HC900 Hybrid Controller

When you need more than just discrete control

Alternator function Block – Product Note

Background:
Managing supply to satisfy demand on many applications has lead to the use of staged control of the supply component to maximize process efficiency. An example would be using multiple boilers to satisfy a demand for steam based on varying load requirements. During low demand conditions only one or two boilers may be used to satisfy requirements, but as demand increases more boilers are brought on-line. This allows higher loading and greater efficiency of the units that are in use, while conserving energy by idling or disabling units that are not needed. This staged supply control method may be found in many industries including water and wastewater for pump control, heating and air conditioning for chiller, blower and compressor control and many others.

Using a simple demand verses supply comparison algorithm in a controller can be used to determine when to activate additional supply resources. A digital output from the controller can execute the needed action. As demand increases, higher setpoint values are exceeded and more supply elements are enabled.

Problem Statement:
The problem with this implementation in a staged control system is that the first supply element gets used almost 100% of the time. The second element in the supply chain gets the next higher percentage of use, and so on. As a result the first supply element in the system wears out while the last element in the supply chain seldom gets used.

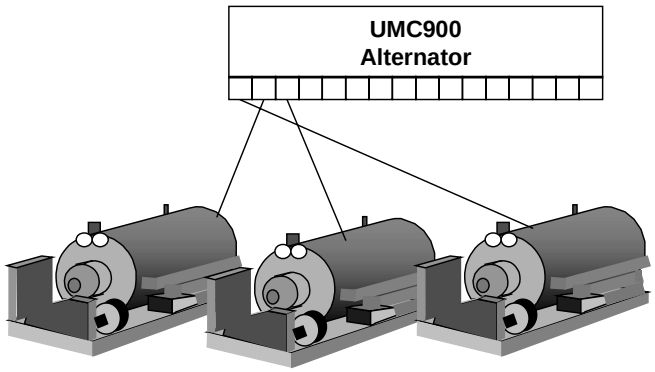
A better solution would be to distribute the amount of run-time of all of the elements in the supply chain to equalize the amount of wear on the system. In addition, have the system automatically compensate for units that have been removed from the supply chain for maintenance or other reasons, and readjust the supply enabling sequence to eliminate any potential gaps in the supply component.

Solution:
A HC900 Controller configured to use its ALTERNATOR Function Block.

The HC900 Alternator algorithm is inserted in the control strategy between the comparison algorithms that call for the supply elements and the digital outputs that execute the action. The Alternator algorithm can accept up to 16

digital inputs and alternate up to 16 digital outputs. The HC900 alternator algorithm can be configured to execute four different methods of alternation as follows:

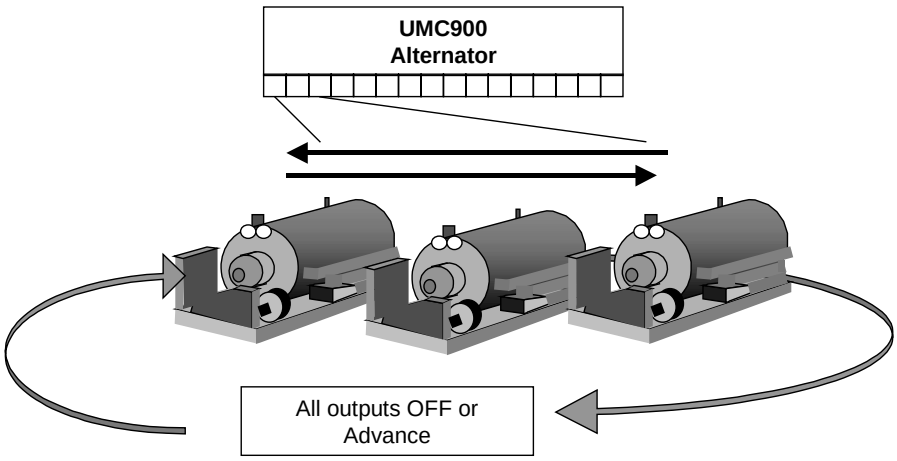
DIRECT: Monitors up to 16 digital inputs and maps them, using a user adjustable map order, directly to the outputs.



Direct Operation

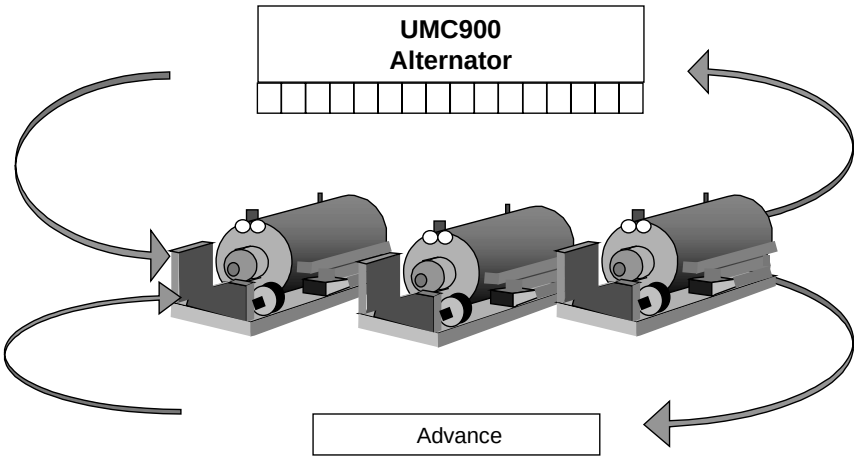
If the inputs selected are 1, 2, 3, 4, 5, 6 and the output order map is 6, 3, 4, 1, 5, 2; when Input 3 is activated, Output 4 is enabled; or if Input 1 is activated then Output 6 is enabled.

ROTARY: Uses the sum of the 16 inputs that are set to ON to determine the required outputs. The output order is managed in a Last ON/First OFF basis (LOFO).
If the Inputs selected are 1, 2, 3 and the mapped output sequence is 1, 2, 3 the alternator sequence changes when all outputs are OFF or there is a request to Advance (Manual Advance enable is a selectable option).
Depending on the capacity required, Outputs 1, 2, 3 come on in order. When the demand falls, Output 3 goes OFF, then Output 2, then Output 1. When Output 1 turns off, the Rotary sequence advances and Output 2 starts the next cycle.



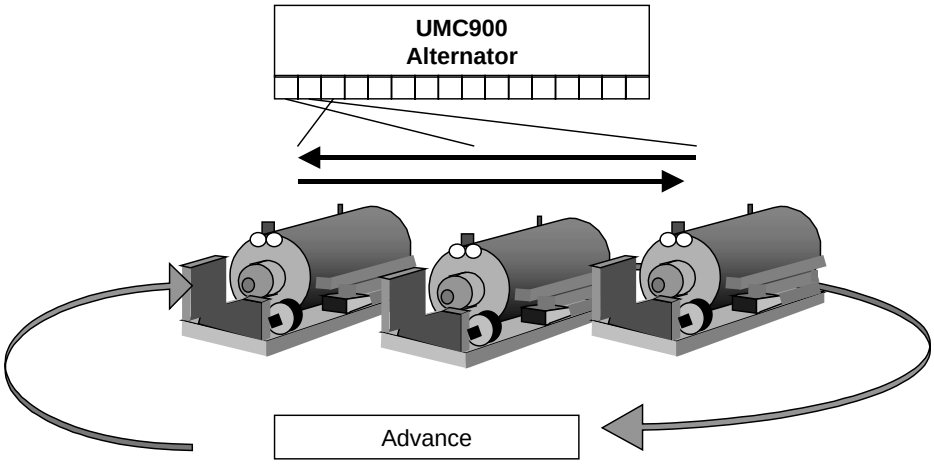
Rotary Operation

FOFO: Uses the sum of the 16 inputs that are set to ON to determine the required outputs. The output order is managed in a First ON/First OFF basis (FOFO).
If 3 Inputs are ON (no mapping), the Alternator sequence changes (first one in the list moves to the end of the list) as the Inputs turn OFF, or, when a manual advance is enabled.



FOFO Operation

FIXED Uses the sum of the 16 inputs that are set to ON to determine the required outputs. The output order is managed in a First ON/Last OFF basis (FOLO). If the Inputs selected are 1, 2, 3, 4 and the output map is 4, 2, 3, 1, the sequence will not change unless an Advance is enabled.



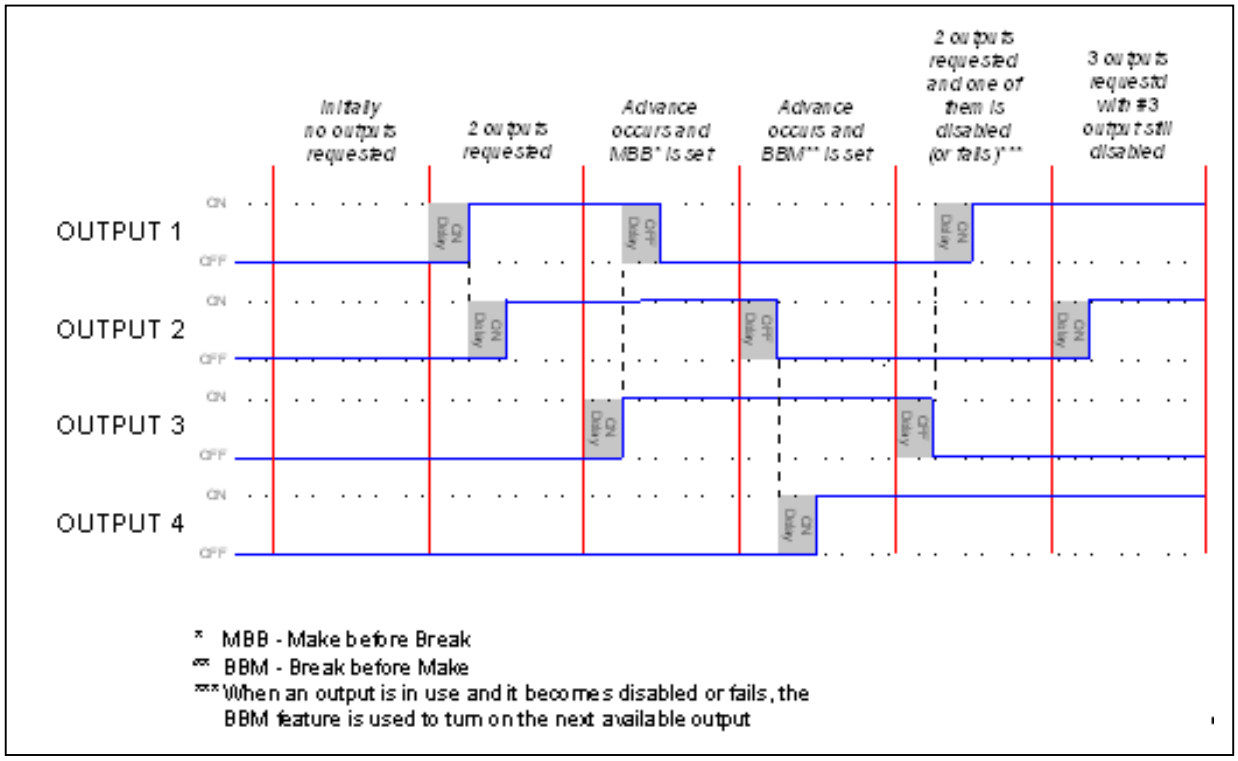
Fixed Operation

In addition to the 16 inputs that request outputs to be enabled, the Alternator Algorithm has an input to accept a signal from a DIGITAL ENCODER function block that is used to determine if external supply elements are available. THE ALTERNATOR FUNCTION BLOCK MUST ALWAYS USED WITH A DEVICE ENCODER FUNCTION BLOCK. If an external supply element is removed from service (i.e. a boiler is shut down for maintenance), a digital input to the Digital Encoder block is used to have the appropriate output automatically removed from the output sequence. The Alternator will then replace the disabled element with the next element in sequence.

The types of supply elements controlled by the Alternator algorithm are often large, power intensive devices that are sensitive to momentary activation. To prevent this type of output action, ON-Delay and OFF-Delay timer values may be set into the Alternator algorithm that prevent momentary changes on the algorithm's inputs from being immediately transferred to the algorithm's outputs. The On-Delay and Off-Delay time values apply to all outputs.

Another condition that can occur during start-up, shut-down or fluctuating demand conditions is to have multiple inputs to the Alternator algorithm activate simultaneously. Transferring these requests directly to the Alternator's outputs can cause an excessive power demand on the energy source being used by the supply elements. (i.e. Attempting to start 3, 4 or more large pumps simultaneously can create a tremendous electrical power drain on a system.) To prevent this condition, the ON-Delay and OFF-Delay timers operate in a cascade fashion. If three outputs are requested, output 1 turns ON, then output 2, then output 3, with each output delayed by the ON-Delay time value.

When manually or programmatically advancing an alternator algorithm, supply spikes caused by one output turning ON before another is off, or supply dips caused by one output turning OFF before another output is ON can occur. To prevent this action the Alternator algorithm provides a selection of Make Before Break (MBB) or Break Before Make (BBM) on its outputs. The MBB or BBM actions work with the ON and OFF delay timers to prevent supply fluctuations. See example below.



A HC900 controller configuration can be configured to execute up to 6 independent alternator algorithms.

1042 Operator Interface used with the HC900 Alternator Function Block

When the HC900 is used with the 1042 Operator Interface, a suite of standard operator displays is available to monitor, adjust and operate the Alternator Function Blocks. The display suite provides an initial monitoring display

to view the input, output and operating status of the function block. It is from this main display that other setup and operate displays for the Alterr

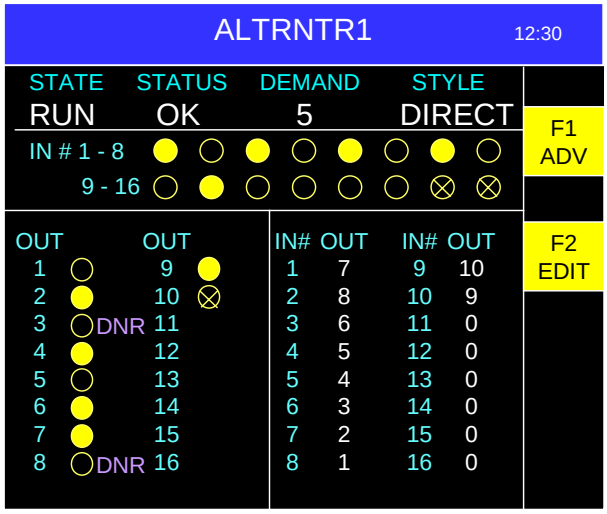


Figure 1
Monitor/Operate

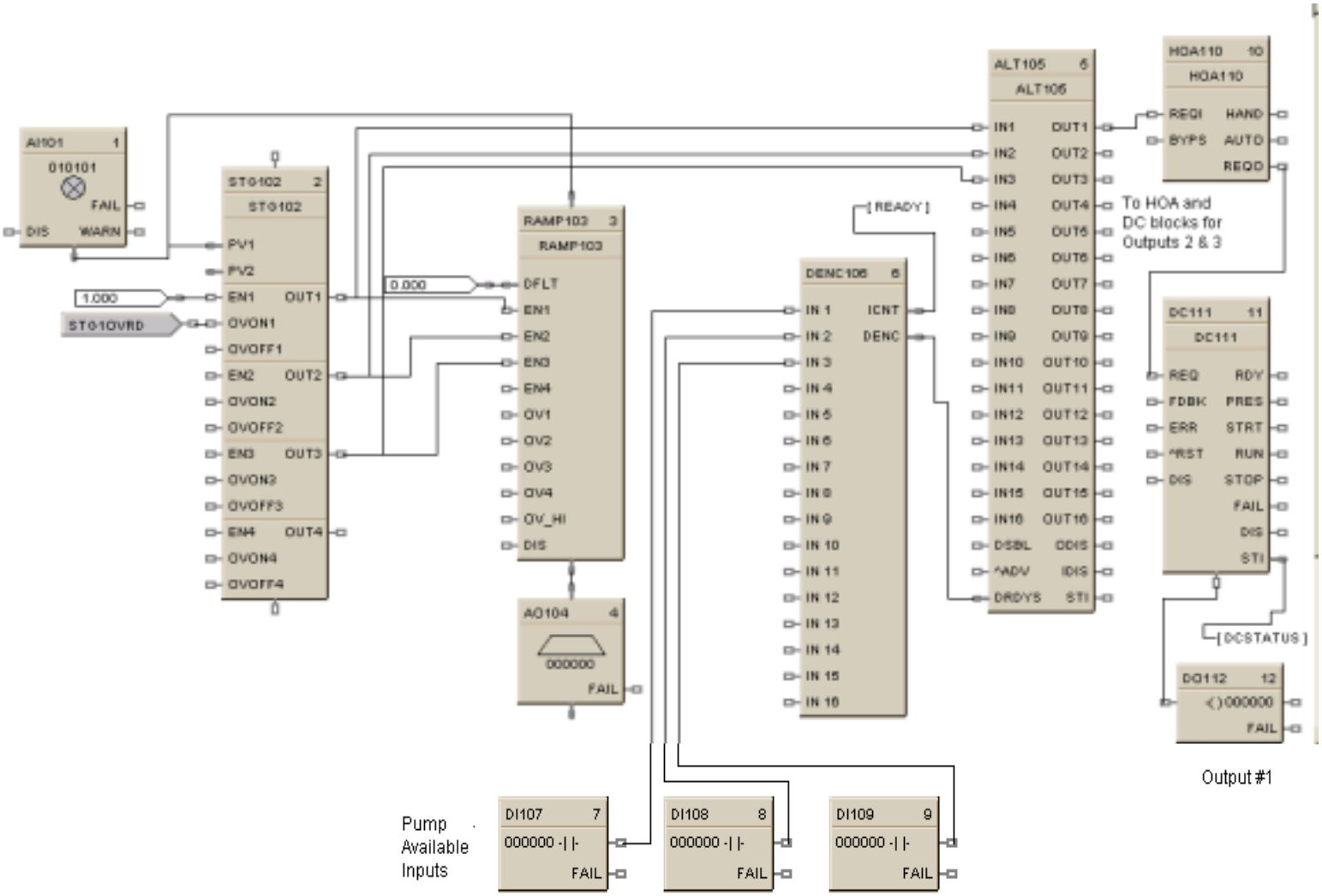
Other editing displays are available to allow on-line setting and adjustment of the following parameters:

Enable or Disable Alternator Outputs
Enable or Disable Alternator Inputs
Edit the Output Sequence Map
Change the Alternator Style (Rotary, FOFO, Fixed, and Direct)
Edit the ON-Delay time
Edit the OFF-Delay time

Summary

The addition of the Alternator algorithm to the HC900 Controller's arsenal of Principal Function Blocks provides an extremely powerful instrument to combat PLCs and other types of control products targeting this sophisticated control application. Similar to PID and Setpoint Programming Principal Functions, the Alternator function block is designed to handle a wide variety of application variations while remaining easy to configure.

Attached is a sample function block diagram to indicate how the Alternator and Digital Encoder function blocks may appear in a typical HC900 configuration. Also see the separate application briefs on the use of the Stage and Ramp function blocks that are pictured in the PV compare portion of the function block diagram.


AI101 1
010101
FAIL
DIS WARN
ST0102 2
ST0102
PV1
PV2
1.000
EN1 OUT1
ST01OVRD
OVON1
OVOFF1
EN2 OUT2
OVON2
OVOFF2
EN3 OUT3
OVON3
OVOFF3
EN4 OUT4
OVON4
OVOFF4
RAMP103 3
RAMP103
0.000
DFLT
EN1
EN2
EN3
EN4
OV1
OV2
OV3
OV4
OV_HI
DIS
AO104 4
000000
FAIL
[READY]
DENC106 6
IN 1 ICNT
IN 2 DENC
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
IN 11
IN 12
IN 13
IN 14
IN 15
IN 16
ALT105 5
ALT106
IN1 OUT1
IN2 OUT2
IN3 OUT3
IN4 OUT4
IN5 OUT5
IN6 OUT6
IN7 OUT7
IN8 OUT8
IN9 OUT9
IN10 OUT10
IN11 OUT11
IN12 OUT12
IN13 OUT13
IN14 OUT14
IN15 OUT15
IN16 OUT16
DISBL ODIS
^ADV IDIS
DRDYS STI
HOA110 10
HOA110
REQI HAND
BYPS AUTO
REQD
To HOA and
DC blocks for
Outputs 2 & 3
DC111 11
DC111
REQ RDY
FDBK PRES
ERR STRT
^RST RUN
DIS STOP
FAIL
DIS
STI
[DCSTATUS]
DO112 12
000000
FAIL
Output #1
Pump
Available
Inputs
DI107 7
000000 -| |-
FAIL
DI108 8
000000 -| |-
FAIL
DI109 9
000000 -| |-
FAIL