



TEST PROJECT DAY 2 / PROJET D'ÉPREUVE JOUR 2

# **AUTOMATION AND CONTROL**

# **CONTROLE ET AUTOMATISATION**

POST-SECONDARY /  
NIVEAU POSTSECONDAIRE

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## 1.0 Process description

### 1.1 – General description

To make a quality whiskey the “mashing” of ingredients is a critical part of the process, mashing consists of mixing cooked grain with malted barley and pure warm water. The amylase in the malted barley converts the starch in the other grains into sugars. After several hours the mixture is converted into a turbid, sugar-rich liquid known as mash. (In making Scotch malt whiskey the mixture consists only of malted barley and warm water. After mashing the mixture is filtered to produce a sugar-rich liquid known as wort.)

A malt hopper holds the grain which is fed into the Mash Tank via a timed screw conveyer, water is fed into the Mash tank from three heated pure water tanks via 2” stainless steel lines, controlled via a solenoid valves, temperature switches and level switch in the Mash Tank.

The Mash tank has an integral agitator, which mixes the water and malt, the speed of the agitator is controlled based on the level of the tank via capacitive level sensors.

Once the mixture reaches the 75% process level in the tank and the water temperature is at or above 62 Degrees, the agitator will run for a select time and then shutdown, the mixture will then be released to the Fermentation Tank via a 2” stainless steel line using a solenoid valve, the valve will close when low level is reached in the Mash Tank. At this point the agitator will run in reverse for 30 seconds to mix any residue left in the tank.





## 2.0 – Manual Mode

### 2.1 – Manual Sequence Description

When selecting between the Manual and Automatic modes, none of the last state/selection/values will be maintained.

When the Automatic/Manual selector switch is set to Manual Mode (SS1):

- L3 will be flashing to indicate a Manual Mode selection.
- Manual step (MAN\_STEP) will be initially set to 0

A Jog Cycle Select pushbutton (PB4) is to be programmed to advance through the steps each time the button is pushed. (Example: press PB4 once for Step 1; push it again for Step 2, etc.)

This cycle repeats for all six selectable items in the process.

If PB4 is pressed when in cycle step 6, the cycle resets to step 0.

A different lamp will flash for each step in the Manual cycle. Each step will enable the operator to jog a different part of the process using the Start/Jog button (PB3). (See table below)

For example:

The first time manual is selected

- L3 will flash to indicate Manual Mode and the Manual Step (MAN\_STEP) will be 0.

Press the Jog Cycle Select button PB4,

- Manual Step advances to Step 1, L4 will flash at 0.5 Hz (on 1 second, off 1 second).

Press PB4 again,

- Manual Step advances to Step 2, L4 will flash at 1 Hz (on 0.5 seconds, off 0.5 seconds)

**Table 1- Manual Step (MAN\_STEP) Cycle Sequence**

Step	Lamp/Flash Freq	Action when Start/Jog pushed
Step 0	N/A	N/A
Step 1	L4 Flashes 0.5 Hz	Screw Conveyor Runs FWD
Step 2	L4 Flashes 1 Hz	Screw Conveyor Runs REV
Step 3	L5 Flashes 0.5 Hz	Tank #1 (Hot Water) Solenoid Opens
Step 4	L5 Flashes 1 Hz	Tank #2 (Cold Water) Solenoid Opens
Step 5	L6 Flashes 0.5 Hz	Agitator Runs 30 Hz
Step 6	L6 Flashes 1 Hz	Water Dump Solenoid Opens



### 3.0 – Automatic Mode

#### 3.1 – Automatic Mode Description

When the Auto/Manual switch is set to Automatic Mode (SS1):

- Amber tower light (L3) will be on steady
- Green tower light (L2) will be on indicating that the process is ready to start

When the Start/Jog (PB3) button is pushed:

- L2 will shut off (Process Is Ready).
- Water Tank #1 (Hot Water) Solenoid (SOL1) will open until will 50% Level Switch #2 (LS2) activates then Solenoid (SOL1) will Close and Agitator (VFD1) Runs at 60Hz. Blue Indicating Lamp (L6) ON to indicate Hot Water being fed into tank. Green Indicating Lamp (L4) ON to indicate Agitator Running.
- Water Tank #2 (Cold Water) Solenoid (SOL2) will open until 75% Level Switch #3 (LS3) activates then Solenoid (SOL2) will close. Agitator (VFD1) runs at 30Hz. Amber Indicating Lamp (L7) ON to indicate Cold Hot Water being fed into tank. Green Indicating Lamp (L4) ON to indicate Agitator Running.
- If Temp Switch #1 (TS1) is not-activated:
  - Water Dump Solenoid (SOL3) will activate until 50% Level Switch #2 (LS2) is deactivated, Amber Tower Lamp (L3) will flash at 0.5 second rate to indicate process is adjusting water temperature.
  - Water Tank #1 (Hot Water) Solenoid (SOL1) will open until 75% Level Switch #2 (LS2) activates then Solenoid (SOL1) will close. Agitator (VFD1) is already running at 30Hz from step above. Blue Indicating Lamp (L6) ON to indicate Hot Water being fed into tank. Green Indicating Lamp (L4) ON to indicate Agitator Running.
  - This process will continue until Temperature Switch (TS2) is activated.
- When Temperature Switch #1 (TS1) is activated:
  - Screw Conveyor (K1) Runs FWD direction for 15 Seconds to feed malt into Mash Tank. Green Indicating Lamp (L5) ON.
  - Agitator (VFD1) Runs at 30Hz for 60 seconds.

- When Agitator (VFD1) 60 second run time is complete:
  - Mash Tank Empty Solenoid (SOL4) Opens feeding mix to Fermentation Tank until Low Level Switch (LS1) is activated.
  - Green Tower Light (L2) will flash at 0.5 second rate to indicate Mash Tank is emptying.
- Process returns to start conditions:
  - Amber tower light (L3) will be on steady
  - Green tower light (L2) will be on indicating that the process is ready to start.
- If at any time during the process the 90% High Level Switch (LS4) activates the process will completely Stop, all motors will stop running and all solenoid valves will close. Red Tower Lamp (L1) will flash at a rate of 0.5 Seconds. To reset the process the Jog Cycle Select Pushbutton (PB4) must be pressed to OPEN the Water Dump Valve until Low Level Switch (LS1) is deactivated and reset the process.



## 4.0 – Inputs and Outputs

### 4.1 – Input Table

Input Detail	Symbol	Contact Type	PLC inputs Assignment	Information supplied at state (1)
Emergency Stop	PB1	NC	In0	Button not pressed
Stop	PB2	NC	In1	Button not pressed
Start/Jog (Manual)	PB3	NO	In2	Button pressed
Jog Cycle Select	PB4	NO	In3	Button pressed
Automatic Mode	SS1	NO	In4	1= Auto Mode 0 =Manual Mode
Tank Temperature	TS1	NO	In5	Water at or above 62 Deg F
Tank Low Level	LS1	NO	In6	Tank Low Level reached
Tank 50% Level	LS2	NO	In7	Tank 50% Full
Tank 75% Level	LS3	NO	In8	Tank 75% Full
Tank High Level (90%)	LS4	NO	In9	Tank High Level reached
VFD Output 1	VFD OUT1	NO	In10	Agitator Running
K1F/K1R Auxiliary Contact (Paralleled)	K1F	NO	In11	Screw Conveyor Running



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## 4.2 – Output Table

Output Detail	Symbol	PLC outputs Assignments	Action at state (1)	
Tower Lamp Red	L1	Q0	Light ON	
Tower Lamp Green	L2	Q1	Light ON	
Tower Lamp Amber	L3	Q2	Light ON	
Indicating Lamp Green	L4	Q3	Light ON	
Indicating Lamp Green	L5	Q4	Light ON	
Indicating Lamp Blue	L6	Q5	Light ON	
Indicating Lamp Amber	L7	Q6	Light ON	
Motor Contactor M1 Fwd (Screw Conveyor)	K1_F	Q7	Contactor activates	
Motor Contactor M1 Rev (Screw Conveyor)	K1_R	Q8	Contactor activates	
Tank #1 Water Solenoid	SOL1	Q9	Solenoid OPEN	
Tank #2 Water Solenoid	SOL2	Q10	Solenoid OPEN	
Mash Tank Empty Solenoid	SOL3	Q11	Solenoid OPEN	
Fermentation Tank Fill Solenoid	SOL4	Q12	Solenoid OPEN	
VFD Digital Input 02	VFD IN02	Q13	Agitator Running Forward	
VFD Digital Input 05	VFD IN05	Q14	VFD Preset Speed 60 Hz	Off
VFD Digital Input 06	VFD IN06	Q15	Off	VFD Preset Speed 30 Hz



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