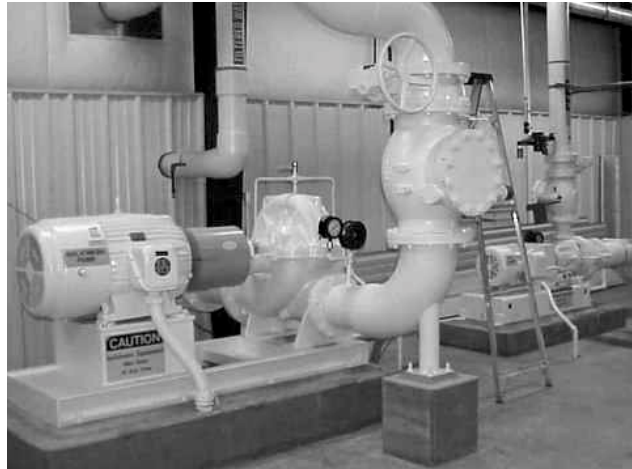# HC900 Hybrid Controller
When you need more than just discrete control

Device Control Function Block – Product Note

Background:
The starting and stopping of motors, pumps and other devices that have significant inertia when running often require special treatment when controlling and monitoring their operation. Because of the inertia of the device it often takes several seconds for the device to come up to speed after being activated, and can take even longer to come to a stop after being deactivated.   Using these devices in a process often requires monitoring the device, or monitoring the results of the device's ON state to be sure it is operational before taking other actions.   If faults are detected or if unexpected feedback from the device is obtained a back-up control strategy may be enabled or the process may simply be shut down. Devices that fall into this category include large electric motors used on air handling equipment and combustion systems, pumps used to move fluids, drive systems to move conveyors and many others.

Problem Statement:
Controlling the ON and OFF state of devices that require an extended amount of time to activate or deactivate requires a control strategy that can handle time delays when monitoring the device's status. In addition, the control strategy should provide fault indication if proper operation is not verified after an appropriate amount of time. Some large pumps and motors also have a pre-start control requirement that may be used to induce lubricant, or begin a priming action that occurs prior to actually triggering the device to start. Faults that occur after the device is running can fall into two categories, those that allow the device to resume the running state once the fault clears and those that force a manual reset of the control strategy before the device can restart. Combining all these control requirements into one concise algorithm provides optimum performance while simplifying setup and maintenance.

Solution:
The HC900 Device Control Function Block provides the features needed to adequately control the start, run and stop conditions of large devices such as pumps, blowers, motors, and other equipment with significant inertia. In a

control strategy the function block is typically inserted between the control logic that is requesting a device to turn ON and the digital outputs that actually drive the output hardware. See figure 1. Up to 16 Device Control function blocks may be configured in a HC900 Hybrid Controller.
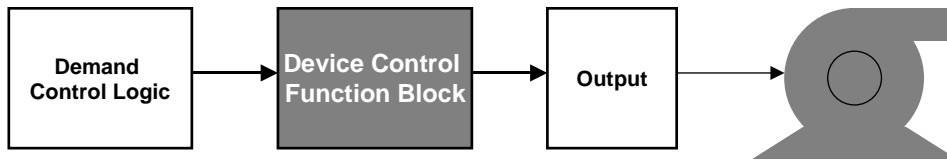

Figure 1

The function block operates as a state machine to set the block outputs based on the state of its inputs. See Figure 2. A digital input provides the request signal to the function block to begin a startup or shutdown sequence.

Start-up State:

When a request to start is received a user specified on-delay timer begins timing. During this time delay a pre-start digital output turns ON to allow for such items as a priming operation or lubrication injection. After the time delay, the primary digital output turns ON, the pre-start output pin turns OFF and a starting (STRT) output pin turns ON.

At the same time the primary output turns ON, a second user specified delay timer is started. This timer monitors the time it takes for the field device to start. If a digital feedback signal is received before the delay timer times out (indicating the device has started) the timer is reset, the Starting output pin turns OFF and a RUN output pin turns ON. If a feedback signal is not received and the timer times out, the primary output turns OFF, a digital output signal indicating a failure turns ON and the function block is latched into this state until manually reset.

Figure 2
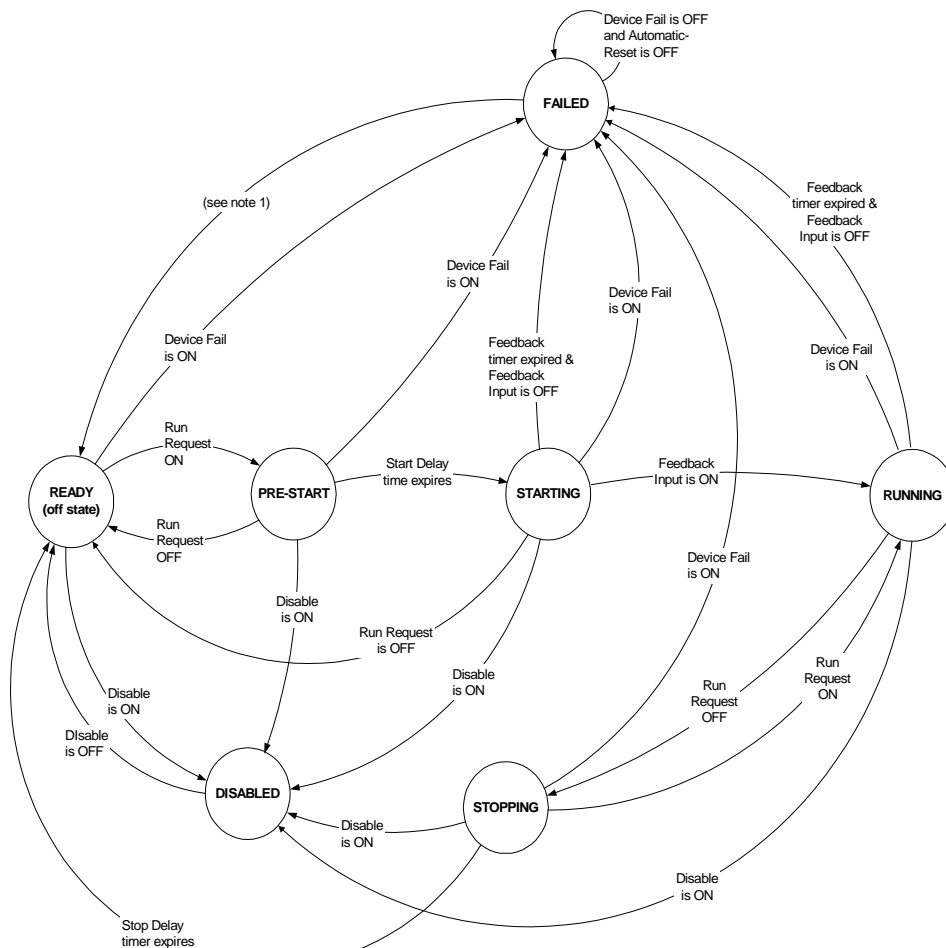
Running State:
When the device is in the running state the primary output and run state output signals are ON. A digital input pin is included on the function block to accept an error (ERR) signal from the running device. If an error is detected during normal operation the Primary output and RUN state output pins both turn OFF and a FAIL output pin turns ON. The recovery from this state can be automatic or require a manual operation based on a user selection during the configuration of the function block. If automatic is selected the block will restart the device when the error condition goes away. If manual was selected, the function block must be manually reset before the device can restart, regardless of the error (ERR) input state.
Stopping State:
When the request input turns OFF, a user specified time delay is activated, the RUN status pin turns OFF and the STOP (stopping) pin turns ON. The primary output pin remains ON until the delay timer times out, then it turns OFF.

Disabled State:
A Disable (DIS) input pin is provided on the function block and under normal operation is in the OFF state. When the Disable input goes from OFF to ON, the primary block output turns OFF immediately, any active state status is also turned OFF and the Disable (DIS) output pin of the block turns ON.

Ready State:
When the Request, Feedback, Error and Disable input signals are all off the function block is in the Ready state. A Ready (RDY) output pin may be used to monitor this state.

User Interface:
The Device Control function block has a dedicated display type in the HC900 operator interface series to monitor the function block states. A single display can monitor up to four Device Control blocks. During operation the display indicates the current state of the block and the time remaining in each state that employs a timer. A single time field on the display changes context to monitor each of the three potential timer values.   See figure 3.
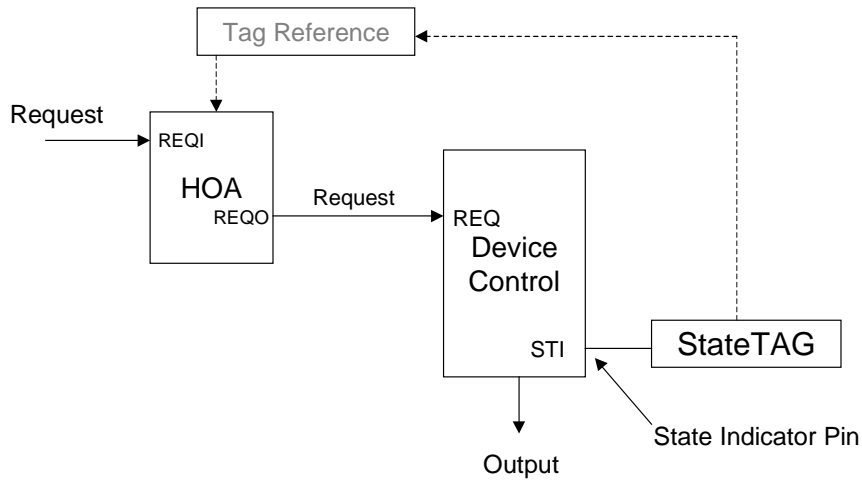
DEVICE CONTROL			
DEVTAG1	READY	99999 SECS	F1
DEVTAG2	PRESTART	99999 SECS	F2
DEVTAG3	STARTING	99999 SECS	F3
DEVTAG4	RUNNING	99999 SECS	F4
ALARM	D MESSAGE TEXT	S	RUN

Figure 3

Connection to Hand-Off-Auto Function Block:
In addition to the status output pins of the Device Control function block that provide digital indication of the current state of the block, an enumerated value representing each state is also available on the State Indicator (STI) output pin of the block.   When the Device Control Block is used with the Hand-Off-Auto (HOA) interface block for monitoring, a signal tag connected to the State Indicator pin can be referenced in the HOA function block to allow state monitoring from the HOA display screen.

Monitoring Device Control with HOA

Figure 4

The HAO display provides monitoring capability for up to 4 HOA Interface function blocks. Each HOA function block supports monitoring one Device Control block. See figure 5.

HAND/OFF AUTO SWITCHES		
TAG45678 STATE1	HOATAG1 AUTO	F1
TAG45678 STATE4	HOATAG2 BYPASS	F2
TAG45678 STATE2	HOATAG3 HAND	F3
TAG45678 STATE7	HOATAG4 OFF	F4
ALARM D MESSAGE TEXT	S H Z RUN	

Figure 5

Summary:

The Device Control Function Block of the HC900 Hybrid Controller provides a complete solution for controlling large pumps, blowers and other process equipment. To duplicate the embedded functionality of this feature using the traditional logic programming techniques of competitive systems can often require hours of complex programming and consume a significant amount of the system resources. The HC900's use of pre-defined user displays further simplifies the configuration project, making the total solution an unmatched combination in the industry.