Series 9000
Time Proportional Outputs

Application Note

Introduction

You can use one of these two recommended methods to provide time proportional on/off outputs with the Series 9000:

1. A UDC 3000 or UDC 5000 Slave Controller. This method can provide all of the virtues of both "single loop integrity" and total integration.
2. Digital Outputs Driven by a Ladder Logic Program. This method provides the lowest cost implementation.

1. UDC 3000 or UDC 5000 Slave Controller

When using a UDC 3000 as a slave to the Series 9000, it is connected via the DMCS network. The Series 9000 has full use of the UDC's I/O and alarms for advanced control schemes. The soft-linking of the UDC 3000 to the Series 9000 is handled by the Continuous Control Chart. Two examples follow:

EXAMPLE 1

This is an example of a single loop controller used for set point control. In this case the operator can set the mode, output and the set point of the UDC 3000 or the set point can be controlled by the Continuous Control Chart.

EXAMPLE 2

This is an example of a single loop controller used for direct output control. The operator has the same access from the Operator Panel. However, the Series 9000 controller has additional flexibility for PV selection and other advanced features.

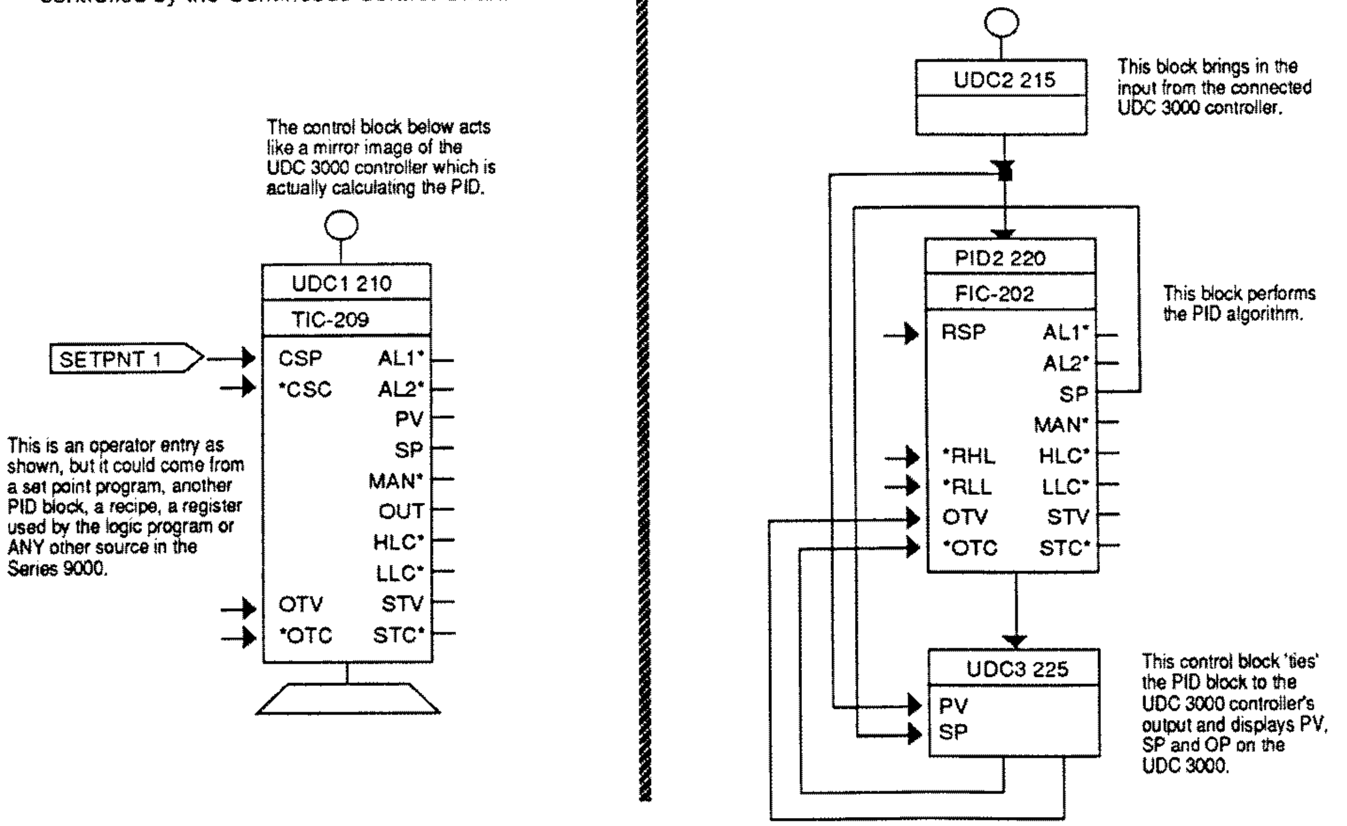

Figure 1—Examples of Control Chart Configuration for a UDC Slave Controller Method

2. Digital Outputs Driven by Ladder Logic

When using digital outputs directly, a very small ladder logic program handles the time proportioning. The Continuous Control Chart is very similar to the second example in Figure 1. The only difference is the use of a register as the analog output.

About the Ladder Logic Program

The connection of the ladder logic to the Continuous Control Chart is made with the "Write Register" block. This passes the 0-100% output signal to a register in the Logic Processor. The write register block is scaled 0-10000. The Logic Processor then performs the On/Off output form conversion.

About Time Proportioning Logic

The following three lines of logic generate the time proportional output form as shown in Figure 3:

LINE 1 is the duty cycle timer which resets itself at the end of each duty cycle. The accumulator is used to measure the expired time.

LINE 2 calculates the on-time required, based on PID_OUT (from the Continuous Control Chart). The on-time is expressed in tenths of seconds, which is the nominal resolution of the duty cycle timer.

LINE 3 compares the expired time to the required on-time. If it is less than the on-time, the output coil is energized.

About the Minimum Reasonable Duty Cycle

There are a number of factors to be considered when selecting the duty cycle for TP outputs. They include the process requirements as well as those of the connected equipment. These will not be discussed here. There is however a limiting factor in the Series 9000 that must be considered. The resolution of the output is given by:

$$\text{Resolution} = \frac{0.1 \text{ sec.}}{\text{Duty Cycle}} \times 100\%$$

Where 0.1 seconds is the "granularity" of the TON timer in the ladder logic.

For example, for a duty cycle of 10 seconds, the resolution of the output is:

$$\text{Resolution} = \frac{0.1 \text{ sec.}}{10 \text{ sec.}} \times 100 = 1.0\%$$

A 10 second duty cycle provides a 1% resolution, which is usually more than adequate. However a duty cycle of 2 seconds may cause problems depending on the specific application. To avoid "hunting," keep the duty cycle as long as practical.

This is an example of a Series 9000 PID loop using analog input and time proportional ouput. he time proportional output form is generated by a TON timer in the accompanying ladder program.

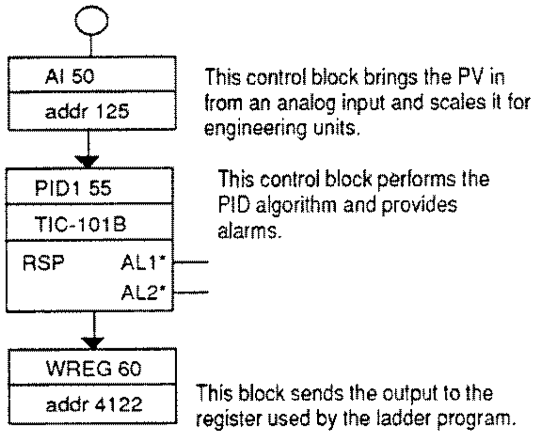

Figure 2—Example of Control Chart Configuration for a Digital Output Driven by Ladder Logic Method

```
----Mon Nov 13 16:17 1989                              Ladder Logic Listing
!                                                                          !
!PAGE    1     Series 9000 -- Time Proportional Outputs          11/13/89  !
!                                                                          !
!                                                                          !
!Line #     1                                                             !
!                                                                          !
!Timer1                                                              Timer1!
!  600                                                                 600 !
---]/[----------------------------------------------------------------(TON)+
!                                                                          !
!                                                                          !
!                                                                   DutyCyl
!                                                                     4120!
!                                                                      PRS!
!                                                                     10.0!
!                                                                   AccTime
!                                                                     4121!
!                                                                      ACC!
!                                                                        0 !
!                                                                          !
!                                                                          !
!Line #     2                                                             !
!                                                                          !
!PID_Out          DutyCyl                                            OnTime!
! 4122              4120                                               4123 !
--[B2]-----[X]----[B2]-----[/]----[K2]------------------------------(S2)-+
!    0              100              100                                0 !
!                                                                          !
!                                                                          !
!Line #     3                                                             !
!                                                                          !
!AccTime          OnTime                                             Output!
! 4121              4123                                                16 !
--[B2]--+--]<[----[B2]--+--]>[----[K2]-------------------------------( )-+
!    0   !             0  !          0                                    !
!        !        OnTime  !                                               !
!        !          4123  !                                               !
!        +--]=[----[B2]--+                                                !
!                      0                                                  !
```

Figure 3—Example of Ladder Logic Program for Time Proportioning Output