1. OBJECTIVE

Details the operation of the '**TM**', Time Modulation, chemical feed pump duty cycle special control

2. APPLICATION

The '**TM**' command targets plating and metal finishing applications where a pump or solenoid ON time is controlled or 'modulated' by the value of the controlling sensor with respect to the Turn ON & OFF Setpoints.

OPERATION
Switches pump power ON/OFF from 0% ON time to 100% ON time between the control setpoints.
Allows REVERSE control to be set which inverts the 0% and 100% setpoints.
User can set the 0-100% PERIOD which defaults to 60 seconds.

Feed Modulation:
Controller set to turn ON at 2000uS and OFF at 2500uS. Reverse control selected.
Modulation period = 60 seconds.
At 2000uS and less, bleed is ON for 60 seconds in every 60 seconds.
At 2500uS bleed is ON for 1 second in every 60 seconds.
At 2501uS bleed is OFF.

Bleed Modulation:
Controller set to turn ON at 2500uS and OFF at 2000uS,.
Modulation period = 60 seconds.
At 2500uS and greater, bleed is ON for 60 seconds in every 60 seconds.
At 2000uS bleed is ON for 1 second or less in every 60 seconds.
At 1999uS bleed is OFF.

Caustic Feed Modulation:
Controller set to turn ON at 8.5pH and OFF at 8.0pH,.
Modulation period = 120 seconds.
At pH 8.5 and above the caustic pump is ON for 120 seconds in every 120 seconds.
At pH 8.0 the caustic pump is ON for 1 second or less in every 120 seconds.
At pH 7.99 the caustic pump is OFF.

Acid Feed Modulation:
Controller set to turn ON at 8.0 pH and OFF at 9.0pH,. Reverse control selected.
Modulation period = 100 seconds.
At pH 8.0 and below, the acid pump is ON for 100 seconds in every 100 seconds.
At pH 9.0 the acid pump is ON for 1 second or less in every 100 seconds.
At pH 9.01 the acid pump is OFF.

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3. FUNCTION

3.1 COMMAND SYNTAX
The Time Modulation, '**TM**' option is entered in the special control field of the '**SW**' switch command using the syntax:

SWx,,,,TMy where **x** = Relay#1..8 and **y**= Period time in seconds, default=60 sec.

Example: **SW1,,,,TC** & *Enter* sets the 0-100% period to the 60 second default.

Example **SW1,,,TC100** & *Enter*   sets the 0-100% modulation period to 100 seconds.

Notes:
1. Setting the control equation to any water meter, removes Time Modulation
2. Attempting to set the Time Modulation special control on a switch controlled by a water meter displays 'meter illegal with special control'
3. Removing the control equation on a switch with Time Modulation, removes the Time Modulation special control.

3.2 'ON' TIME RESOLUTION & RECALCULATION
1. The controller calculates ON time in seconds, as an integer. The change in sensor value required to increase the ON time by one second is a function of <u>both</u> the ON-OFF difference and the PERIOD.
2. EXAMPLE: Turn ON = 2000uS,   Turn OFF= 1000uS, PERIOD = 60 seconds

Conductivity	ON Time (secs)	Floating Point Calculation converted integer
1000	0	60 x (1000 – 1000) / (2000–1000) = 0
1016	0	60 x (1016 – 1000) / (2000–1000) = 0.96
1018	1	60 x (1018 – 1000) / (2000–1000) = 1.08
1036	2	60 x (1036 – 1000) / (2000–1000) = 2.16
1508	30	60 x (1508 – 1000) / (2000–1000) = 30.48
1984	59	60 x (1984 – 1000) / (2000–1000) = 59.04

3. The ON time is recalculated at the end of every OFF time.
CAUTION: Do not use the **TM** special control for control of processes where the sensor traverses between setpoints in less than 5-10 PERIODS; poor control will result.

3.3 DIAGNOSTIC – 'ST' COMMAND
1. The 'ST' command will count down both ON and OFF times in seconds in the **Special Control** field.
2. **Modulated 25** will be displayed if the **'TM'** special control is set and you have either 25 seconds of ON or OFF time remaining. The relay state will change when the time count down time zeroes.
3. **Clear Alarms** starts a new OFF time.

3.4 LIMITS & OUT-OF-LIMITS RESPONSE
1. Minimum 0-100% period is 60 seconds. Attempting to set the period to less than 60 seconds, sets the period to 60 seconds.
2. Maximum period is 3600 seconds. Attempting to set the period to more than 3600 seconds, sets the period to 3600 seconds.
3. Setting the control equation to a water meter disables the control. Attempting to set the control on a relay with a water meter control, causes an error message.
4. Clearing alarms resets the current cycle and starts another ON time. Owed time is zeroed.
5. Priming adds time owed to the ON calculated by the **TM** special control.

3.5 ALARMS & DATA LOGGING
1. There is no change in feed limit timer or data logging. The controller logs the pump ON time and times out on minutes per actuation exceeded and minutes per day exceeded.
2. The controller will log the actual pump run time and will display relay ON & OFF state correctly while modulating the pump or solenoid between setpoints.