2018

SCNC
SKILLS CANADA NATIONAL COMPETITION

OCMT
OLYMPIADES CANADIENNES DES MÉTIERS ET DES TECHNOLOGIES

SkillsCompétences
Canada
Edmonton2018

TEST PROJECT DAY 2 / PROJET D'ÉPREUVE JOUR 2

INDUSTRIAL CONTROL

CONTRÔLE INDUSTRIEL

POST - SECONDARY /
NIVEAUX POSTSECONDAIRE

TABLE OF CONTENT

1. GENERAL DESCRIPTION

1.1 Contextualization

Edmonton International Airport (EIA) is the primary air passenger and air cargo facility for the Province of Alberta's capital city, Edmonton. Additionally, it is a hub facility for Northern Alberta and Northern Canada providing regularly scheduled nonstop flights to over fifty communities in Canada, the United States, Latin America and Europe. It is Canada's largest major airport by total land area, and 5th busiest airport by passenger traffic. This passenger traffic includes luggage sorting in order for them to be stored in the cargo compartment of the planes. Of course, the luggage are sorted by destinations, using barcode readers, but for the purpose of this contest, this project represents an automated process for sorting and transporting passenger luggage within EIA according to their size.

1.2 Terminology definition

1.2.1 Lit light

When the sequence describe a lit light, it means that light will be continuously ON.

1.2.2 Flashing light

When the sequence describe a flashing light, it means that light will be cycling continuously ON for 1 sec and OFF for 1 sec

1.2.3 Fast flashing light

When the sequence describes a flashing light, it means that light will be cycling continuously ON for 0,5 sec and OFF for 0,5 sec

1.3 Process Diagram
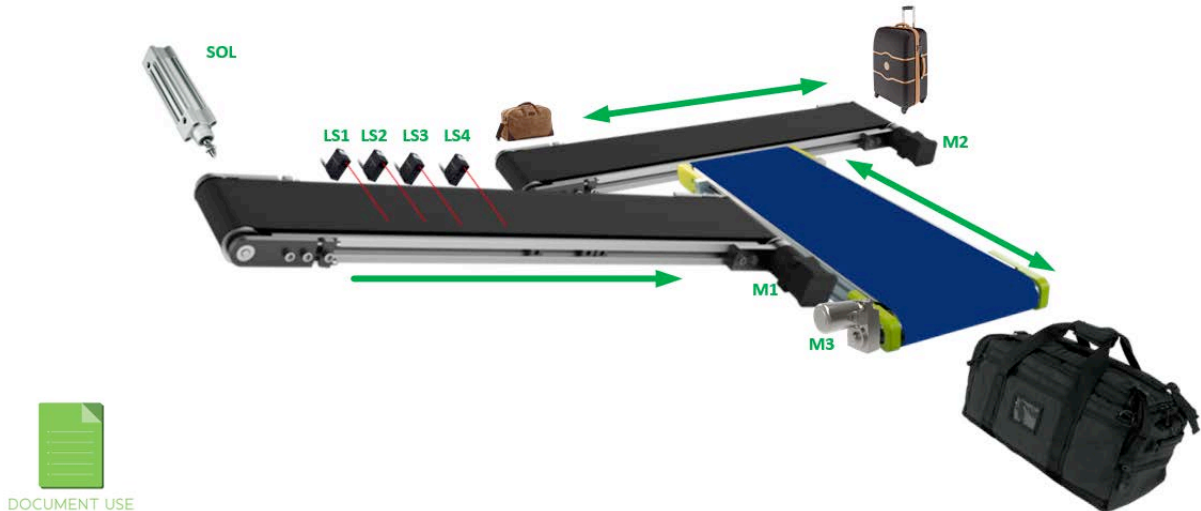
1.4 Process Equipment Function

This section resume the function of each component use in the process.

1.4.1 Tower stack lights (L1, L2 & L3)

The stack lights are used to indicate the process state.

1.4.1.1 Green stack light (L1)

This stack light is indicating that the process is running, in either manual or automatic mode, or in clear out sequence.

1.4.1.2 Amber stack light (L2)

This stack light is indicating that the process is ready to start or that the process need to be reset.

1.4.1.3 Red stack light (L3)

This stack light is indicating a fault condition.

1.4.2 Green pilot light (L4)

This pilot light is indicating the detection of luggage's size in automatic mode or the size selection in manual mode.

1.4.3 White pilot light (L5)

This pilot light is indicating that energy is available to the PLC's outputs.

1.4.4 Red pilot light (L6)

This pilot light is indicating that an over-height baggage is detected

1.4.5 Maintained 3 position selector switch (SS1)

This selector will be used to select between manual operation (Hand), stopped process (OFF) or automatic operation (AUTO). The process will not start, or run, if the selector is in the center position (OFF).

1.4.6 Maintained 3 position selector switch (SS2)

This selector will be used to select baggage size between small, regular and oversized while in manual mode. Left position is small size, center position is regular size and right position is oversized.

1.4.7 Emergency Stop push-pull button (PB1)

As describe in material portion (Day 1) documentation, this button is activating the MCR/emergency Stop circuit which de-energize all of the PLC's outputs.

1.4.8 Green Momentary Push button (PB2)

This push button will be used to start the process in either automatic or manual mode.

1.4.9 Red Momentary Push button (PB3)

This push button will be used to stop the process in either automatic or manual mode (in non-emergency condition).

1.4.10 Black Momentary Push button (PB4)

This push button will be used to reset the process in either automatic or manual mode.

1.4.11 3 Poles Contactor (K1)

This contactor is feeding the unidirectional Sorting Belt Conveyor motor (M1) and it is equipped with a thermal overload relay (K1_OL).

1.4.12 3 Poles Forward-Reverse Contactor (K2)

This contactor is feeding the bidirectional Size Belt Conveyor motor (M2) and it is equipped with a thermal overload relay (K2_OL). The forward direction is sending luggage to the regular size side while the reverse direction is sending luggage to the small size side.

1.4.13 Variable Frequency Drive (VFD)

This inverter is feeding the bidirectional distribution belt motor (M3). The forward direction is sending luggage to the size belt side while the reverse direction is sending luggage to the oversized side.

1.4.14 Optical sensors [Limit switches] (LS1 to LS4)

Those sensors are replaced by limit switches for the purpose of this project. They are used to detect the baggage size.

1.4.15 Solenoid (SOL)

This solenoid is controlling a pneumatic actuator that keeps new luggage to access the distribution belt. The solenoid need to be activated to let baggage come to the sorting belt.

2 Off Mode Description

When the mode selector (SS1) is in the center position (OFF), all the outputs will be de-energized except for the white pilot light (L5). This output shall be activated at all time (including when process is stopped) which will result to have the pilot light constantly lit as long as the emergency stop button is not pressed.

DOCUMENT USE

3 Manual Mode Description

The purpose of the Manual mode is to have the baggage sorting and transporting operation work under the direct supervision of the operator.

There is no size detection in this mode as the operator select the destination of the luggage. The operator will take care of manually removing any over-height baggage and bring them in the oversized area.

3.1 Initialisation and process start

In order to start the process in Manual mode, the selector switch SS1 must be in the Manual position, and no fault must be detected. If a fault is present, the red stack light (L3) will light, if not, the amber stack light (L2) will light instead announcing the operator that the process is ready to start in manual mode. All other outputs are un-activated except for the white pilot light (L5).

The operator need to select the luggage size with selector SS2, then the operator starts the process by pressing the green push button (PB2).

3.2 Manual process

- Once the manual mode is started:

- The amber stack light (L2) will be de-energized
- The green stack light (L1) will light.
- The green pilot (L4) light will indicate the size selection:
  - Flashing fast if small size is selected
  - Flashing if regular size is selected
  - Lit if oversized is selected
- The sorting belt (K1) will be energized
- The distribution belt will run in the oversized direction (VFD03) if oversized is selected, otherwise it will run in the size belt direction (VFD02)
- The size belt will run in the small direction (K2_F) if small size is selected or in the regular direction (K2_R) if regular size is selected. It won't be running if the oversized is selected.
- The solenoid valve will be activated, allowing baggage to access the sorting belt, as long as no sensor detect a baggage. This will ensure space gap between each baggage to avoid jamming.

Once the process starts, the process must be stopped before selecting another luggage size (SS2 position change won't have any effect on the process.

3.3 System stop

To normally stop the process, the operator need to press the red push button (PB3) and the following will occur:
- All the running belt conveyors will stop
- The green pilot light (L4) and the green stack light (L1) will be turned off
- The amber stack light (L2) will light indicating that the manual mode is back to its "ready to start" state; which means the operator can start the process again by pressing the green push button (PB2).

4. Automatic Mode

The purpose of the Automatic mode is to have the baggage sorting and transporting operation work without the direct supervision of the operator.

There is a size detection in this mode as the operator doesn't have to select the destination of the luggage. When required, the operator will still have to take care of manually removing any over-height baggage and bring them in the oversized area.

4.1 Initialisation and process start

In order to start the process in Automatic mode, the selector switch SS1 must be in the Auto position, and no fault must be detected. If a fault is present, the red stack light (L3) will light, if not, the amber stack light (L2) will light instead announcing the operator that the process is ready to start in automatic mode. All other outputs are un-activated except for the white pilot light (L5).

Before starting the process in automatic mode, the operator must make sure no baggage are in any belt as they may end in an improper destination.

The operator starts the process by pressing the green push button (PB2).

4.2 Automatic process

Once the automatic mode is started:
- The amber stack light (L2) will be de-energized
- The green stack light (L1) will light
- The sorting belt will run (K1)
- The solenoid (SOL) will be activated (pneumatic actuator will allow new luggage to access the sorting belt)

Then, the process will endlessly wait for a luggage size detection.

As soon as the first proximity sensor (LS1) detects a luggage, the solenoid (SOL) will be deactivated, keeping new luggage to enter the process.

Once the luggage is delivered in the appropriate destination (see size detection section for details), the solenoid will be re-activated to allow a new luggage to be sorted. This process will cycle as long as the process is not in clear out sequence.

THINKING   DOCUMENT USE

4.3 Size detection

Once detected on the running Sorting Belt, all passenger baggage will be sorted into one of three (3) categories, based on size: Small, Regular and Oversized. This size evaluation will happen when the luggage reaches the 4th proximity sensor (LS4).

4.3.1 Small size detection

When the 4th proximity sensor is activated, if only the 3rd sensor (LS3) is detecting, this means a small luggage is in the sorting belt and the following will occur:
- The distribution belt will run in the size belt direction (VFD02)
- The size belt will run in the small direction (K2_F)
- The green pilot (L4) light will flash fastly
- After a delay of 10 seconds
  - The distribution belt (VFD02) will stop.
- After an additional delay of 5 seconds:
  - The size belt (F2_F) will stop
  - The green pilot (L4) light will turn off.

4.3.2 Regular size detection

When the 4th proximity sensor is activated, if only the 2nd and 3rd sensor LS2 & LS3) are detecting, this means a Regular luggage is in the sorting belt and the following will occur:
- The distribution belt will run in the size belt direction (VFD02)
- The size belt will run in the Regular direction (K2_R)
- The green pilot (L4) light will flashing
- After a delay of 10 seconds
  - The distribution belt (VFD02) will stop.
- After an additional delay of 5 seconds:
  - The size belt (F2_R) will stop
  - The green pilot (L4) light will turn off.

4.3.3 Over-length size detection

When the 4th proximity sensor is activated, if all sensors (LS1, LS2 & LS3) are detecting, this means an over-length luggage is in the sorting belt and the following will occur:

- The distribution belt will run in the size oversized direction (VFD03)
- The green pilot (L4) light will light
- After a delay of 10 seconds
  - The distribution belt (VFD03) will stop.
  - The green pilot (L4) light will turn off.

4.3.4 Over-height detection
Between the first (LS1) and the second sensor (LS2) there is a height barrier (not shown in the process diagram) that keep over-height baggage to enter the sorting process. If a baggage is simply "standing up", it will fall on the sorting belt and keep going on his journey.

This means that if a luggage is held in front of the first sensor (LS1) for more than 4 seconds without activating the second sensor (LS2), an over-height baggage is on the sorting belt and the following will occur:

- The sorting belt will stop (K1)
- The red pilot (L4) light flash to warn the operator an over-height baggage is detected

The operator then needs to manually remove the luggage from the sorting belt and bring it to the oversized area himself.

Then operator will be able to restart the process using the black push button (PB4).

Once the process is restarted, the red pilot light will turn off and the sorting belt (K1) will restart. The process will wait again for a luggage size detection.

4.4 Clear out sequence

To normally stop the process, the operator need to press the red push button (PB3) and the following will occur:

- The solenoid will be deactivated, keeping new baggage to come to the sorting belt.
- The green stack light (L1) will be flashing, indicating the process is in clear out sequence.
- If the process has not already detected a size, the sorting belt (K1) will run for an extra 10 seconds (allowing the process to detect a size or to detect an over-height baggage.

The clear out sequence may be ended in 3 ways:

- The process ends the sorting of a baggage (a size was detected)
- The operator clears the over-height luggage
- The extra 10 seconds delay ends without detecting

Once the clear out sequence ended:

- The green pilot light (L4) is turned off (if not already)
- The green stack light (L1) is turned off
- The amber stack light (L2) will light indicating that the automatic mode is back to its "ready to start" state; which means the operator can start the process again by pressing the green push button (PB2)

THINKING

DOCUMENT USE

5. Emergency stop

In both manual or automatic mode, upon the activation (push) of the emergency stop button (PB1):

- All belts will stop (outputs are turned off)
- The solenoid (SOL) will be de-energized
- The green stack light (L1) will turn off
- The amber stack light (L2) will flash to warn the operator that the process needs to be reset upon reset of the e-stop button (PB1)*

[*: as all the outputs are de-energized by the MCR, the reaction of the controls will only be visible when the E-stop button (PB1) will be pulled back to its non-activated state.]

As long as the emergency stop button is pushed, the operator won't be able to reset the process.

Once the emergency stop button is pulled, no belt should run, the operator will be able to reset the process using the black push button (PB4).

Once the process is reset, the amber stack light (L2) will become lit, indicating that the manual mode is back to its "ready to start" state; which means the operator can start the process again by pressing the green push button (PB2).

Note that another condition, such as fault detection or over-height size detection may prevent the user to reset the process.

6. Fault detection

In both manual or automatic mode, upon a detection of a VFD fault or an overload trip:

- All belts will stop
- The solenoid (SOL) will be de-energized
- The green stack light (L1) will be de-energized
- The red stack light (L3) will light to warn the operator of the presence of a fault
- The amber stack light (L2) will flash to warn the operator that the process needs to be reset

As long as the fault detection remains, the operator won't be able to reset the process.

Once the fault condition is cleared, the red stack light (L2) will be turned off and the operator will be able to reset the process using the black push button (PB4).

Once the process is reset, the amber stack light (L2) will become lit, indicating that the manual mode is back to its "ready to start" state; which means the operator can start the process again by pressing the green push button (PB2).

Note that another condition, such as emergency stop or over-height size detection may prevent the user to reset the process.

7. Inputs and outputs table

The following tables are a recommended assignment of the inputs and outputs for your programmable control. As controllers vary in how they are connected and function, you must check your particular PLC to see if these assignments are suitable.

7.1 Inputs

Input Detail	Symbol	Contact Type	PLC inputs Assignment	Information supplied at state (1)
Master Control Relay / Emergency Stop Circuit	MCR	NO	In0	E-Stop Button not pressed
Green push button	PB2	NO	In0	Button pressed
Red push button	PB3	NC	In1	Button not pressed
Black push button	PB4	NO	In2	Button pressed
3 positions Selector Switch 1 - Left Position	SS1_1	NO	In3	Selector in HAND position (Left)
3 positions Selector Switch 1 - Right Position	SS1_3	NO	In4	Selector in AUTO position (Right)
3 positions Selector Switch 2 - Left Position	SS2_1	NO	In5	Selector in SMALL position (Left)
3 positions Selector Switch 2 - Right Position	SS2_3	NO	In6	Selector in OVERSIZED position (Right)
Contactor K1 Overload	K1_OL	NO	In7	Overload tripped
Contactor K2 Overload	K2_OL	NO	In8	Overload tripped
VFD fault	VFD_FLT	NO	In9	VFD in fault
Optical sensor 1	LS1	NC	In10	Limit switch not activated
Optical sensor 2	LS2	NC	In11	Limit switch not activated
Optical sensor 3	LS3	NC	In12	Limit switch not activated
Optical sensor 4	LS4	NC	In13	Limit switch not activated

7.2 Outputs

Output Detail	Symbol	PLC outputs Assignments	Action at state (1)
Tower Lamp Green	L1	Q0	Light ON
Tower Lamp Amber	L2	Q1	Light ON
Tower Lamp Red	L3	Q2	Light ON
Indicating Lamp Green	L4	Q3	Light ON
Indicating Lamp White	L5	Q4	Light ON
Indicating Lamp Red	L6	Q5	Light ON
Contactor K1	K1	Q6	Contactor activates
Contactor K2 Forward	K2_F	Q7	Contactor activates
Contactor K2 Reverse	K2_R	Q8	Contactor activates
Solenoid	SOL	Q9	Solenoid OPEN
(Spare / not used)	-	Q10	-
VFD Digital Input 02 (Forward command)	VFD02	Q11	Motor running forward
VFD Digital Input 03 (Reverse command)	VFD03	Q12	Motor running reverse

THINKING

DOCUMENT USE