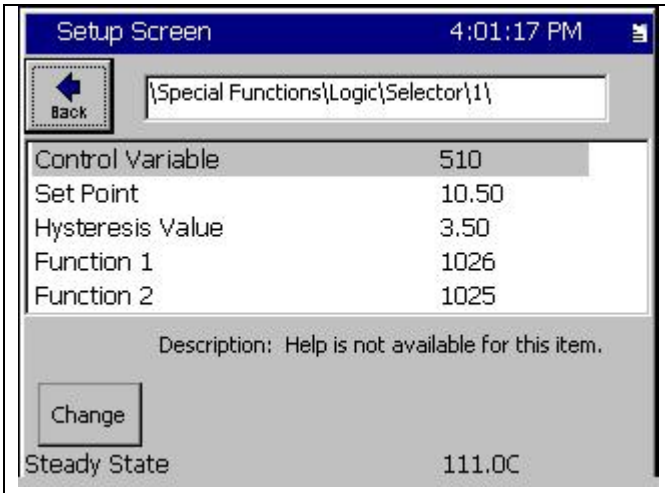
	On/Off Output Active Low
	On/Off Output Active High

Selector Primitive Function

The Selector Primitive's output selects between two inputs based on the value of the Control Variable. The Function 1 input is copied to the Primitive's output when the value of when the Control Variable is less than the Set point and Function 2 input is copied to the Primitive's output when the Control Variable is less than or equal to the threshold.

The function of this primitive in its simplest form is as follows:

$$f(x) = \begin{cases} Function\ 1, & x > Threshold \\ Function\ 2, & x \leq Threshold \end{cases}$$



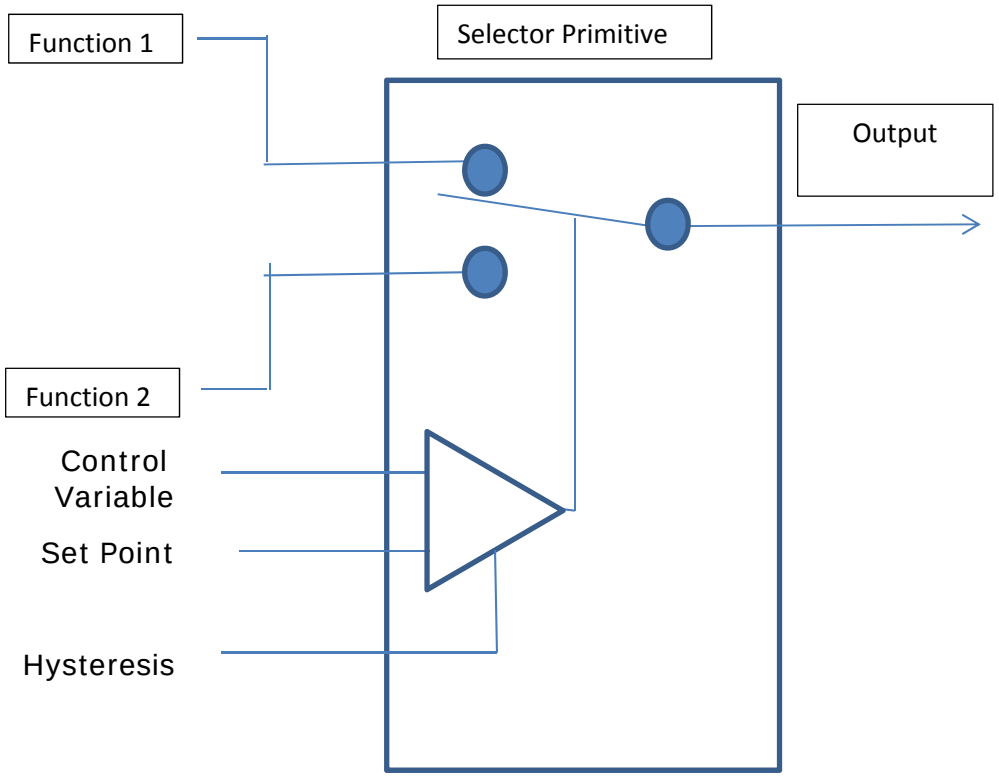
Control Variable parameter defines the source variable x in the equation above.
SELECTOR#_SRC

Set Point parameter defines the threshold that the source variable is compared with.
SELECTOR#_SP

Hysteresis Value Parameter defines the switching Hysteresis
SELECTOR#_HYST

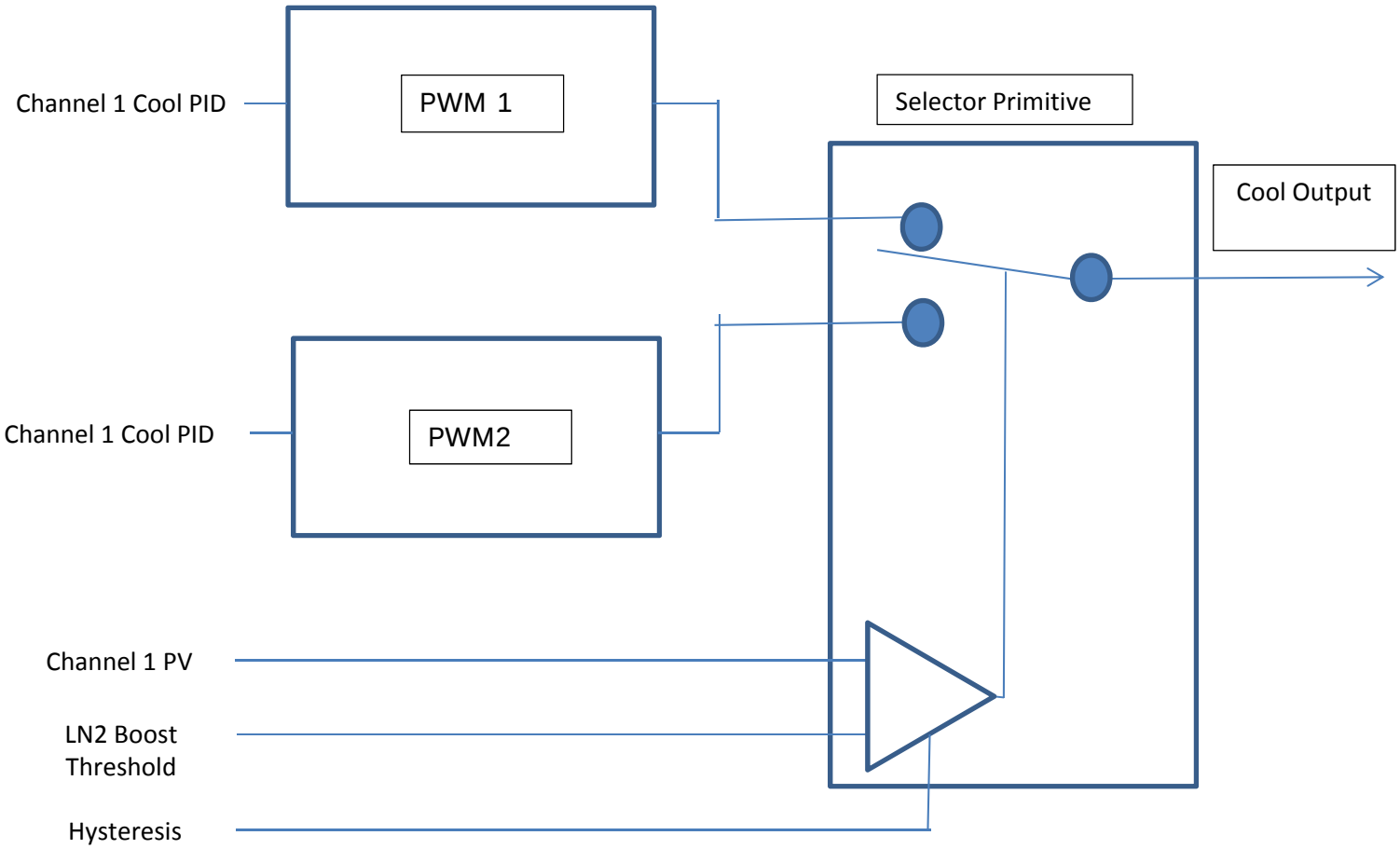
Function 1 parameter is used to select the Function 1 variable.
SELECTOR#_FUNC1

Function 2 parameter is used to select the Function 2 variable.
SELECTOR#_FUNC2



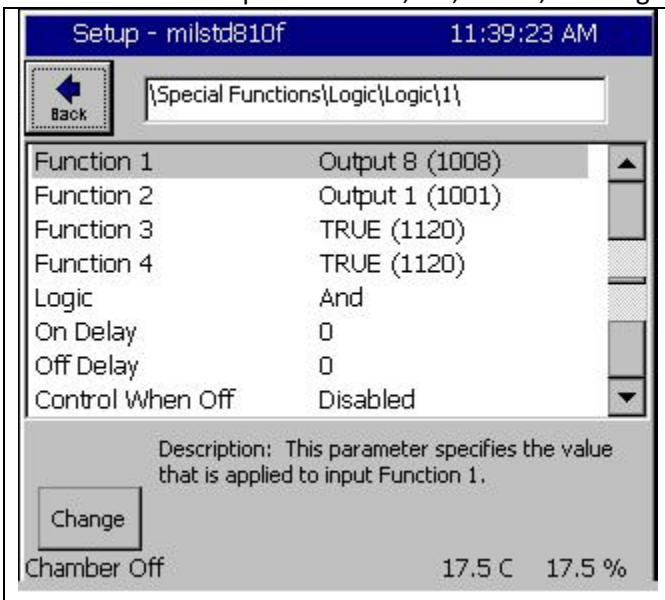
Selector output example

This Output switches between PWM1 and PWM 2 using the Selector Primitive.
PWM1 and PWM2 can be setup for different PV conditions.
The Selector Source variable is set to Actual Channel 1 (PV) and the threshold is setup for the switch temperature.



Logical Primitive Function

These functions implement AND, OR, NAND, NOR logic gates.



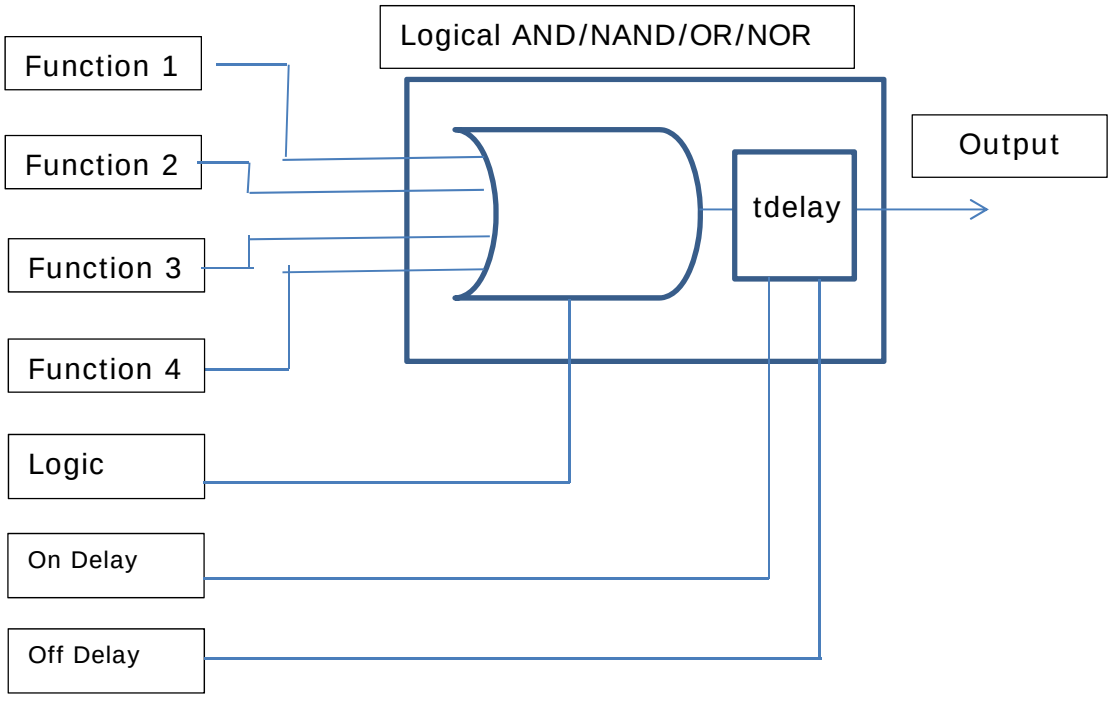
Function n Four input functions are selected from a drop down list.
LOGIC#_FUNCn

Logic set to AND, OR NAND, NOR.
LOGIC#_TYPE

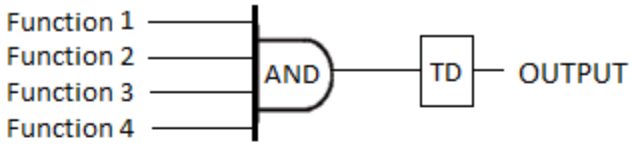
On Delay is the number of seconds of delay before the output state changes after the source parameter gets inside the threshold limits.
LOGIC#_ONT

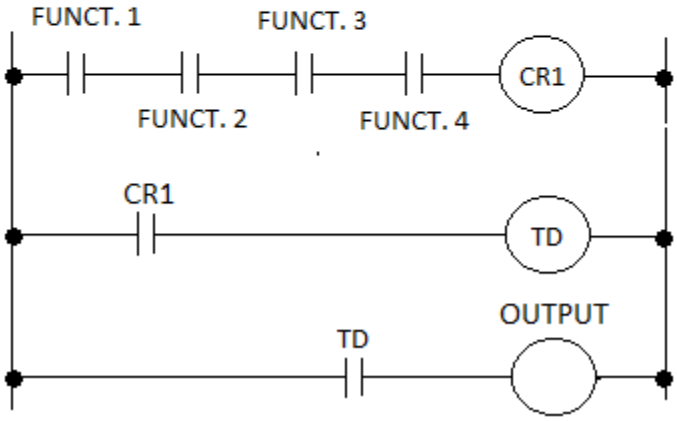
Off Delay is the number of seconds of delay before the output state changes after the source parameter goes outside the threshold limits.
LOGIC#_OFFT

Control When Off. When this parameter is Disabled, the output of this Logic function will always be off when the chamber is off. When this parameter is Enabled, this output is still calculated and can be On even if the chamber is Off.

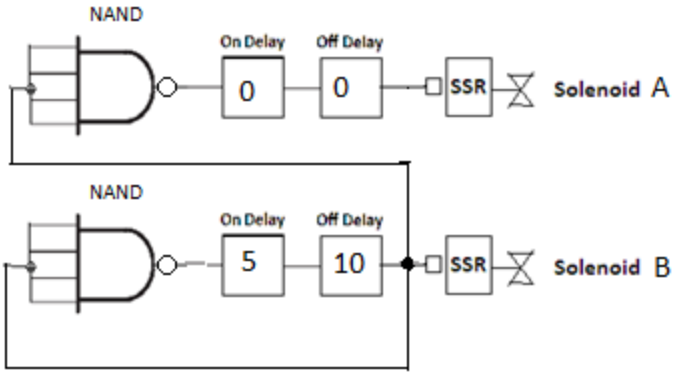


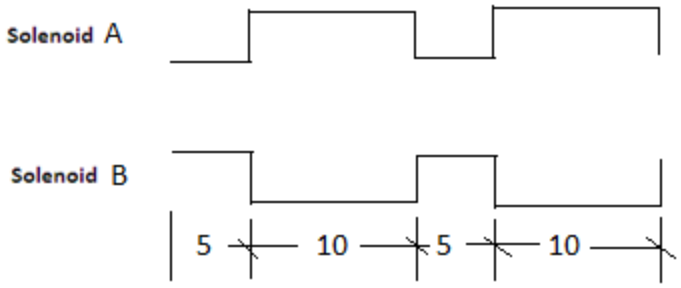
Logic AND Example with equivalent Relay logic





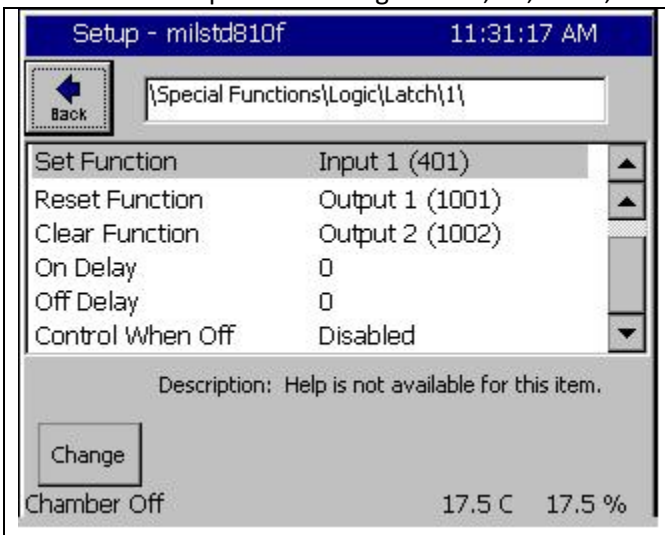
Logic NAND Example for periodic timer function





Latch Primitive Functions

This function implements a Logical And, Or, Nand, Nor.



Set Function This input turns the latch on unless Reset or Clear Inputs are active.

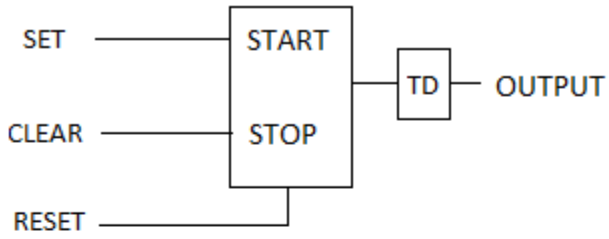
Reset Function This input turns the latch off unconditionally.

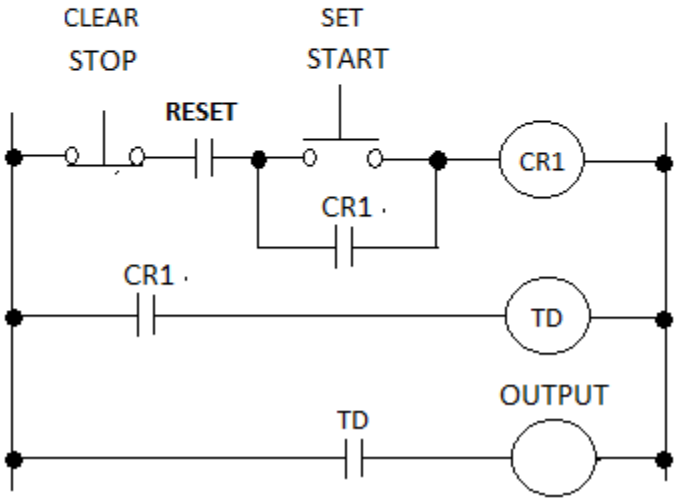
Clear Function This input turns the latch off.

On Delay is the number of seconds of delay before the output state changes after the Latch is set.

Off Delay is the number of seconds of delay before the output state changes after the Latch is cleared.

Control When Off. When this parameter is Disabled, the output of this latch will always be off when the chamber is off. When this parameter is Enabled, this output is still calculated and can be On even if the chamber is Off.





Appendix A Logic Programming Commands

On/Off Primitive Function Commands

Command Noun	Actions	Syntax	Arguments	Examples
ON/Off Function Control Variable	ONOFF#_SRC Set	= ONOFF#_SRC ARG1	# - On/Off Instance 1-8 ARG1: 1-18	= ONOFF1_SRC 8 Set Source to CH1 Cool PID
	ONOFF#_SRC Query	? ONOFF#_SRC	# - On/Off Instance 1-8	? ONOFF1_SRC Response: 8
On/Off Function High Threshold	ONOFF#_ENGMAX Set	= ONOFF#_ENGMAX ARG1	# - On/Off Instance 1 - 8 ARG1: -200 to 5000	= ONOFF7_ENGMAX 30
	ONOFF#_ENGMAX Query	? ONOFF#_ENGMAX	# - On/Off Instance 1 - 8	? ONOFF7_ENGMAX Response: 30
On/Off Function Low Threshold	ONOFF#_ENGMIN Set	= ONOFF#_ENGMIN ARG1	# - On/Off Instance 1 - 8 ARG1: -200 to 5000	= ONOFF7_ENGMIN 10
	ONOFF#_ENGMIN Query	? ONOFF#_ENGMIN	# - On/Off Instance 1 - 8	? ONOFF7_ENGMIN Response: 10
On/Off Function Hysteresis	ONOFF#_HYST Set	= ONOFF#_HYST ARG1	# - On/Off Instance 1 - 8 ARG1: 0 -999	= ONOFF8_HYST 1.5
	ONOFF#_HYST Query	? ONOFF#_HYST	# - On/Off Instance 1 - 8	? ONOFF8_HYST Response: 1.5
On/Off Function Active State	ONOFF#_ACTST Set	= ONOFF#_ ACTST ARG1	# - On/Off Instance 1 - 8 ARG1: 0 - 3600 Seconds	= ONOFF 8_ ACTST 1
	ONOFF#_ ACTST Query	? ONOFF#_ ACTST	# - On/Off Instance 1 - 8	? ONOFF 8_ ACTST Response: 1
On/Off Function Activation (ON) Delay Timer	ONOFF#_ONT Set	= ONOFF#_ONT ARG1	# - Logic Instance 1 - 8 ARG1: 0 - 3600 Seconds	= ONOFF7_ONT 30
	ONOFF#_ONT Query	? ONOFF#_ONT	# - Logic Instance 1 - 8	? ONOFF7_ONT Response: 30
On/Off Function Deactivation (OFF) Delay Timer	ONOFF#_OFFT Set	= ONOFF#_OFFT ARG1	# - Logic Instance 1 - 8 ARG1: 0 - 3600 Seconds	= ONOFF8_OFFT 120
	ONOFF#_OFFT Query	? ONOFF#_OFFT	# - Logic Instance 1 - 8	? ONOFF8_OFFT Response: 120

Logic Primitive Function Commands

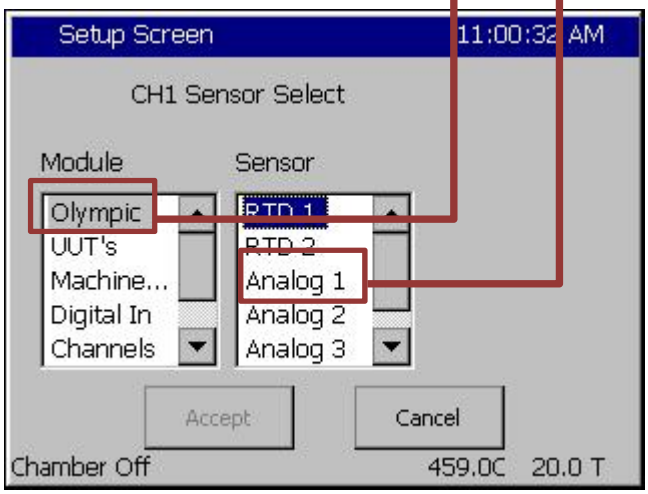
Command Noun	Actions	Syntax	Arguments	Examples
Logic Primitive Input Functions	LOGIC#_FUNCn Set	= LOGIC#_FUNCn ARG1	# - Logic Instance 1-8 n 1-4 ARG1: Seem table below	= LOGIC1_FUNC2 1003 Set Log 1 Function 2 to Output 3
	LOGIC#_FUNCn Query	? LOGIC#_FUNCn	# - Logic Instance 1-8 n 1-4	? LOGIC1_FUNC2 Response: 1003
Logic Primitive Function Type	LOGIC#_TYPE Set	= LOGIC#_TYPE ARG1	# - Logic Instance 1-8 ARG1: 0 - AND 1 - OR 2 - NAND 3 - NOR	= LOGIC1_TYPE 2
	LOGIC#_TYPE Query	? LOGIC#_TYPE	# - Logic Instance 1-8	? LOGIC1_TYPE Response: 2
Logic Primitive Activation (ON) Delay	LOGIC#_ONT Set	= LOGIC#_ONT ARG1	# - Logic Primitive 1 - 8 ARG1: 0 - 3600 Seconds	= LOGIC7_ONT 30
	LOGIC#_ONT Query	? LOGIC#_ONT	# - Logic Primitive 1 - 8	? LOGIC7_ONT Response: 30
Logic Primitive Deactivation (OFF) Delay	LOGIC#_OFFT Set	= LOGIC#_OFFT ARG1	# - Logic Primitive 1 - 8 ARG1: 0 - 3600 Seconds	= LOGIC8_OFFT 120
	LOGIC#_OFFT Query	? LOGIC#_OFFT	# - Logic Primitive 1 - 8	? LOGIC8_OFFT Response: 120

Selector Primitive Function Commands

Command Noun	Actions	Syntax	Arguments	Examples
Selector Primitive Control Variable	SELECTOR#_SRC Set	'= SELECTOR#_SRC ARG1	# - Selector Instance 1-8 ARG1: 110 - 1299	= SELECTOR1_SRC 1211 Set to Channel 1 PID Heat
	SELECTOR#_SRC Query	? SELECTOR#_SRC	# - Selector Instance 1-8	? SELECTOR1_SRC Response: 1211
Selector Primitive Set Point	SELECTOR#_SP Set	= SELECTOR#_SP ARG1	# - Selector Primitive 1 - 8 ARG1: Setpoint, float	= SELECTOR7_SP 30
	SELECTOR#_SP Query	? SELECTOR#_SP	# - Selector Primitive 1 - 8	? SELECTOR7_SP? Response: 30
Selector Primitive Hysteresis	SELECTOR#_HYST Set	= SELECTOR#_HYST ARG1	# - Selector Primitive 1 - 8 ARG1: Hysteresis, float	= SELECTOR8_HYST 120
	SELECTOR#_HYST Query	? SELECTOR#_HYST	# - Selector Primitive 1 - 8	? SELECTOR8_ HYST Response: 120
Selector Primitive Functions	SELECTOR#_FUNCn Set	= SELECTOR#_FUNCn ARG1	**# - Selector Instance 1-8** **n – 1 or 2** ARG1: Function	= SELECTOR1_FUNC1 1025 Set Function 1 to Output 25
	SELECTOR #_FUNCn Query	? SELECTOR#_FUNCn	# - Selector Instance 1-8 n – 1 or 2	? SELECTOR1_FUNC1 Response: 1025

Appendix B Control variables selection from the Sensor Selection screen.

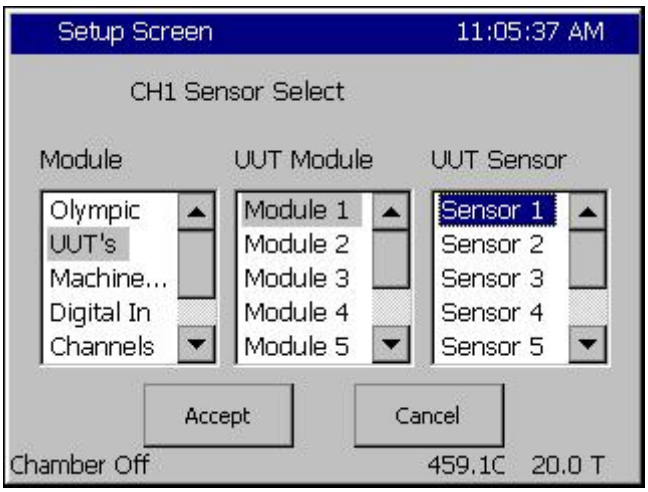
1. Select the Module from the list in the first column.
2. Then select the sensor or the sub-module from the Sensor list.
3. When necessary, select the sensor from the sensor list in third column.



Olympic (High Resolution Inputs)
RTD 1
RTD 2
Analog 1
Analog 2
Analog 3
Analog 4
TC 1*
TC 2*
UUT (Up to 64 T-type T/Cs)
Module 1 Thru 8
Sensor 1 thru Sensor 8
Machine Inputs (Low Resolution Inputs)
Low Res 1 thru 8
Digital Inputs
Dig. In. 1 thru 16
Channels (PV)
Act CH 1 thru Act CH 4
Setpoints (SP)
Setpt CH 1 thru Setpt CH 4
Virtual Sensors
Dual Press.
Wet Bulb/Dry Bulb
Virtual Kft
PIDS
PID CH 1 thru PID CH 4

Note: * Direct Thermocouple Inputs are not available on Synergy Micro 2.

Use the TE1908 Thermocouple Signal Conditioner if thermocouples are required.



♦ <u>UUT Sensor Selection</u>
To select a sensor from the UUT Thermocouple module, Select UUTs from the Module column, and then select the UUT Module (1 thru 8) and then the Sensor (1 thru 8).

Control Variable IDs

Command Noun	Screen Identifier	Code	Example
High Res Analog	RTD1,RTD2 Analog1-Analog 4	110, 120 130, 140, 150, 160	110 is RTD1
UUT	UUT n	211, 212,..218 221, 222,..228 .. … .. 281., 282,..288	UUT Module 2, Sensor 5 is 225 UUT Module 8, Sensor 8 is 288
Low Res Analog	LowRes n	310, 320, .. 380	3800 is LowRes Analog 8
Digital Inputs	Digital In	400 + n	416 is Input 16
Actuals Process Variables	Actual n	510, 520, 530, 540	Channel 2 PV is 520
Setpoints	Setpoint n	710, 720, 730, 540	Setpoint 2 is 720
Digital Outputs	Outputs	1000 + n	1030 is Digital Output 30
Constants	Logic	1110 is False 1120 is True	1110 is False 1120 is True
PIDS	12nx n is the Channel x is the PID type	12nx x = 0 Heat PID x = 1 Cool PID x = 2 Full PID x = 3 Cascade PID	1210 is Chan. 1 Heat 1211 is Chan. 1 Cool 1213 is Chan. 1 Full 1214 is Chan. 1 Cascade 1230 is Chan. 3 Heat 1231 is Chan. 3 Cool 1233 is Chan. 3 Full 1214 is Chan. 1 Cascade
Not Digital Inputs	!Digital In	1400 + n	1405 is Not Digital Input 5
Not Digital Outputs	!Outputs	1300 + n	1330 is Not Digital Output 30

About the Synergy Controller Family
Tidal Engineering's Synergy Controllers; the Synergy Micro 2, Synergy Quattro, and the ¼ DIN Synergy Nano provide state-of-the-art usability and connectivity for environmental test control and data acquisition and combine the functions of a chamber controller and a data logger and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards.

Synergy Controller feature highlights includes:

- ➔ Color touch screen
- ➔ Ethernet, RS-232 and GPIB communications
- ➔ Built in 100 MB Data logger with USB drive support
- ➔ Data Acquisition, up to 64 T-type thermocouples (Optional)
- ➔ Built-in Web Server for remote control; WebTouch Remote ™
- ➔ Compatible with Synergy Manager for PC based control, monitoring and programming.
- ➔ Built-in FTP Server for factory automation and test and measurement applications

For more information regarding these controllers please visit http://www.tidaleng.com/synergy.htm

About Tidal Engineering
Headquartered in Randolph, NJ, Tidal Engineering Corporation has been designing and building award-winning embedded hardware and software for test and measurement and data acquisition applications since 1992. The company is recognized for technical expertise in such areas as Embedded IEEE 488, and turnkey SCADA (Supervisory Control and Data Acquisition) systems.

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