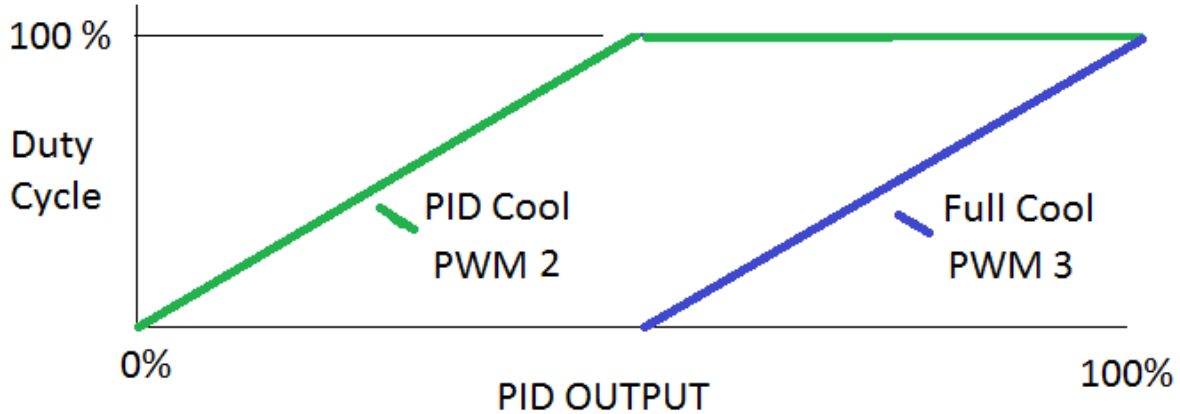## Time-Proportioning (PWM) Features


Staging Full Cool for Linear Response

Overview

Frequently in large capacity environmental test chamber, process oven, and vehicle chamber applications, heating and cooling equipment are partitioned into multiple stages. For example, high stage/low stage heat and large liquid/small liquid solenoids. The Synergy Controller provides up to 32 Time-Proportioning, AKA Pulse Width Modulated (PWM), Outputs that can be used to control these stages in a linear and continuous fashion.

In addition to staging, the PWM Time-Proportioning Outputs can be used to control any system or user functions requiring a general-purpose Time proportioning control signal. Setpoints, process data, constants, and internal PID values can be transmitted this way.   The PWM Retransmit Feature provides programmable scaling and can be controlled thru a set of communication commands or APIs.
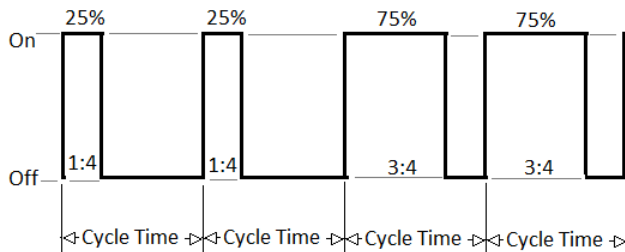
The following section will guide you through the setup for PWM 1 for a custom PID Cooling output. A second example at the end of the application note provides setup for heater staging.
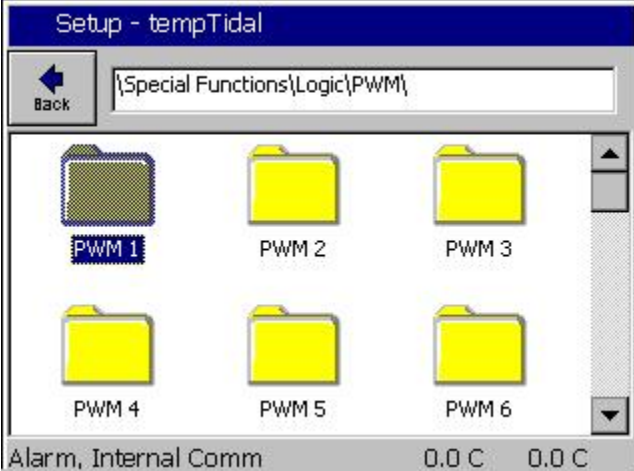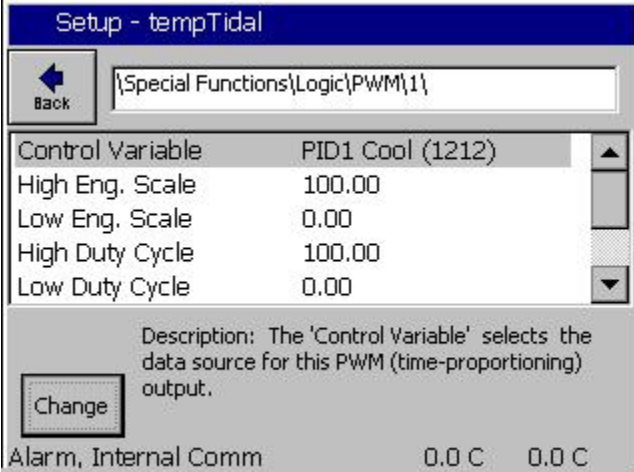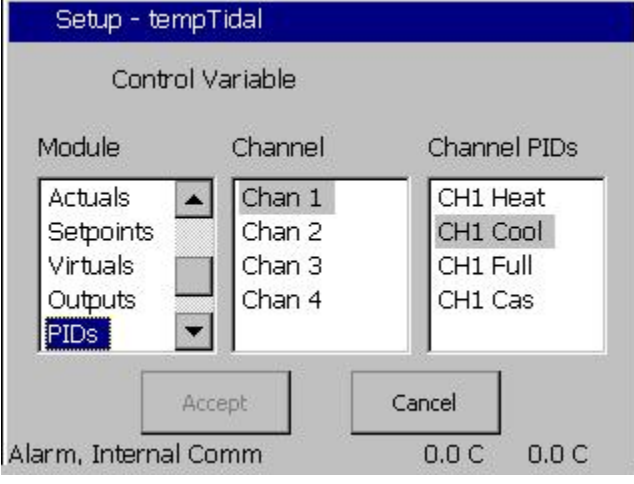
Note that this feature was introduced in Version 2.9.6 Build 786 and is supported on the full-sized Synergy Micro 2, Synergy Quattro and the ¼ DIN Synergy Nano models.
The current version, 5.3 includes the following improvements:

- 32 Channels (up from 16)
- Control Variable selection using Sensor Selection Wizard
- Enable Logic
- Control while the chamber is off parameter

Contact the factory to upgrade your controller software if required. Also note that the Chamber Definition File (CDF) must map the desired PWM primitives to appropriate outputs. The screenshots below refer to version 5.3 and higher.

Example 1:

Setup - tempTidal Back \Special Functions\Logic\PWM\ PWM 1 PWM 2 PWM 3 PWM 4 PWM 5 PWM 6 Alarm, Internal Comm 0.0 C 0.0 C	To configure the PWM Retransmit Output, open the *SETUP* screen on the Synergy Controller and browse to the folder on the left.
Setup - tempTidal Back \Special Functions\Logic\PWM\1\ Control Variable PID1 Cool (1212) High Eng. Scale 100.00 Low Eng. Scale 0.00 High Duty Cycle 100.00 Low Duty Cycle 0.00 Description: The 'Control Variable' selects the data source for this PWM (time-proportioning) output. Change Alarm, Internal Comm 0.0 C 0.0 C	Open the Setup\Special Functions\PWM Retransmit 1 folder. Select the Retransmit Source parameter and press the **Change** button.
Setup - tempTidal Control Variable Module Channel Channel PIDs Actuals Chan 1 CH1 Heat Setpoints Chan 2 CH1 Cool Virtuals Chan 3 CH1 Full Outputs Chan 4 CH1 Cas PIDs Accept Cancel Alarm, Internal Comm 0.0 C 0.0 C	Select the desired variable from the Sensor Selection Screen and press **Accept**. API Command: PWMnSRC See sensor IDs in the list below.

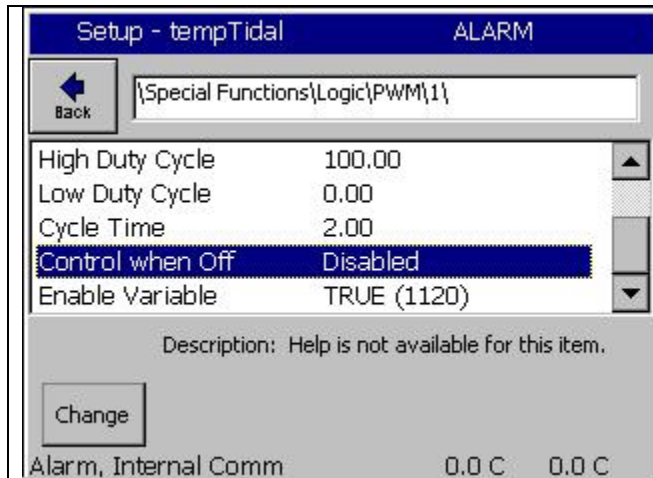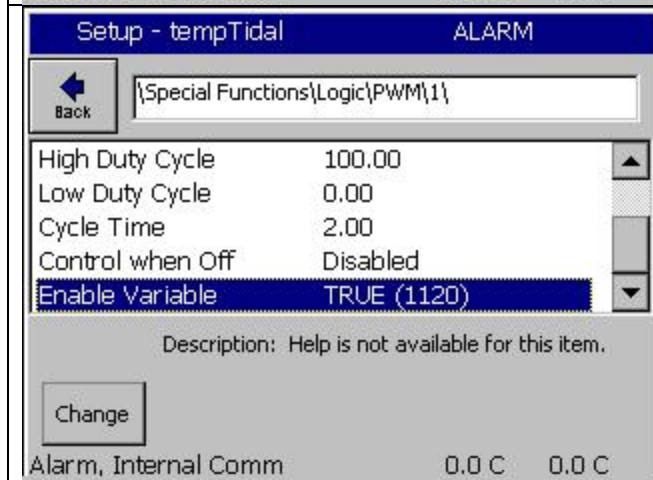|	
Setup Screen 12:40:04 PM Back \Special Functions\PWM Retransmit 1\ Retransmit Source CH 1 Cool... High Eng. Scale 100.00 Low Eng. Scale 0.00 High Duty Cycle 100.00 Low Duty Cycle 50.00 Description Help is not available for this item. Change Chamber Off 29.3 C 0.0 %	Adjust the Engineering Scaling as required. To retransmit the Channel 1 Cooling PID in the example, set the High and Low Engineering Scale to 100% and 0% respectively. API Commands: PWMnENGMAX [-200 - 5000] PWMnENGMIn [-200 - 5000]
Setup Screen 12:42:08 PM Back \Special Functions\PWM Retransmit 1\ Retransmit Source CH 1 Cool... High Eng. Scale 100.00 Low Eng. Scale 0.00 High Duty Cycle 100.00 Low Duty Cycle 15.00 Description Help is not available for this item. Change Chamber Off 29.4 C 0.0 %	Adjust the Duty Cycle Scaling as required. To retransmit the Channel 1 Cooling PID in the example, so the minimum output duty cycle is 15%, and the maximum output duty cycle is 100% set the High and Low Duty Cycle to 100% and 15% respectively. Note that a constant PWM output can be set by setting both the High and Low Duty Cycle parameters to the desired constant value. API Commands: PWMnDUTYMAX [0 - 100] PWMnDUTYMIN [0 - 100]
Setup - tempTidal Back \Special Functions\Logic\PWM\1\ High Duty Cycle 100.00 Low Duty Cycle 0.00 Cycle Time 2.00 Control when Off Disabled Enable Variable TRUE (1120) Description: Help is not available for this item. Change Alarm, Internal Comm 0.0 C 0.0 C	Set the Cycle Time (period) of the PWM output in seconds using the Cycle Time parameter as shown at left. API Commands: PWMnCYCLE [0 - 60 Seconds]

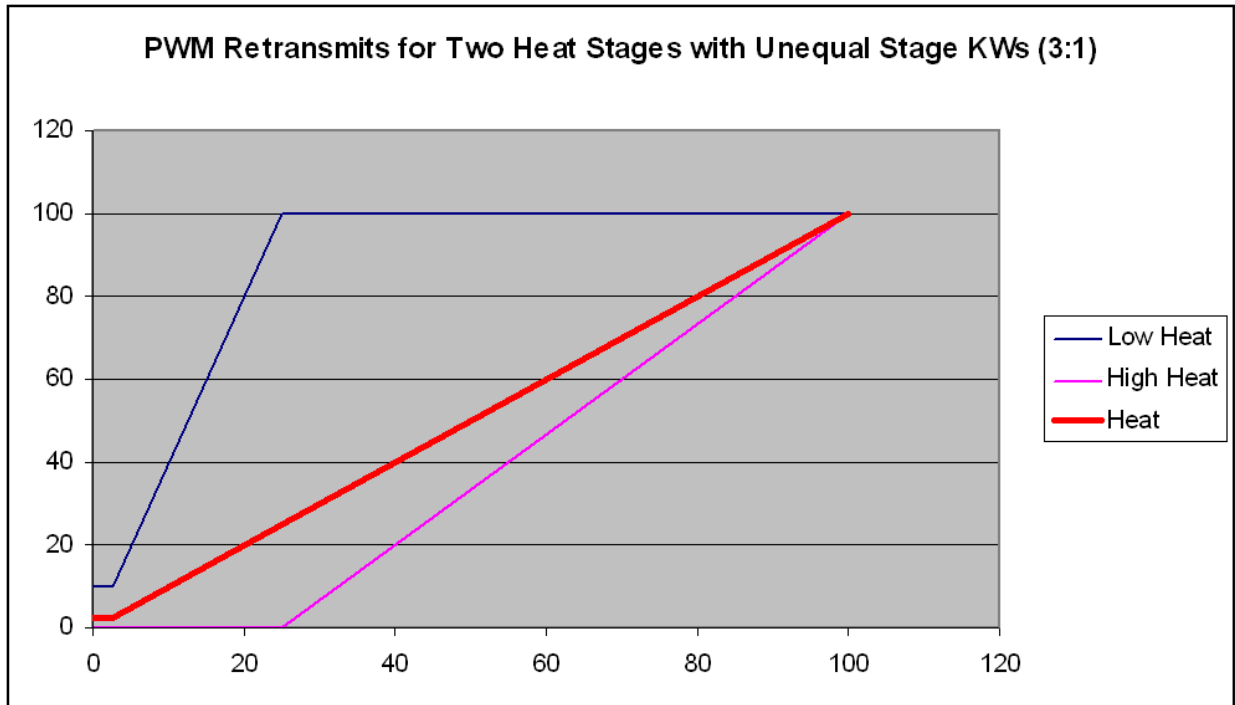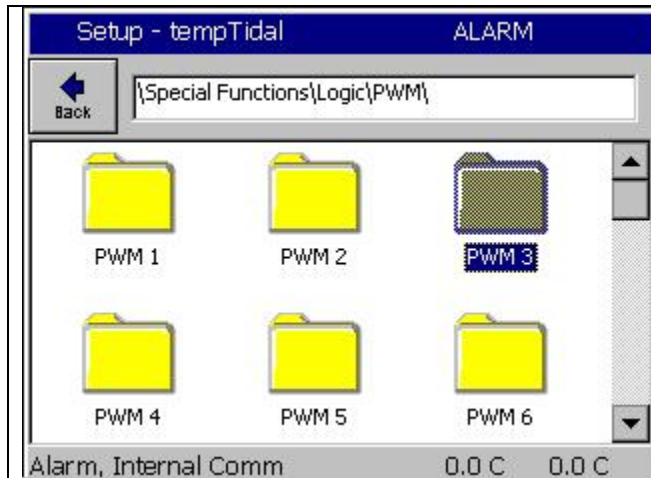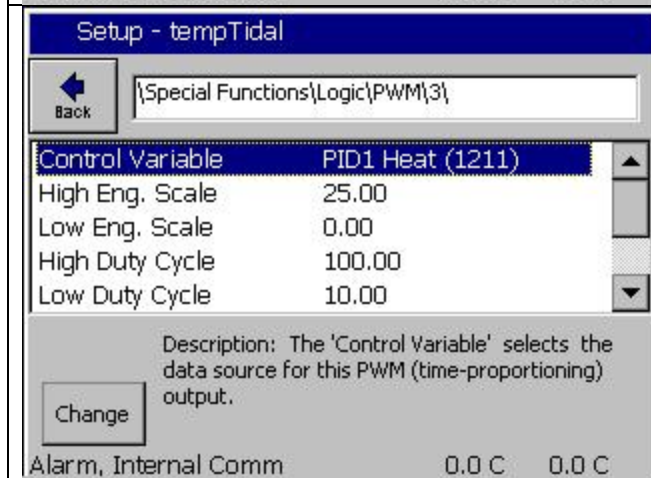|	
Setup - tempTidal ALARM ◀ Back \Special Functions\Logic\PWM\1\ High Duty Cycle 100.00 Low Duty Cycle 0.00 Cycle Time 2.00 **Control when Off Disabled** Enable Variable TRUE (1120) Description: Help is not available for this item. Change Alarm, Internal Comm 0.0 C 0.0 C	Set the "Control when Off" option • Enabled • Disabled. API Commands: PWMnENAID [0,1]
Setup - tempTidal ALARM ◀ Back \Special Functions\Logic\PWM\1\ High Duty Cycle 100.00 Low Duty Cycle 0.00 Cycle Time 2.00 Control when Off Disabled **Enable Variable TRUE (1120)** Description: Help is not available for this item. Change Alarm, Internal Comm 0.0 C 0.0 C	Set the "Enable Variable" to True to operate the PWM when ever the chamber is on, or to an output or input, such as "Compressor" to enable only under certain conditions; i.e. when the compressor is on. • Enabled • Disabled. API Commands: PWMnENAID [Sensor ID]

Example 2:
As mentioned in the introduction at the beginning of this application note, the heaters in a fast ramp chamber will often be divided into two stages. Sometimes these stages are not equal wattages. The PWM Retransmit Feature can be setup to partition and linearize the control of the heating system between multiple stages.

In addition, a small minimum heat output can sometimes improve control performance. In the following example, the high stage to low stage heater capacity is 3:1 (i.e. 3KW to 1KW) and 2.5% minimum heat is desired. The chart below represents this configuration. The X Axis is the Channel PID Heat Output.
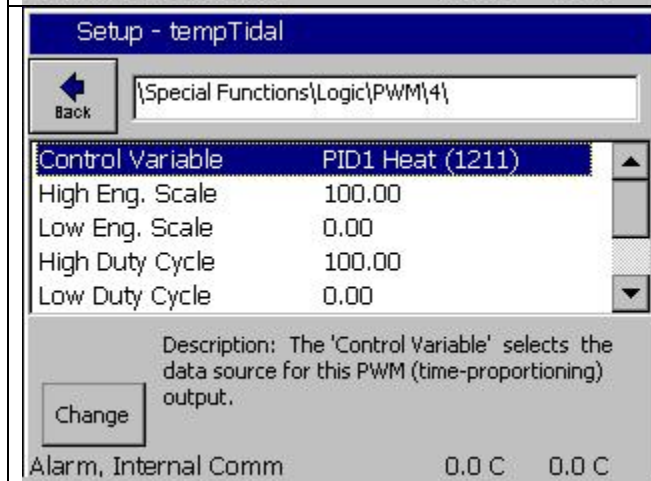
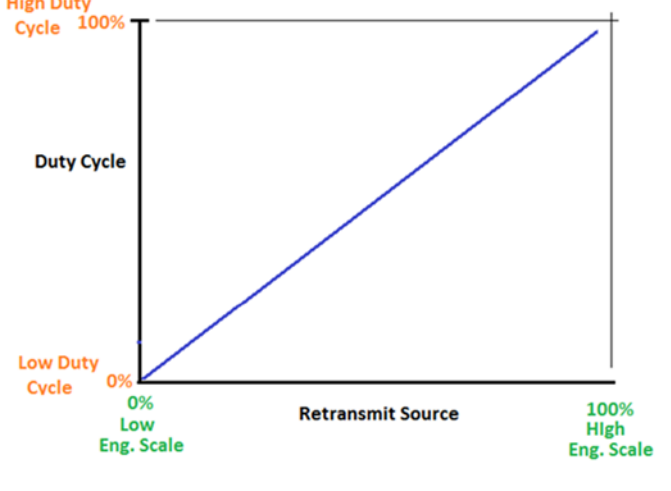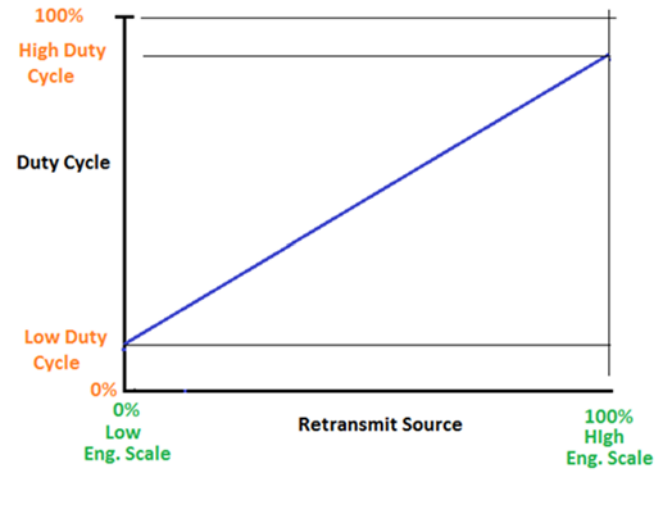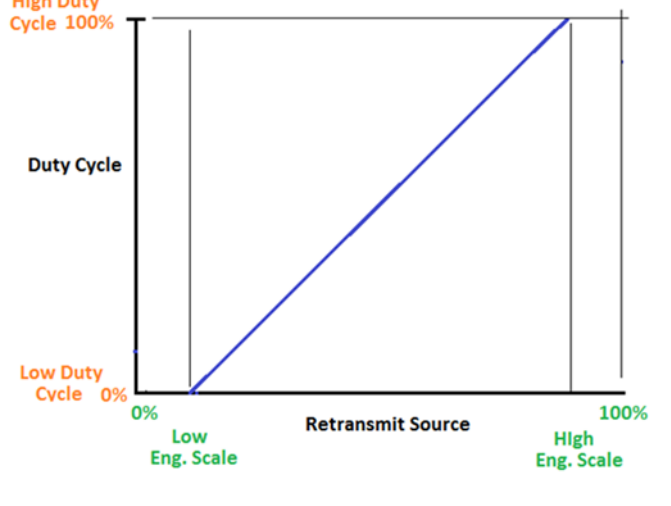| Screen	Instructions
Setup - tempTidal ALARM Back \Special Functions\Logic\PWM\ PWM 1 PWM 2 PWM 3 PWM 4 PWM 5 PWM 6 Alarm, Internal Comm 0.0 C 0.0 C	Browse to the PWM Retransmit Folder as shown at left.
Setup - tempTidal Back \Special Functions\Logic\PWM\3\ Control Variable PID1 Heat (1211) High Eng. Scale 25.00 Low Eng. Scale 0.00 High Duty Cycle 100.00 Low Duty Cycle 10.00 Description: The 'Control Variable' selects the data source for this PWM (time-proportioning) output. Change Alarm, Internal Comm 0.0 C 0.0 C	Set PWM3 for Low Stage Heat Set the Retransmit Source to CH1 Heat PID. Set the 4 parameters as shown at left. Then set the Cycle Time as required.
Setup - tempTidal Back \Special Functions\Logic\PWM\4\ Control Variable PID1 Heat (1211) High Eng. Scale 100.00 Low Eng. Scale 0.00 High Duty Cycle 100.00 Low Duty Cycle 0.00 Description: The 'Control Variable' selects the data source for this PWM (time-proportioning) output. Change Alarm, Internal Comm 0.0 C 0.0 C	Set PWM 4 for High Stage Heat Set the Retransmit Source to CH1 Heat PID. Set the 4 parameters as shown at left Then set the Cycle Time as required.

The Application Programming Interface commands (APIs) for the PWM Retransmit feature are as follows:

= PWMnSRC x where x is sensor ID   Example: = PWMnSRC 1211
 n selects the source variable for the PWM output x .

PID Outputs (PID1..PID4)
PID1 Heat=1211, Cool=1212, Full=1213, Cascade=1214
PID2 Heat=1221, Cool=1222, Full=1223, Cascade=1224
PIDy Heat=12y1, Cool=12y2, Full=12y3, Cascade=12y4 (Where y is the channel)

Process Variables, Actual (ACT1..ACT4))
ACT1=510, ACT2=520, ACT3=530, ACT4=540

Set Points, Actual (SP1..SP4))
SP1=710, SP2=720, SP3=730, SP4=740

Virtual Calculations (VCALC1 thru VCALC10)
VCalc1=670, VCalc2=671, VCalc3 =672, .. VCAL10=679.

Virtual Lookup Table (VLookup1 thru VLookup10)
VCalc1=680, VCalc2=681, VCalc3 =682, .. VCAL10=689.

Virtual MultiSensor (VMulti1 thru VMulti4)
VMulti1=651, VMulti2=652, VMulti3 =653, VMulti4=654.

= PWMnENGMAX [-200 - 5000]   Example: = PWM1ENGMAX 100
This sets the maximum PID % which will be sent to the Olympic board

---

= PWMnENGMIN [-200 - 5000]   Example: = PWM1ENGMIN 0
This sets the minimum PID % which will be sent to the Olympic board

---

= PWMnDUTYMAX [0 - 100%]   Example: = PWM1DUTYMAX 100
This sets the maximum value of the sensor/input being used. This is used in calculating the % output

---

= PWMnDUTYMIN [0 - 100%]   Example: = PWM1DUTYMIN 15
This sets the minimum value of the sensor/input being used. This is used in calculating the % output

---

= PWMnCYCLE [0 - 60 Seconds]   Example: = PWM1CYCLE 2
This sets the cycle time for the PWM x output.

Note: In the APIs list above, n is 1 for PWM Retransmit 1, and n is 2 PWM Retransmit 2

	Standard (1:1) The Duty Cycle Output is Scaled from the Control Variable Input
	Clamped Duty-Cycle The Duty Cycle Output Range doesn't go from 0 to 100%.
	Clamped Engineering Scale The Engineering Input Range doesn't go from 0 to 100% to produce a 0 to 100% Duty Cycle Output

About the Synergy Controller Family

Tidal Engineering's Synergy Controllers; the ¼ DIN Synergy Nano, the Synergy Micro 2, and the Synergy Quattro provide state-of-the-art usability and connectivity for environmental test control and data acquisition. They 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 see the full Synergy Controller Technical Manual on our website at 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.

Tidal Engineering Corporation
2 Emery Avenue
Randolph, NJ 07869
Tel: 973/328-1173
www.TidalEng.com
info@tidaleng.com