ATMN - 351

MACHINE VISION
&
AUTO ID

WINTER-2024

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Declaration of Authorship

We the members of Project #3, solemnly declare that the Machine Vision & Auto ID report is presented and submitted as our own.

We acknowledge that the authors listed below have proof read and approved the report before submission thus making both equally liable. Any and all external sources of information except for the authors have been given thorough credit to avoid plagiarism, a list of references with acknowledgements is also included in the report.

The members acknowledge to being the primary contacts in this process. The members acknowledge to being responsible for the final version of the publication.

Members of Project #3 SICK 3 Machine Vision & Auto ID:

Date of Signatures: 02/20/2024

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Abstract

The project entails building a system to demonstrate the functions and capabilities of SICKs 2D Camera Inspector 63x, Image Based Code Reader Lector, Barcode Reader CLV621 and RFID Reader RFU620.

- There are 2 mechanically moving parts in the project which are the rotary table and the conveyor belt.
- The main purpose of the rotary table is to demonstrate high speed barcode reading and the contrast sensor. A Stepper-Servo Hybrid motor and controller rotates the turntable that displays an array of colors. Once CLV621 is told to scan a barcode it waits for a trigger on from a contrast sensor and a trigger off from the contrast sensor.
- The purpose of the conveyor belt is to demonstrate the defect detection, image-based code reader and RFID tag reading ability of the provided sensors. Defect detection would be achieved by a deep learning model developed by SICK and trained by our group.
- The product *(a box of mechanical parts)* when placed onto the running conveyor goes up to the photoelectric sensor which then triggers the conveyor off and the Lector Flex63x, Inspector Flex63x and the RFID scanner on to start collecting data which then decides the outcome for the product.

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Introduction

The problem our group has chosen to work on is defect detection via vision systems that comes under project number 3 *“Machine Vision”* which is a project proposed by SICK, it involves demonstration of their advanced sensor intelligence by using deep learning algorithms to teach the ML (machine learning) model a huge database of images of the chosen product so that the software is able to differentiate between good and defective products thus aiding the sorting and inventory management process in any industrial setting. The goal of the contrast sensor is to activate the high-speed barcode reader to activate thus scanning any rotating barcodes even at high speeds thus demonstrating the sensing capabilities of SICK products.

The project will be taken to different trade shows once completed and it will be shown as a stand-alone cell and also as a part of the integration of three cells in the trade show, the primary customer if this as scaled up for industry would be shipping and receiving companies who can use the power of the Lector63x and Inspector63x to implement defect detection in their sequence.

Methodology

Cell Layout

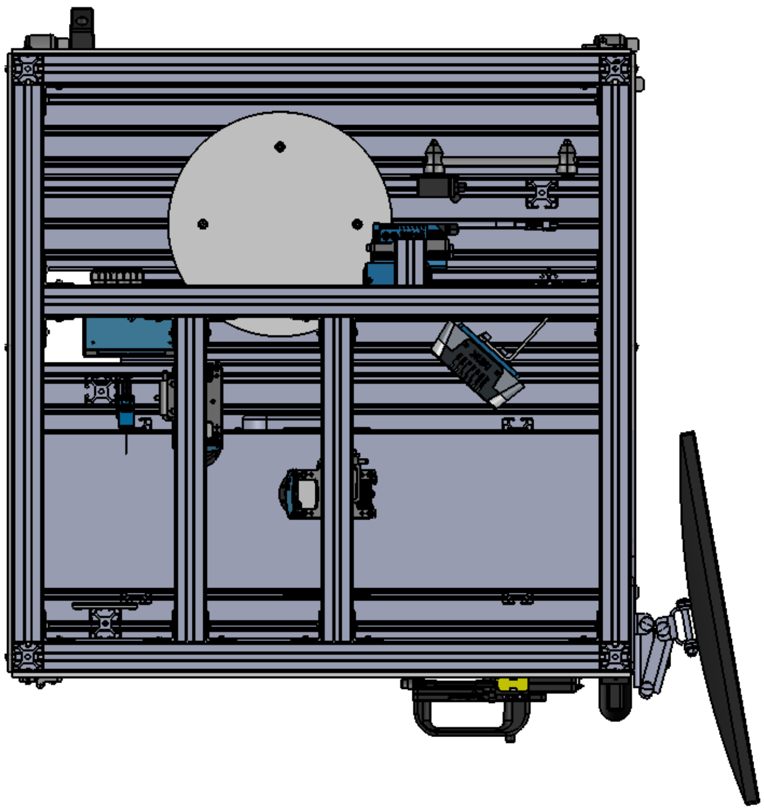


Figure 1: Cell Layout - Isometric View

The cell has a compact layout as all the primary sensor apparatus along with the linear actuator (conveyor belt) and the rotary actuator (rotary table) are condensed onto an 800mm x 800mm base made of 40x40 aluminum extrusions. It is a very apt representation of industrial layouts as it performs crucial and complex applications while occupying minimum area thus saving cost of estate, making it an effective layout for industries. The design is inspired from defect detection cells at large scale manufacturing companies like Tesla Motors Inc. *Figure 1* depicts an isometric view of the mechanical design of the cell.

A list of all the major components used on the cell is provided below:

Dorner Conveyor	*KTS Prime*
Photoeye	*CLV 650*
Lector 63x	*SICK Safety Door Lock*
Inspector 63x	*E Stop & Reset*
RFU 620	*Rotary Table*

Design Specifications

Sick requires our cell to be used in any of the upcoming trade shows. Due to this we want to show off the potential of what our main 4 sensors InspecterP63X Flex, Lector63x, CVL650 and RFU620 are all capable of doing.

- InspectorP63 Flex:

  We are required to teach/train an Inspector to use its 2D camera to analyze given items and identify what the item is. In the cell function Inspector will be prompted with an item to expect and should be able to tell the operator if the item was what it was prompted with.

- Lector63x:

  Lector is a 2D matrix and barcode scanner. Lector should be able to use data from an encoder to snap a photo of a passing item and read, store and display the given data matrix/barcode.

- RFU620:

  RFU is a RFID Reader with a unique ranged topology that allows the RFU to see and read, store and display the RFID tag that has entered its field of vision.

- CLV650:

  CLV is a High-Speed Barcode Reader. Our objective with CVL is to use a rotary table to spin relatively fast and show the speed at which barcodes can be read.

- KTS WB9:

  KTS is a contrast sensor, it is taught different colors and a trigger value is also taught thus causing it to trigger only for a single color among an array of colors rotating at a high speed with the rotary table.

Sequence of Operation

There are 2 main operations for our individual cell and 2 process for the integration part of the project. In our own stand alone cell the processes that are happening are object detection and rotary operation. Object detection is accomplished by identifying different pastas loaded on a conveyor and evaluating them based on a pretrained deep learning algorithm deployed onto the Inspector P63x, the processes happening during this sequence are 2D data matrix collection and RFID data collection, for the rotary operation contrast detection and high-speed barcode reading are being demonstrated.

In the integration portion, our cell alongside 'SICK 2 I4.0' and 'SICK 1 Robot Guidance' cells is emulating a shipping and receiving sequence.

Object Detection

1. Pasta type selected on the HMI.
2. Pasta is placed on conveyor.
3. The distance sensor beam is broken.
4. Conveyor belt stops.
5. Inspector P63x takes a picture of the pasta and determines job ID.
6. If job ID matches input job, then product passes evaluation and continues conveyor energizes.
7. Lector P63 scans and stores Barcode/Data Matrix for the database while the conveyor is running.
8. After Lector is done collecting barcode data, RFU 620 is triggered to collect RFID data.
9. All of the collected data is stored on the PLC and populated on the database.
10. If the product does not pass evaluation from inspector, then the other sensors are not triggered and the conveyor is energized in reverse direction until the product reaches the beginning of the conveyor belt where is recollected by the operator and the process is reset.

1. Trigger sequence chosen on HMI
2. CLV 650 waits for a trigger on from contrast sensor
3. KTS WB9 triggers for a certain color (blue in our case) thus energizing the step logic for barcode data collection.
4. Once contrast sensor is energized, CLV 650 can now be triggered to collect barcode data from UPC-A labels rotating at speeds up to 120,000Hz on the rotary table.
5. Once the data is collected it can be seen on PLC tags.

Integration – Shipping Sequence

1. Starts from our cell (SICK 3 Machine Vision and Auto ID) by selecting a product on the HMI.
2. Inspector P63x evaluates the product. If the product it bad it goes down the cell into 'Industry 4.0' cell where all the sensors are muted and the conveyor keeps running until the product reaches the 'Robot Guidance' cell where the object falls in the bad item bin.
3. If the object passes evaluation by Inspector P63x then Lector P63x collect barcode data and store on the database and RFID data is also collected down the line.
4. The product then enters 'Industry 4.0' cell where data pertaining to height, width and length are collected and displayed on the monitor.
5. After that the product reaches 'Robot Guidance' cell where Trispector notices it and prompts the UR (robot) to pick it up and drop it off into a specified bin.

Integration – Receiving Sequence

1. Starts from 'Robot Guidance' cell by placing a box of pasta onto the conveyor using UR and PLB.
2. The product then enters 'Industry 4.0' cell where data pertaining to height, width and length are collected and displayed on the monitor.
3. After that the product reaches our cell 'Machine Vision and Auto ID' where RFID data is collected then Lector P63x is triggered to collect barcode data.
4. After Lector P63, Inspector P63x is triggered to take a picture for evaluation and the data for the type of pasta is stored onto the database.
5. The conveyor stops when the distance sensor on our cell is broken.
6. The process can be restarted from the HMI.

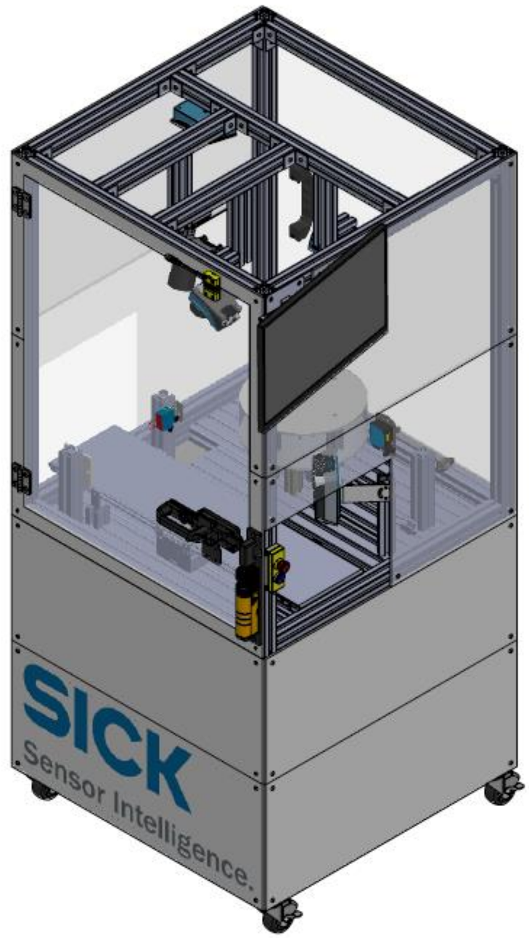


Figure 2: Isometric Cell Layout

The design of the cell was made keeping in mind the space constraints of any industrial manufacturing facility. Even though the cell is compact all the components are mounted such that they integrate without any problem, all functionalities proposed were achieved with this design. Many iterations of the layout had been proposed throughout the design phase extending till the build phase, the process included repositioning of the conveyor and sensor systems at different locations on the cell. This design was approved by the group lead and also by the project coordinator. The design will be explained starting from safety then sensors and finally moving component mounting.

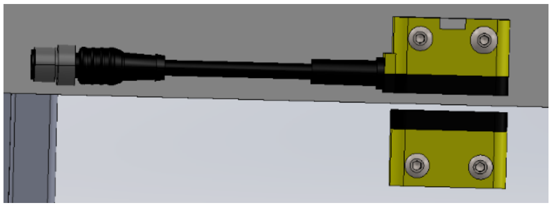


Figure 3: RFID Safety Door Lock and Monitor

The SICK RFID safety door switch was mounted on the front door acrylic panel just below the border frame, one part of the lock is mounted on the white acrylic frame and the other is mounted on the front door transparent acrylic. The monitor is mounted to the right side of the cell on a VESA mounting bracket using 2 screw slots.

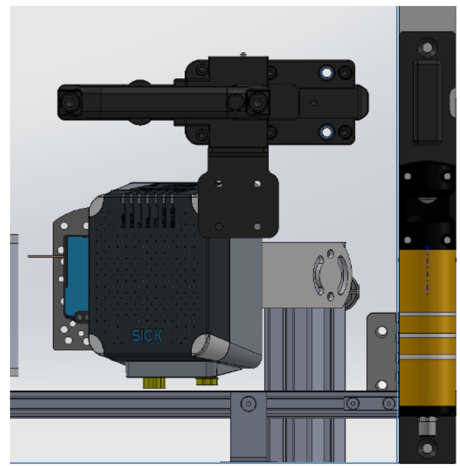


Figure 4:SICK Flexi Lock

The SICK flexi safe lock is n electromechanical door interlock that is used to ensure that the front door is locked and safety is established in order for the operations to run inside the cell.

The actuator part of the lock is mounted on a custom mounting bracket from SICK which came with a slot for the key to pass through.

The handle part of the lock is mounted on the front door transparent acrylic, the handle is mounted 669 mm form the left side of the cell and 643mm from the top of the cell.

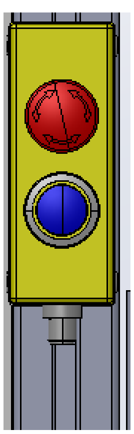


Figure 5: E Stop and Reset Button

The physical E stop and the reset button is used for stopping the cell, it is mounted on the right side of the cell where the product comes out after the process is over.

It is mounted on an aluminum extrusion approximately 190mm from the base on the cell it is screwed into a T nut which goes inside the T Slot rail inside the 1000mm aluminum extrusion.

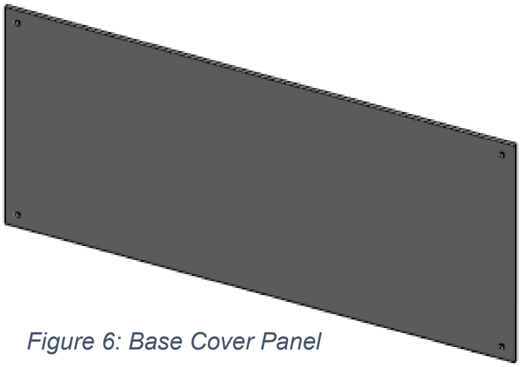


Figure 6: Base Cover Panel

The base of the cell is covered by 6 acrylic panels that are 6mm thick with one of them having SICK logo etched into it. The panels provide guarding to all components like the Doner conveyor controller, PC, oriental stepper motor controller unit, SICK sensor blocks etc. which are mounted below the cell base.

The rotary table assembly consists of 2 acrylic plates 6mm each made of white acrylic with one of them having 6 m4 clearance holes for mounting on the oriental hollow rotary actuator. The actuator itself is mounted to the cell base using 4 pieces of 4040 aluminum extrusion 72mm each to keep the motor just flush with the base.

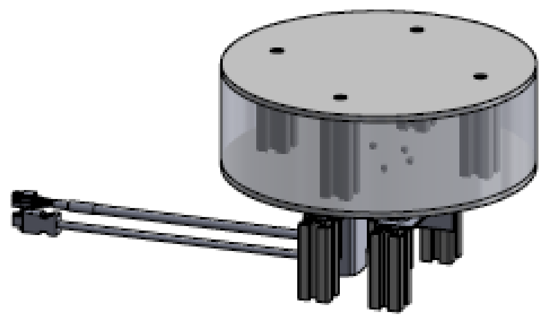


Figure 7:Rotary Table Assembly

The two rotary plates are spaced apart using 4 88mm pieces of 4040 aluminum extrusions and L brackets to permanently mount it to the cell.

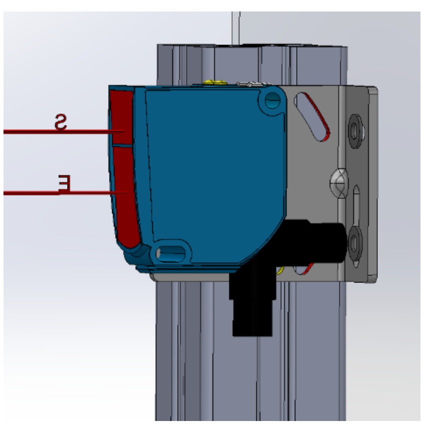
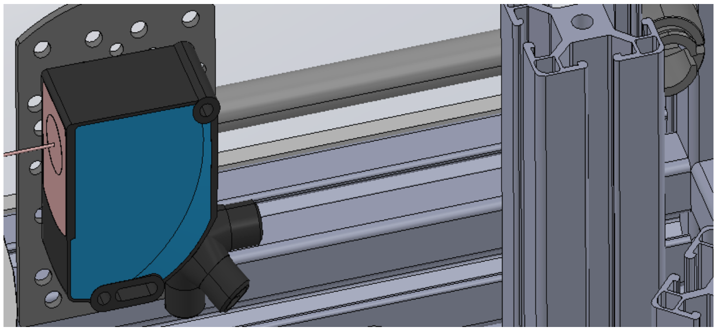


Figure 8:Distance Sensor Mounting

The distance sensor was mounted to cell base on a 4040 extrusion of length 240mm and the reflector is positioned exactly parallel to the distance sensor, the distance sensor is placed 150mm away from the left corner of the cell and the reflector is positioned at approximately 155mm from the corner of the cell.



The contrast sensor is mounted on a mounting bracket received from SICK, it is mounted on a 4040-aluminum extrusion of height 240mm and is approximately 75mm away from the right-side corner extrusion.

Figure 9: Contrast Sensor Mounting

RFU is also mounted on a 4040-aluminum extrusion mounted at an angle of approximately 45 degrees with the base plane, it is mounted approximately 100mm away from the right-side corner extrusion.

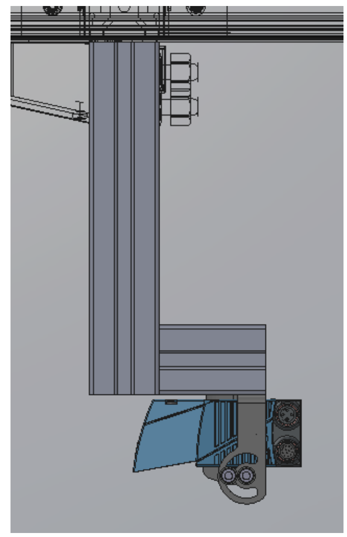


Figure 10:RFU sensor mounting

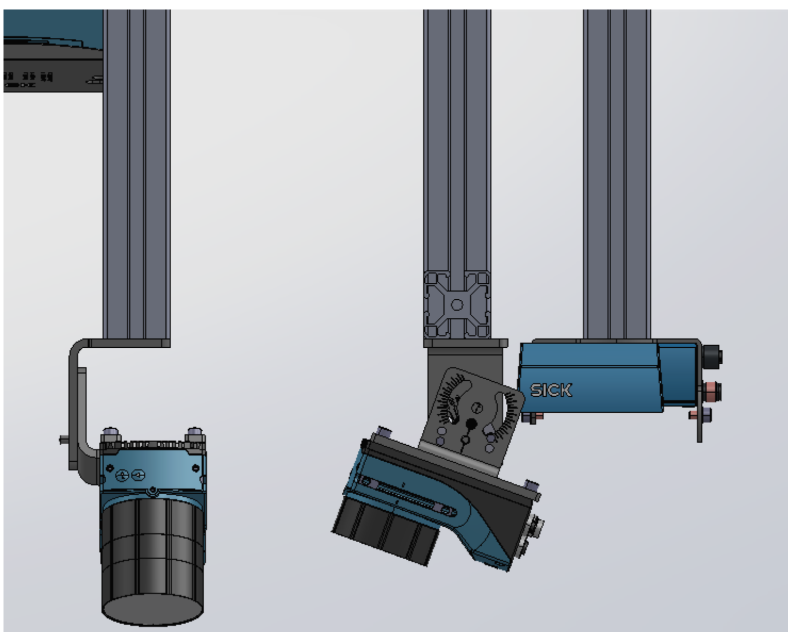


Figure 11: Lector and Inspector Mounting

Both Inspector P63x and Lector P63 are mounted such that they are centered on the conveyor and their height is set to such that they are perfectly focused on the product of interest (boxes of pasta in our case) Inspector P63x is mounted on a piece of 4040-aluminum extrusion that is 240mm in height and is 250 mm away from the left side of the cell, Lector is mounted on a similar piece of 4040-aluminum extrusion that is 440mm away from the left side of the cell. Both Lector and Inspector are mounted on custom brackets from SICK which are mounted on pieces of 4040-aluminum extrusion that is 60mm in length which centers both the cameras perfectly on the conveyor.

Schematic 1:

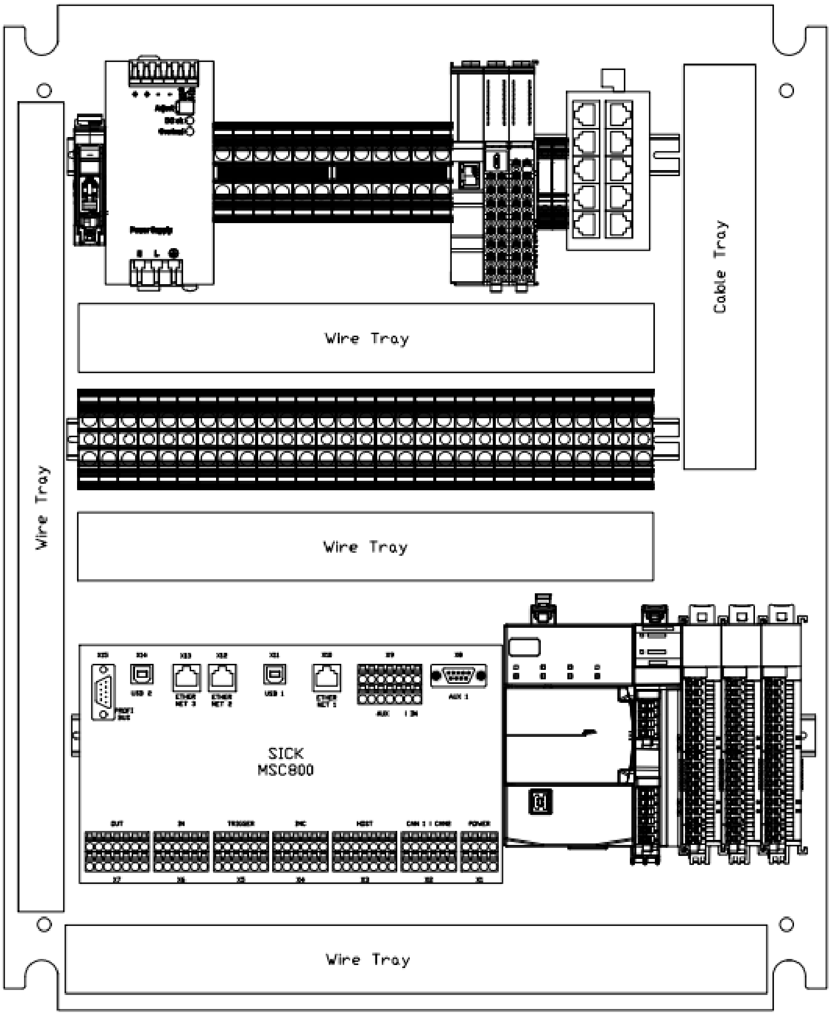


Figure 12: Panel Drawing

This schematic is a view of the actual electric back panel layout that is installed on the cell.

It shows all the components that are included in the actual electric panel.

It also shows the supporting components such as wire trays, din rails and cable trays.

Major components in this drawing are the 24V power supply, AB PLC, SICK MSC800, SICK FlexiSoft safety controller, ethernet switch etc.

Schematic 2:

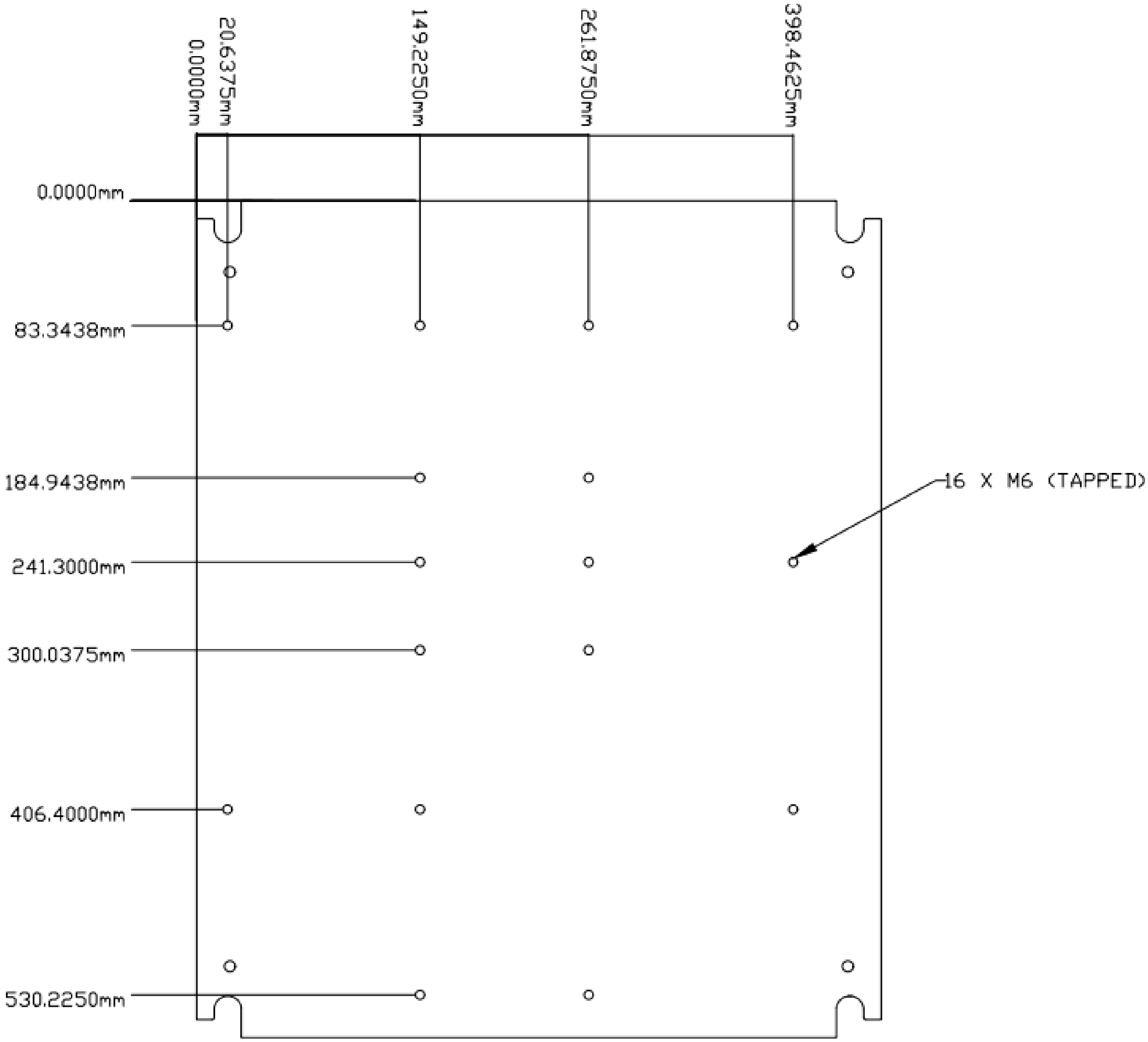


Figure 13: Panel Layout

This schematic is a mechanical representation of the panel back plate showing any mechanical operation performed on the backplate to mount the components on. It gives dimensions to each hole drilled and tapped to mount all the components needed.

Schematic 3:

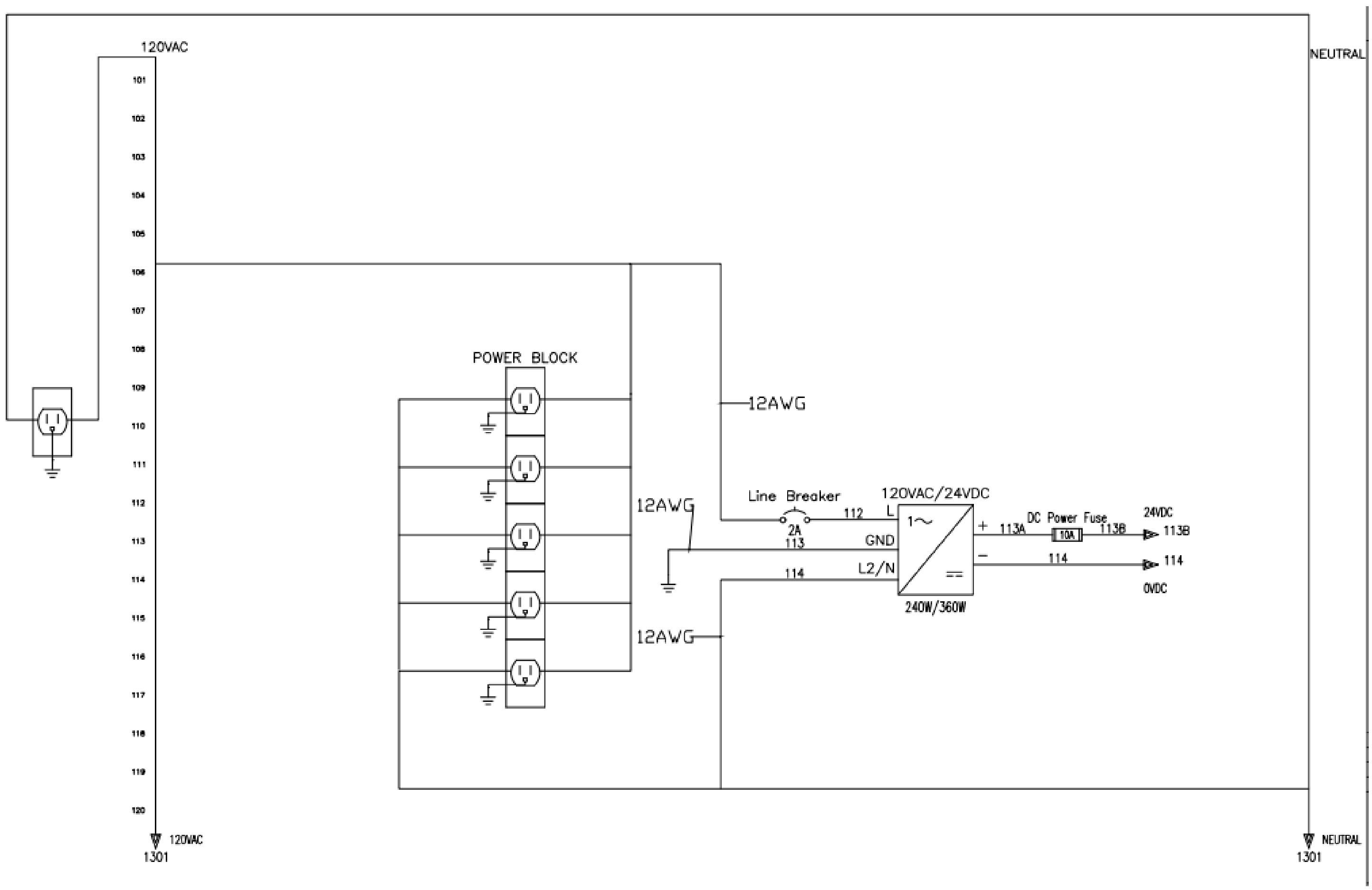


Figure 14: Power Drawing

Schematic 3 shows the 120 V feed from the power block connected to a wall outlet, it feeds the 120VAC/24VDC 240W/360W power supply which is protected by a 2A breaker, the downstream circuit form the 24V power supply is protected by a 10A fuse. All wires here are 12-gauge wires. The power block is feeding the main control panel, the doner conveyor controller, PC, monitor, RFU and Lector.

Schematic 4:

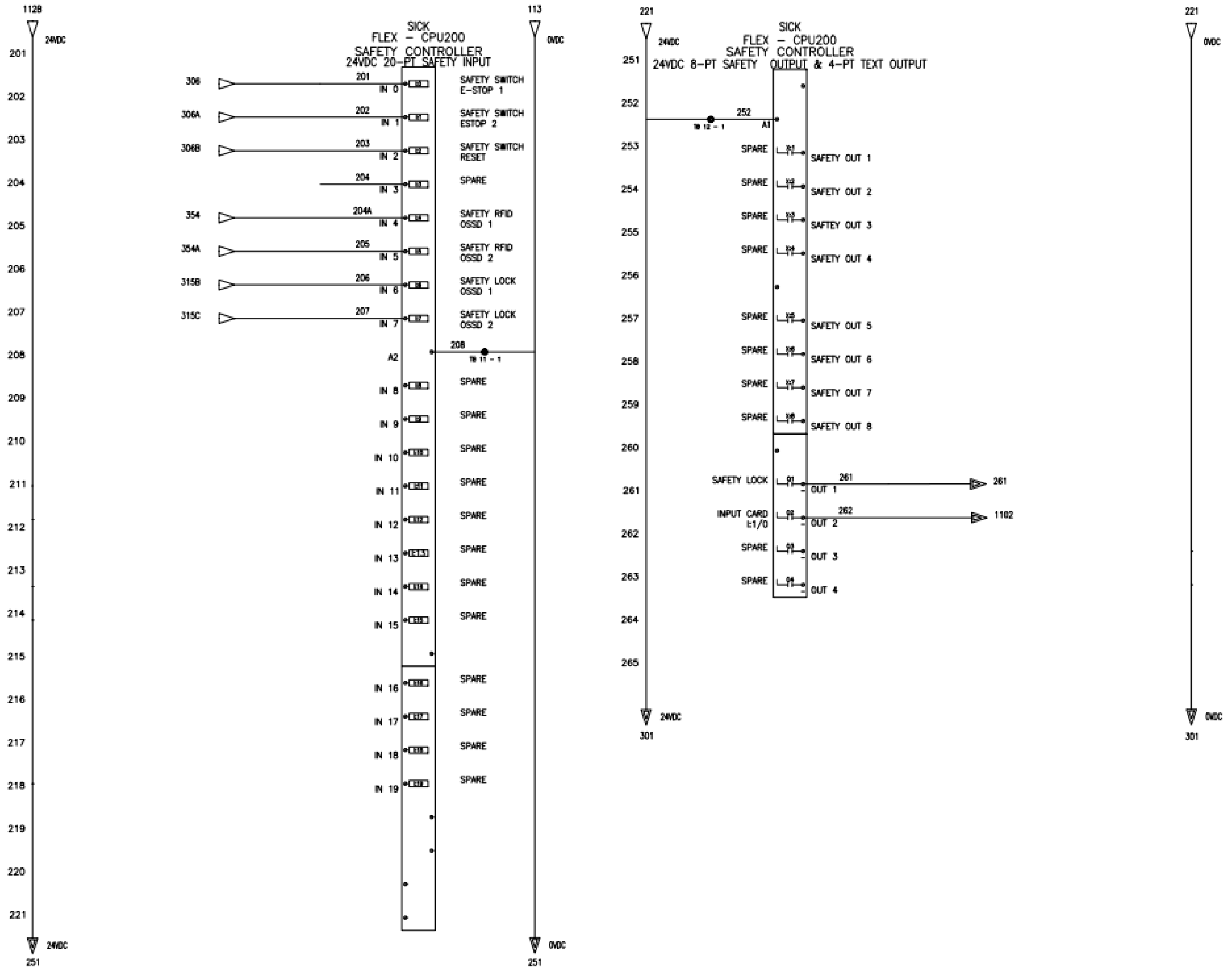


Figure 15: Safety Controller

Schematic 4 is dedicated to the safety controller connections, on the left are all the inputs and on the right are all the outputs, it shows the safety input and safety output, there are 2 safety switch E-Stop coming into the controller from the Physical Estop as safety input 0 and 1, the safety reset button is coming in into input 2, the safety RFID lock is coming in into 4 inputs, input 4,5,6 and 7. Inputs 3, 8-19 are spare input points.On the output side only 2 outputs are bring sent out, one to the safety lock and other to the PLC input card (I:1/0).

Schematic 5:

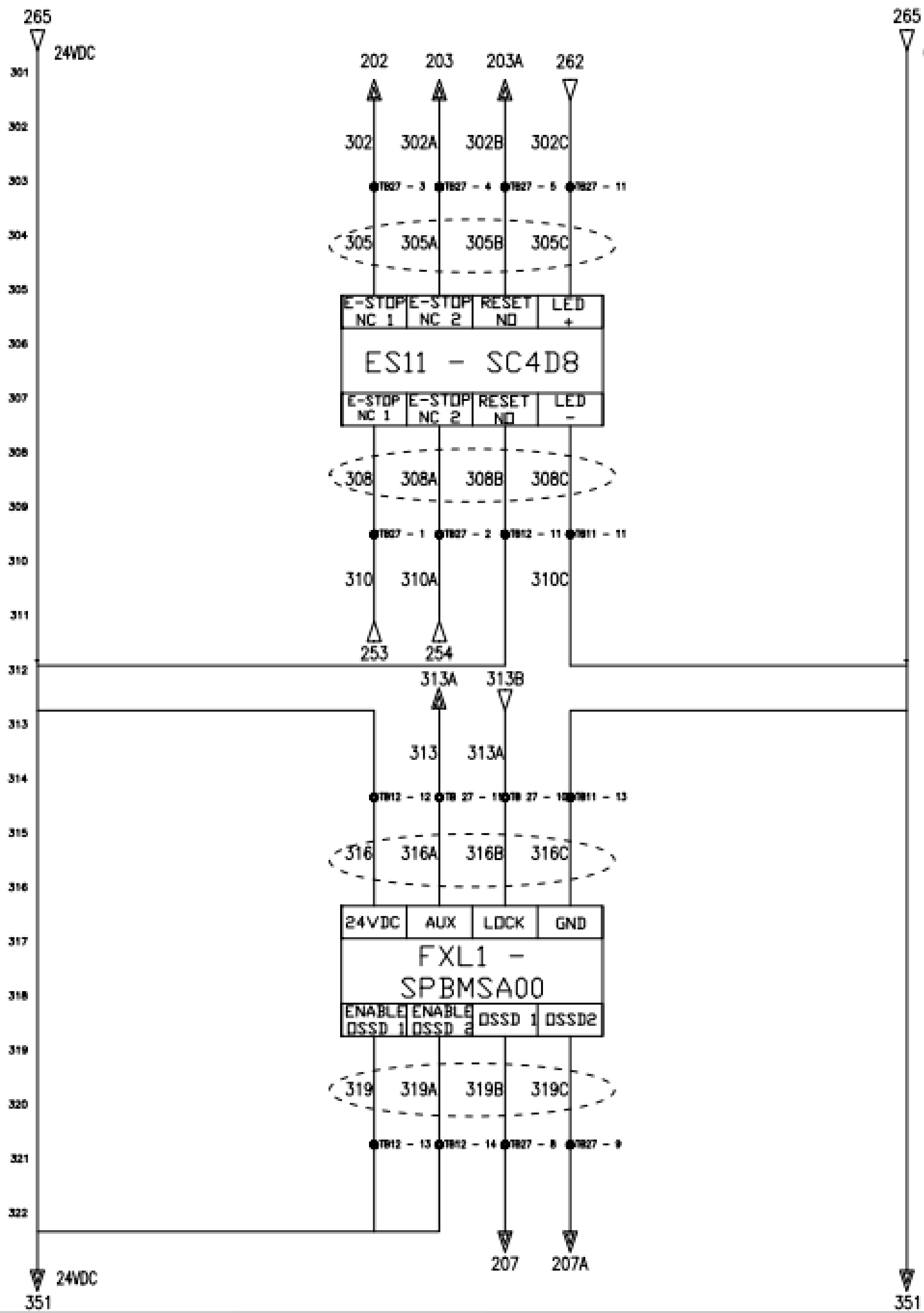


Figure 16: EStop, Reset and Flex Lock Wiring

The left rung is a 24V feed and the right rung is a 0V feed, there are 3 devices in total shown in this schematic out of which 2 are shown here, the E Stop button is shown on the top alongside the reset button and the one on the bottom is for the flex lock electromechanical interlock itself.

It shows the connect of the device to the power circuit.

A color-coded legend is provided in figure (*5a*) for showing the color to lead connection for easy installation.

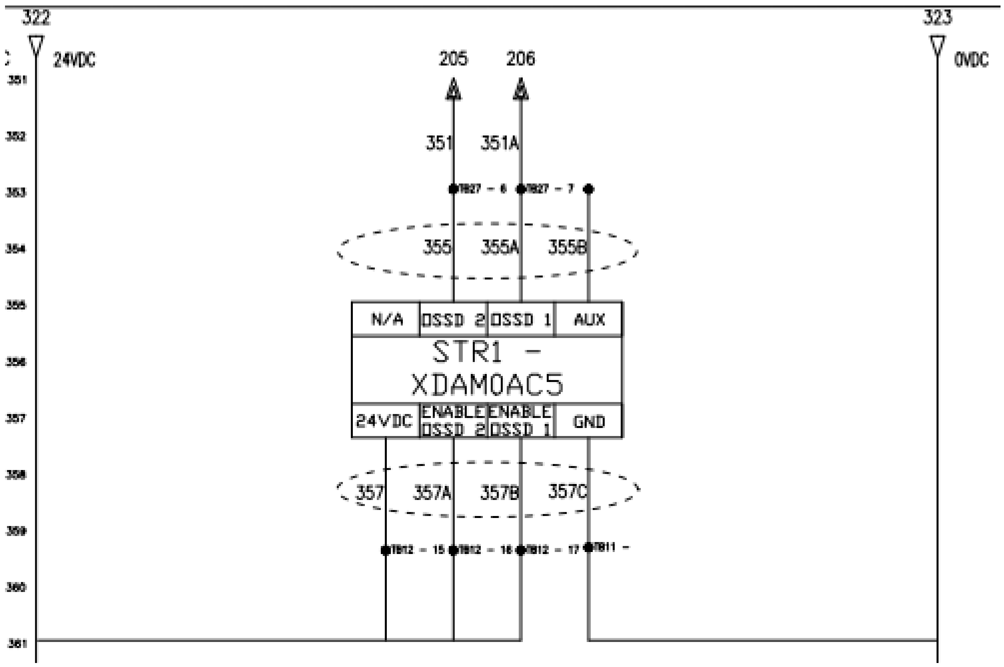


Figure 17: RFID Safety switch wiring

This is a continuation of schematic 5, this shows the connection of the RFID safety switch with the with 24V power bus. A pin to lead color coded legend is also provided for this safety device as well in figure (*5b*).

M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS	
E-STOP NC 1	WHITE
	BROWN
E-STOP NC2	GREEN
	YELLOW
LED +	GRAY
LED -	PINK
NO CONTACT (RESET)	RED
	BLUE

M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS	
24VDC	BROWN
GND	BLUE
N/A	GREEN
DSSD 1	PINK
DSSD 2	GRAY
AUX	WHITE
ENABLE DSSD 1	RED
ENABLE DSSD 2	YELLOW

Figure 5a:

E Stop Pin to connection

Flex Lock Pin to lead color color connection

M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS	
24VDC	BROWN
GND	BLUE
LOCK	GREEN
DSSD 1	PINK
DSSD 2	GRAY
AUX	WHITE
ENABLE DSSD 1	RED
ENABLE DSSD 2	YELLOW

Figure 5b: RFID safety switch lead to pin color legend

Schematic 6:

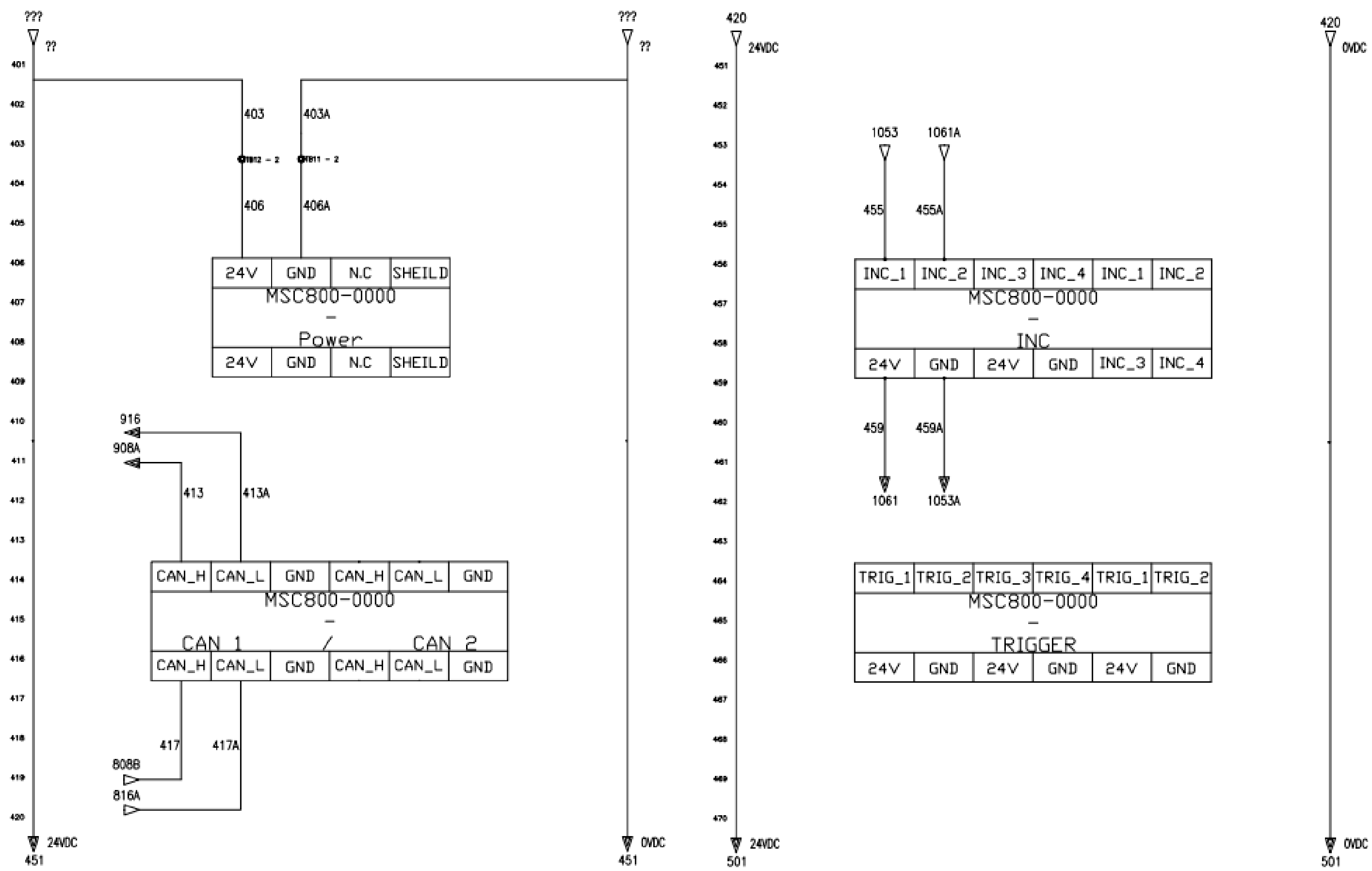


Figure 18: MSC 800 - 1

The drawing on the left side shows the power and CAN1 module onboard the MSC 800 module, it shows the power connections to the MSC 800 power module it shows the 24V and ground node being connected.

The CAN1 & CAN2 module has 4 connections to the 2 CAN high and 2 CAN low buses.

The 2 modules on the right are mainly used for communications and trigger, the trigger module is not currently connected to nothing and the INC module has 4 connections, 2 to power and 2 to INC 1 & 2.

Schematic 7:

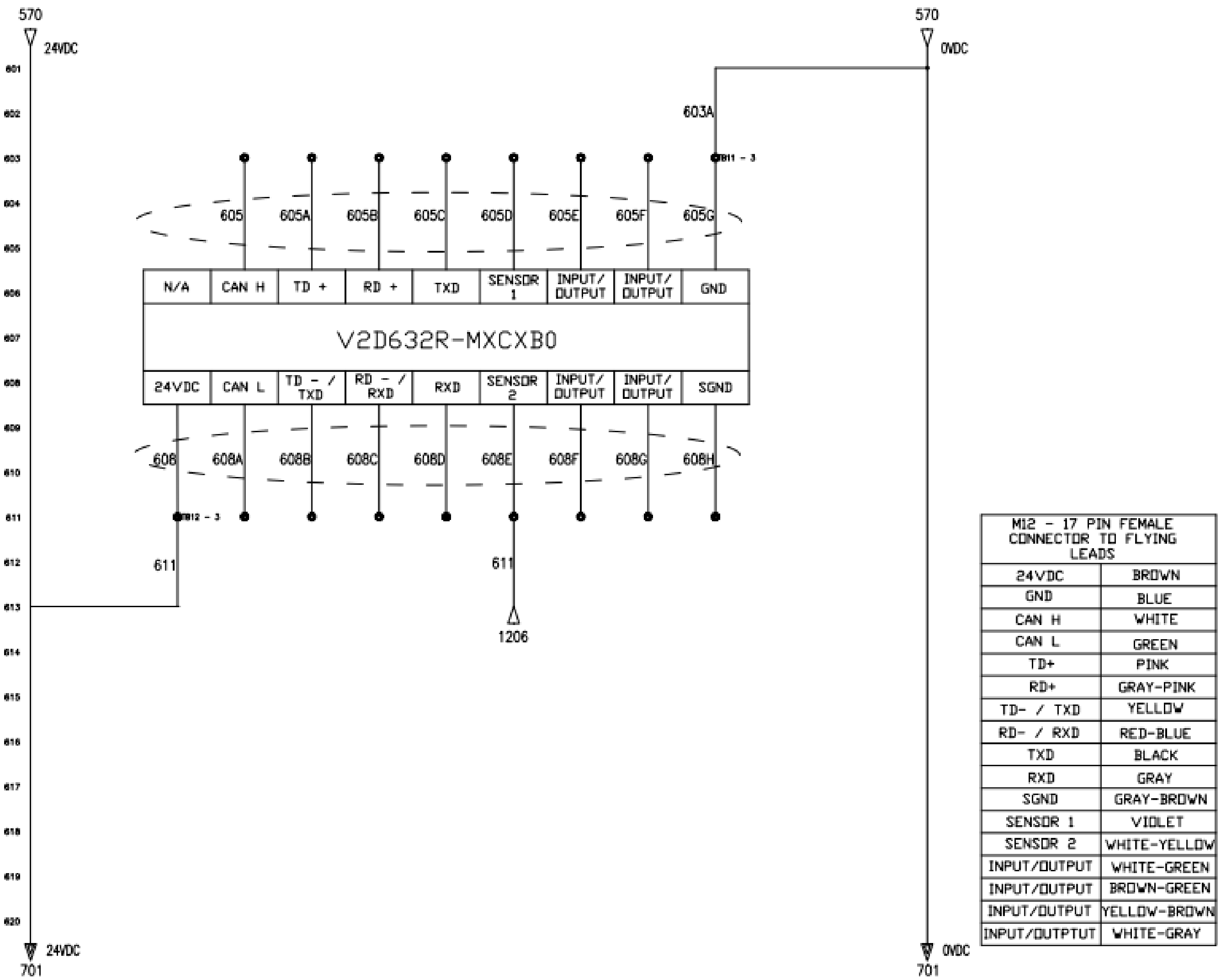


Figure 19: MSC 800 - 2

Schematic 7 shows the connections for the Inspector P63x it a 24V power connection and a ground connection, pin 608E gets an input signal from lien 611 of the PLC which acts as a trigger for the camera via the onboard sensor 2.

The ground pin is connected to the 0V line, all the other pin connections are referenced in the M12-17 pin female connector to flying leads table inside the schematic. It is also interfaced with the PLC via ethernet.

Schematic 8:

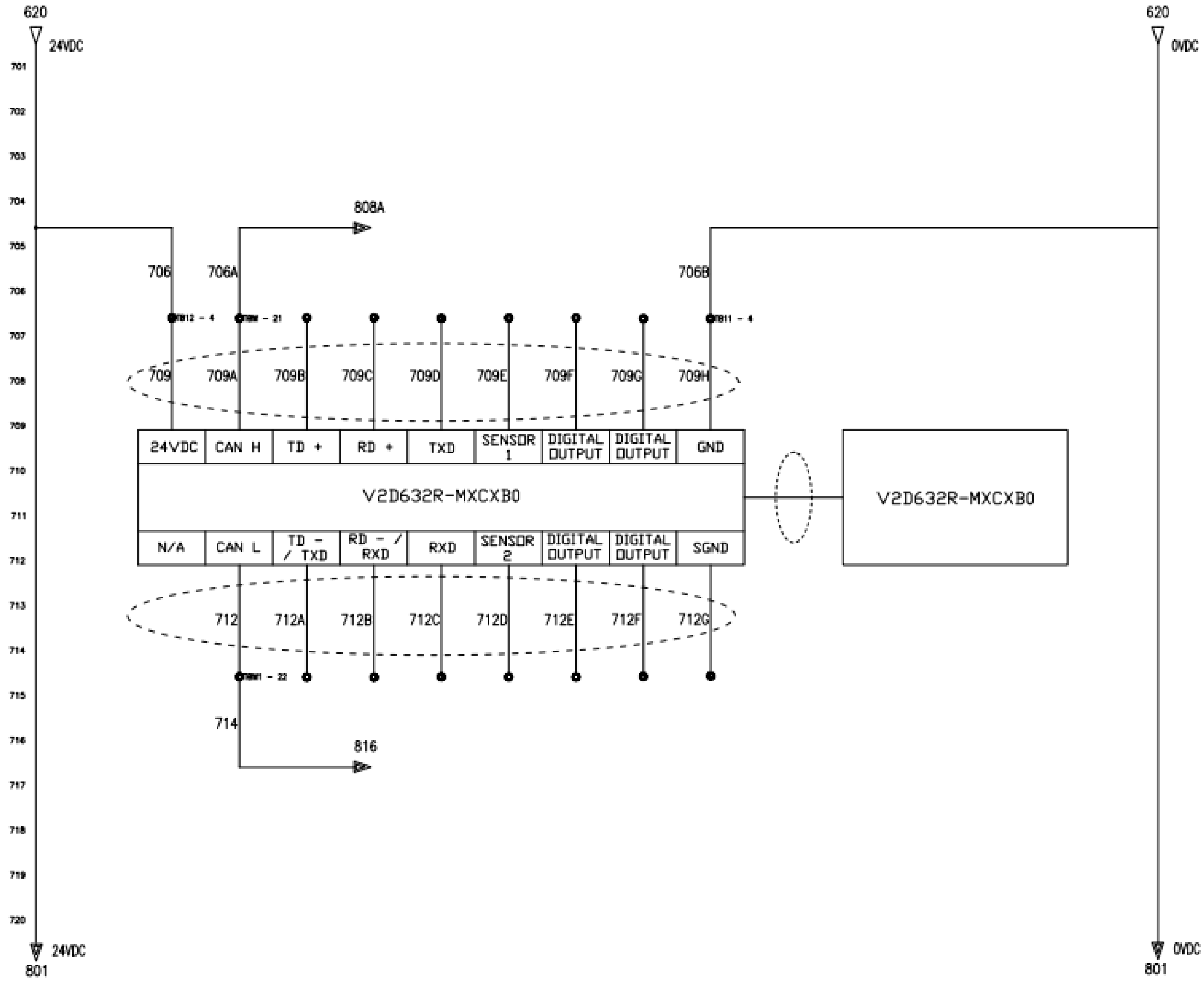


Figure 20: Inspector Wiring Diagram

Schematic 8 shows the connection of Lector P63 to the power bus and 0V and also the connections of individual pins and for lector to its module. Lector P63 has its CAN H node connected to RFU 620's CAN H bus for interfacing them with the PLC. The CAN L bus of this module goes to the CAN L bus of the RFU 620 module. It is also interfaced with the PLC via ethernet.

Schematic 9:

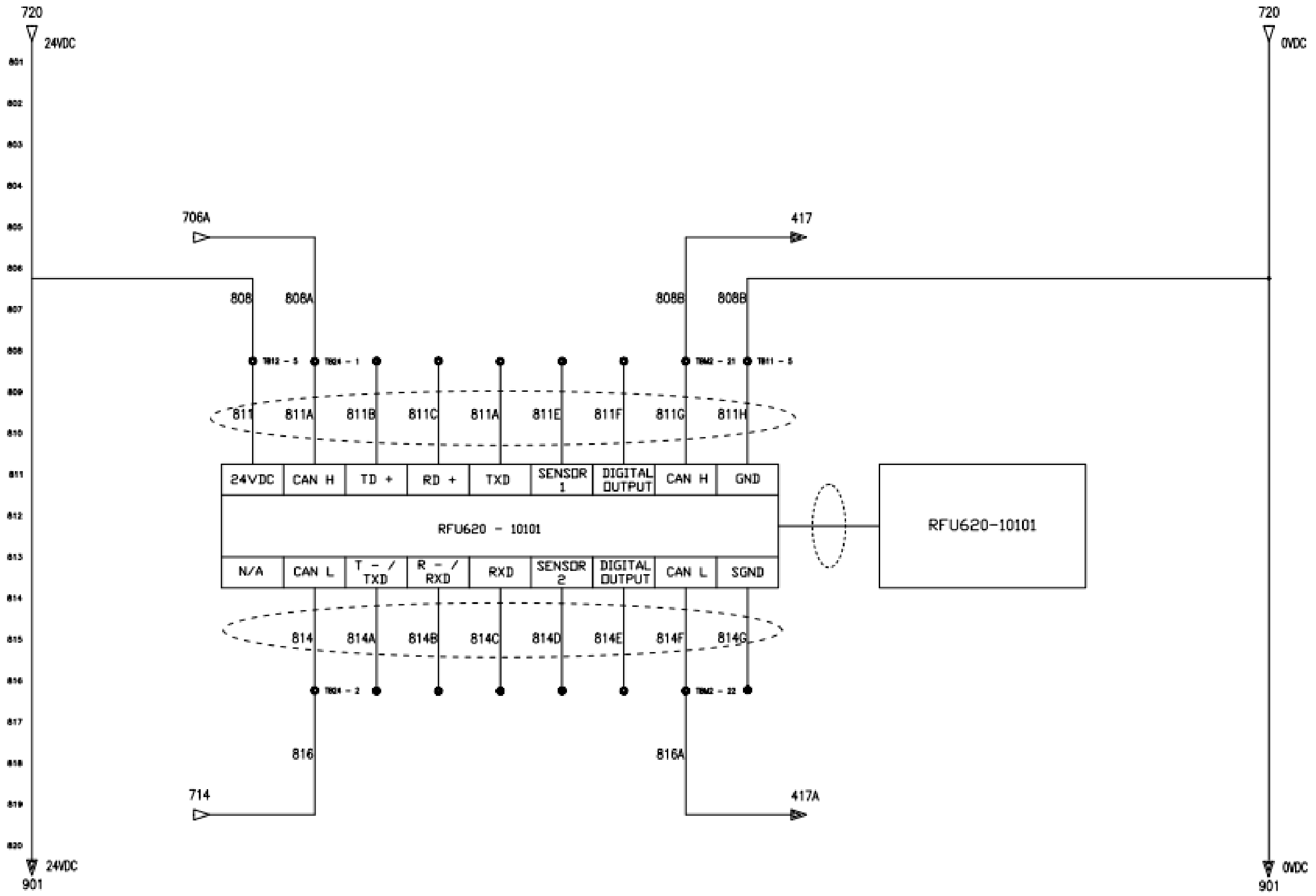


Figure 21:lector Wiring Diagram

Schematic 9 shows connections for the RFU 620 and its module with Lector P63 through CAN H input via lead 811A and output via lead 811G, CAN L connections are as follows, inputs to 814 and CAN L outputs to 814F. RFU 620, Lector 63 and MSC 800 are all connected via CAN bus so they are interfaced with each other in this method. It is also interfaced with the PLC via ethernet.

Schematic 10:

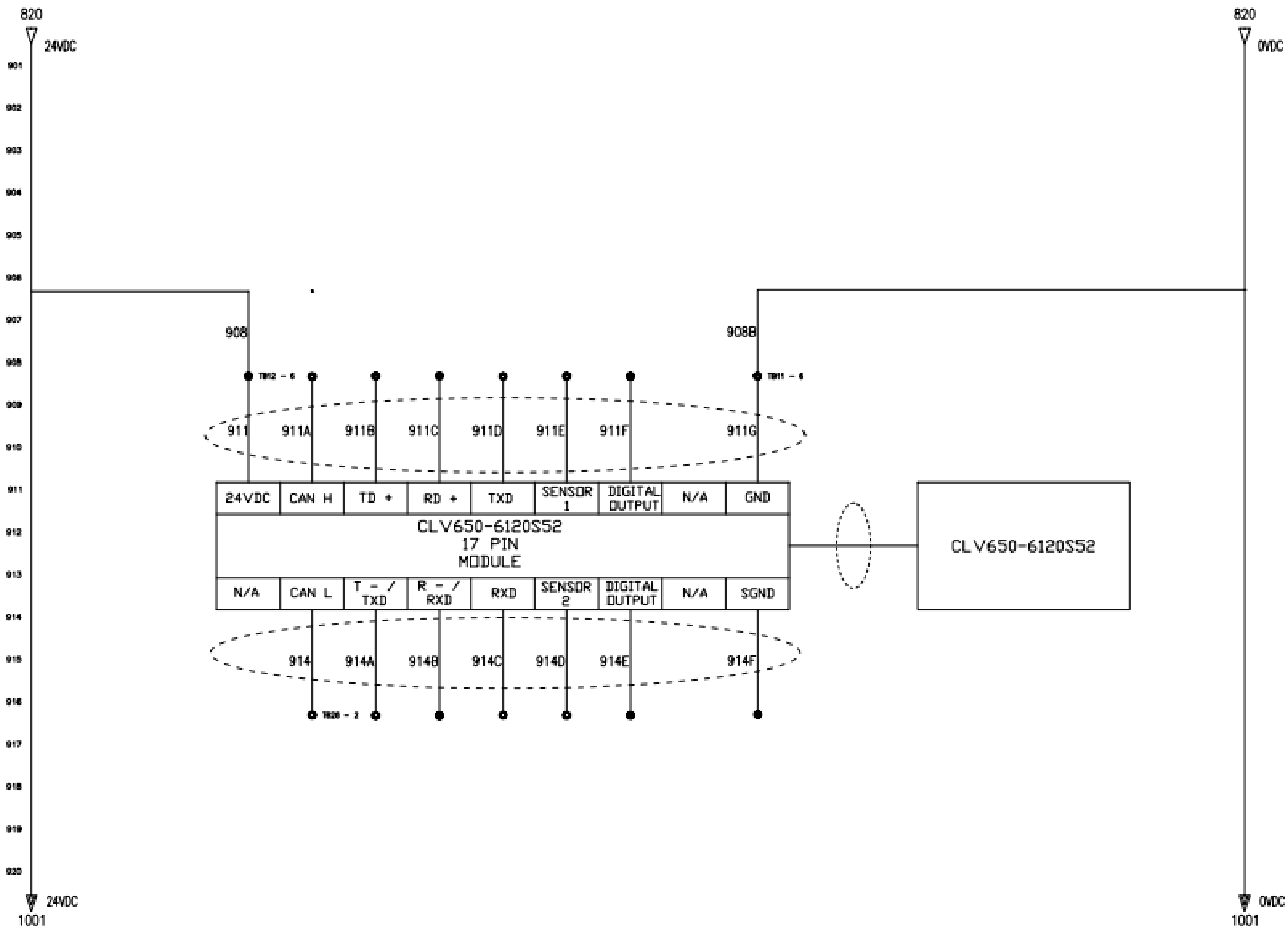


Figure 22: CLV Wiring Diagram

Schematic 10 show the connection of the CLV 650 high speed barcode scanner to the common power bus and local ground, it shows the connection of the CLV 17 pin module to the CLV 650 module.

CLV 650 is triggered from the PLC it is registered as a generic ethernet module on the PLC and so it is interfaced via the ethernet

Schematic 11:

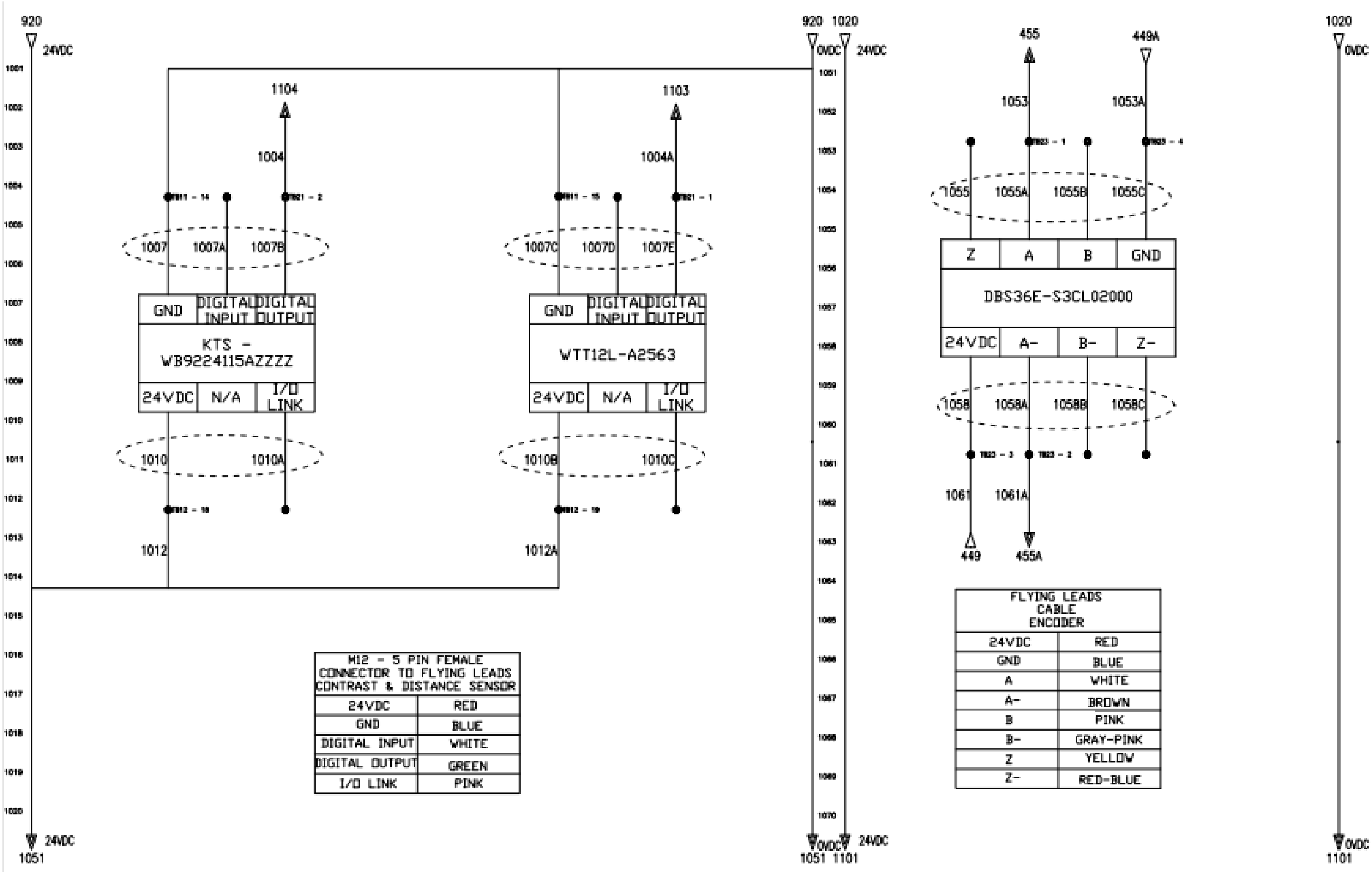


Figure 23: Other Sensors Wiring Diagram

Schematic 11 shows the connections for KTS WB9 (contrast sensor), photoelectric sensor and the encoder.

On the left most side of the schematic is the connection diagram for the contrast sensor. In the middle is the connection diagram for the photoelectric sensor and on the extreme right is the encoder connections. 2 tables have been provided to show connector to flying lead color legend.

Schematic 12:

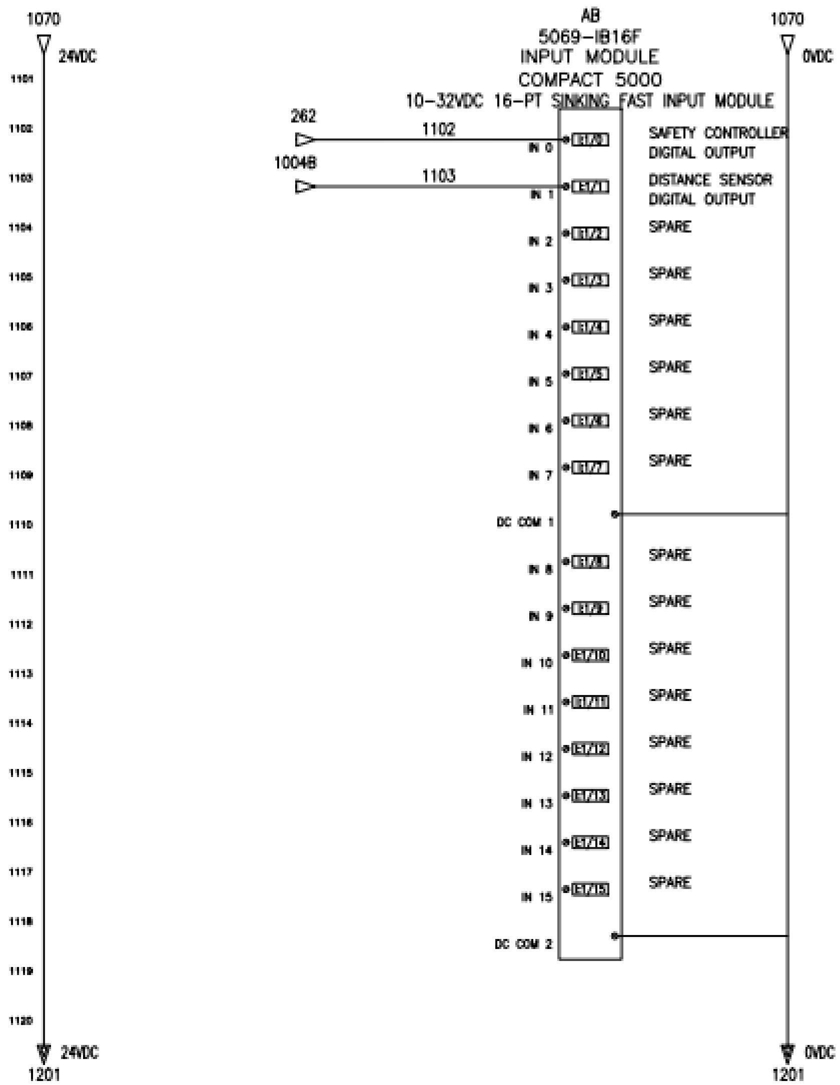


Figure 24: PLC Input Module

Schematic 12 shows the input card diagram for the AB PLC input module 5069-IB16F in slot 1 of the PLC chassis. It is a sinking fast input module with 2 inputs being engaged.

Input 0 is connected to the safety controller digital output and input 1 is connected to the distance sensor digital output.

There are not many connections to the input card because most of the major sensors are either on the CAN bus network of the MSC-800 or directly via ethernet as a generic ethernet module.

Schematic 13:

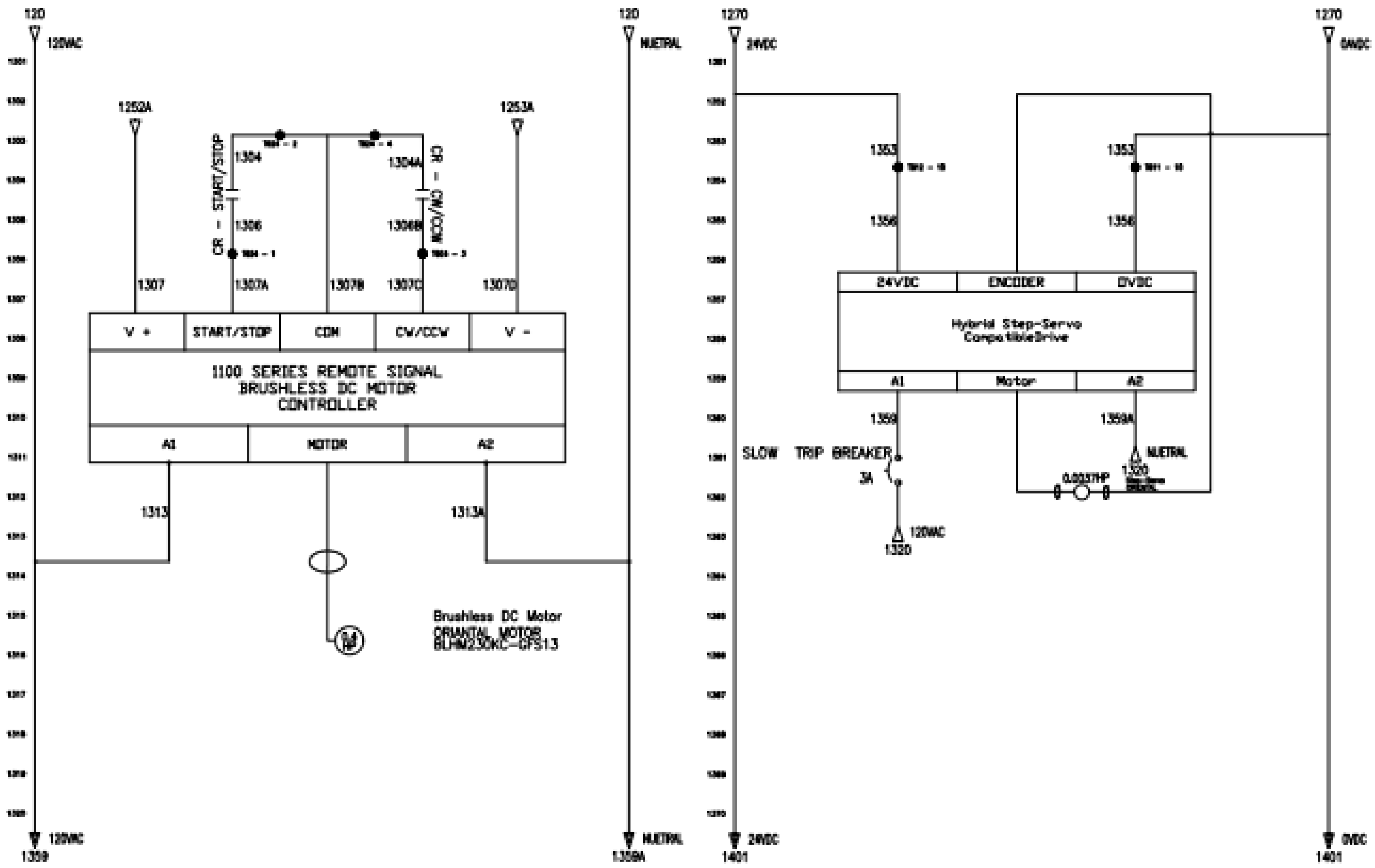


Figure 25: DC motor Drives and Servo Controller

Schematic 12 shows the connections for the brushless DC motor controllers, one for the conveyor belt controller and other for the step servo drive. The 1100 series remote signal brushless DC motor controller has an internal control circuit and 4 power connections, with 2 positive voltage connections and 2 negative voltage connections, it drives a 0.4 HP motor.

The hybrid servo drive has a separate 3Amp breaker and a 120VAC feed and a 24V control feed, it drives a 0.0037 HP motor as an output.

Schematic 14:

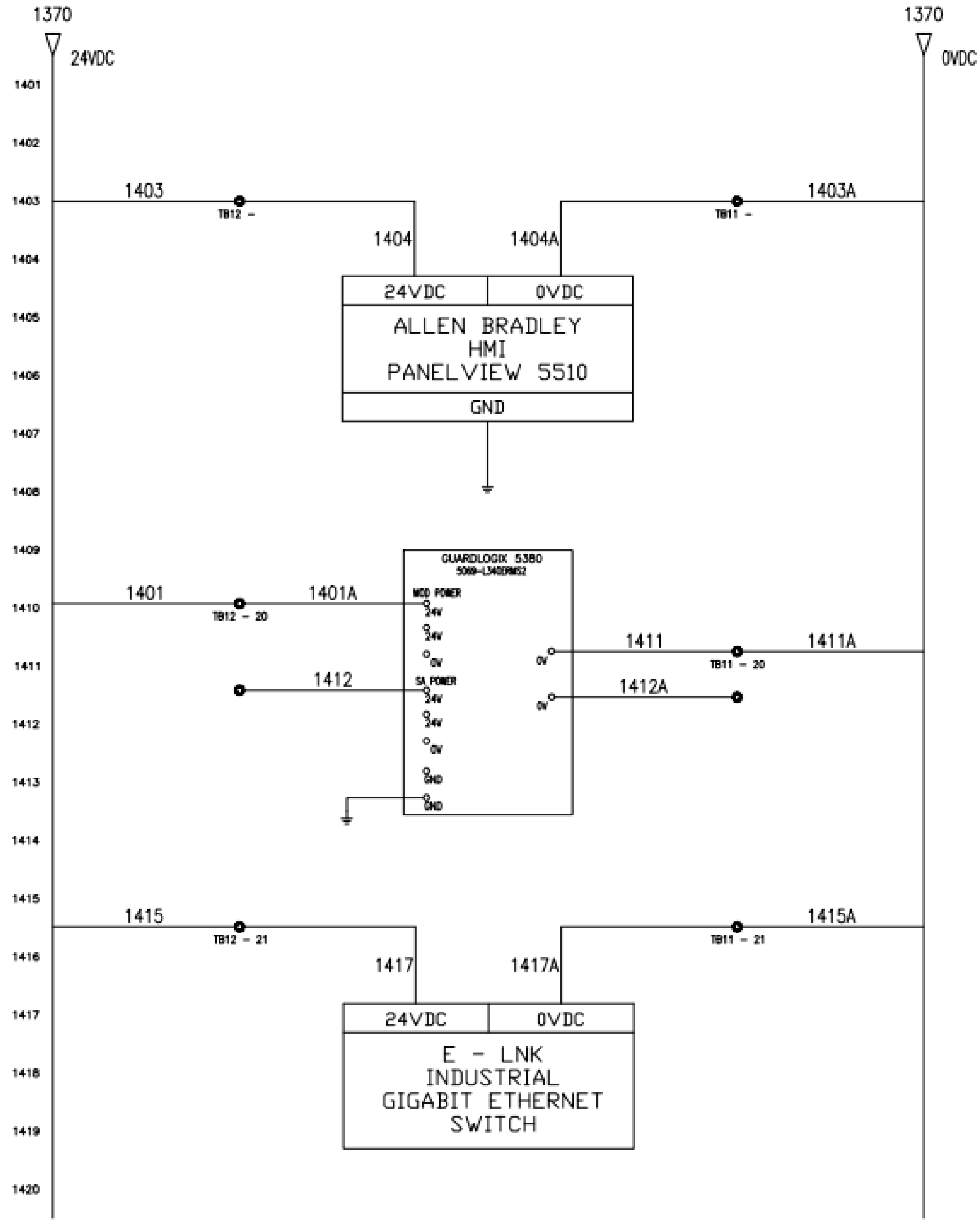


Figure 26: PLC, HMI & Ether Switch Drawings

Schematic 13 shows power connections for the AB HMI PV5510, AB GuardLogix 5380 PLC and a E-LNK industrial ethernet switch.

Schematic 15:

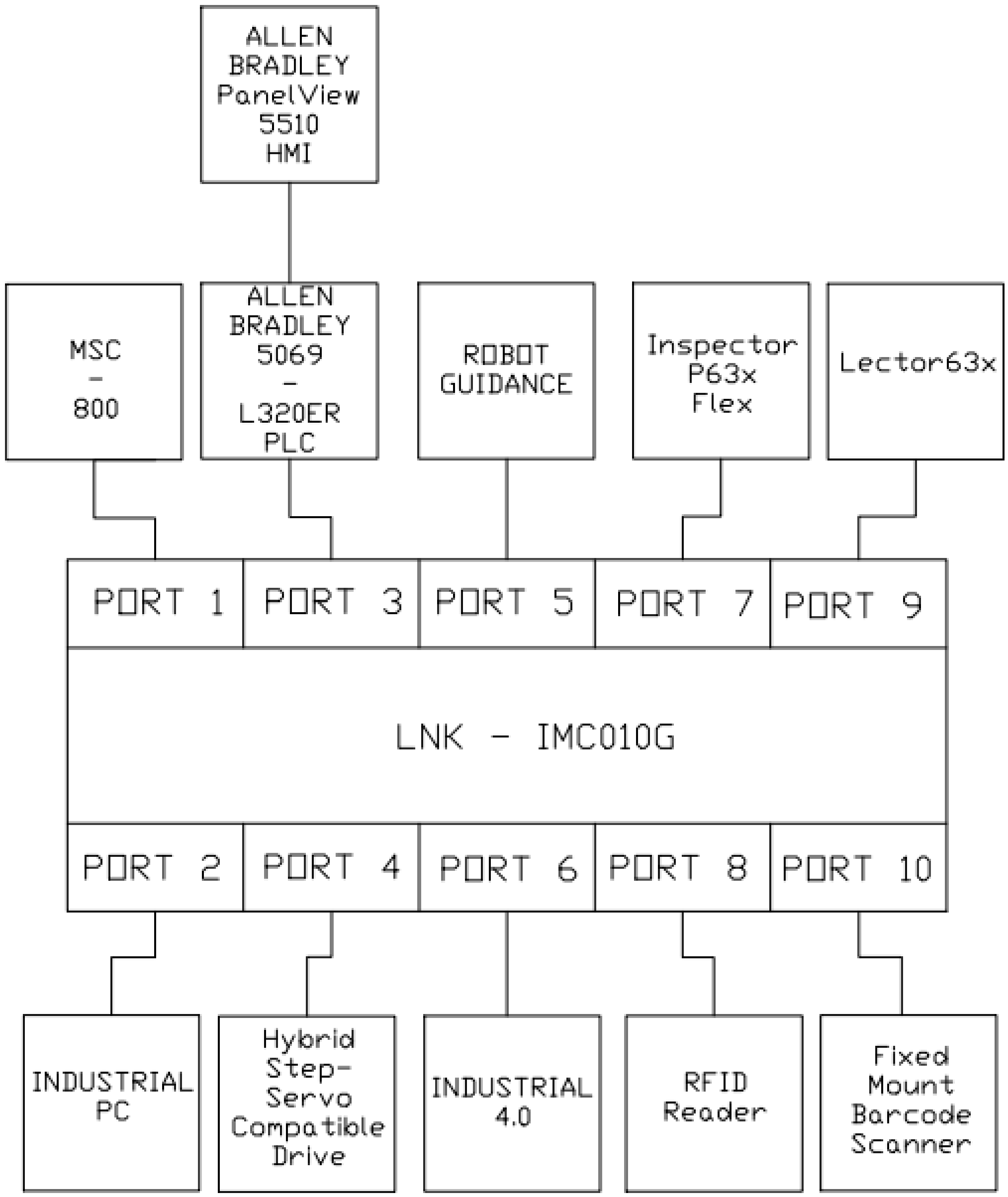


Figure 27: Ethernet Switch

Schematic 14 shows the ethernet port mapping for the ethernet switch.

2 ports are assigned for the integration of the 3 cells, all other ports are being used for internal connections.

Results/Data Analysis

PLC Logic

The PLC model used for this project is the 5380-L320ER PLC. Two major add-ons, one for object detection/identification and the other for the high-speed barcode scanner. The rotary actuator is coded in the PLC after downloading EDM files from the oriental motor website. All the sensors are added as function blocks, AOI or data types for generic ethernet module configuration. All cameras were interfaced using either EDS files or generic ether modules, L5X files, AOI's or data types from the manufacturer.

Starting the process would require the operator to release the E stop, press reset and also toggle master start on the HMI, all the safety logic was configured on SICK safety designer and brought in as a normally closed input to the PLC, it has been shown in the attached figure.

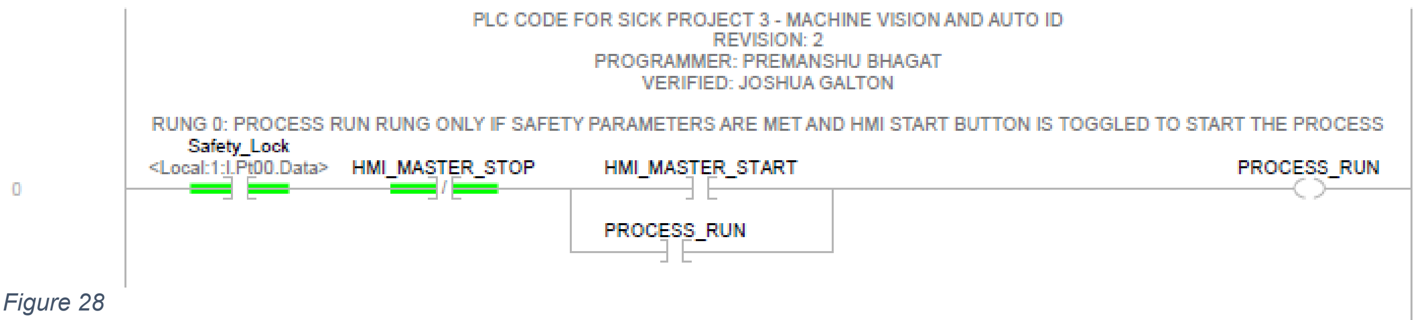


Figure 28

Shown below is a basic alarm routine for these basic procedures:

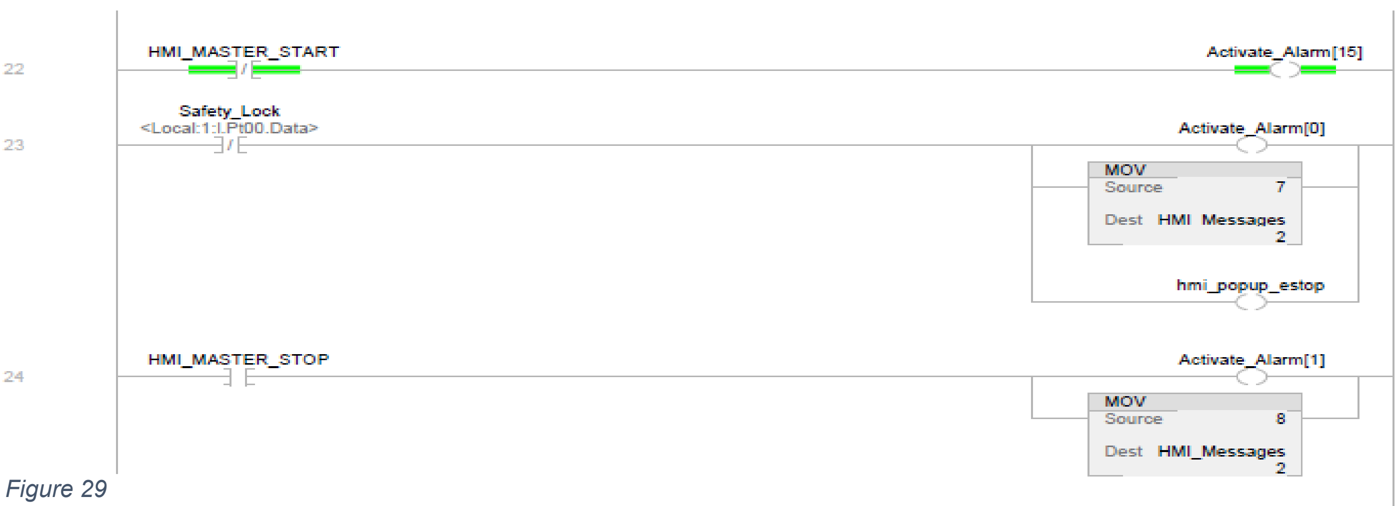


Figure 29

Once the process has been started 2 addons are activated to trigger the 2 main processes at the same time. One of them being object detection and the other being rotary operation.

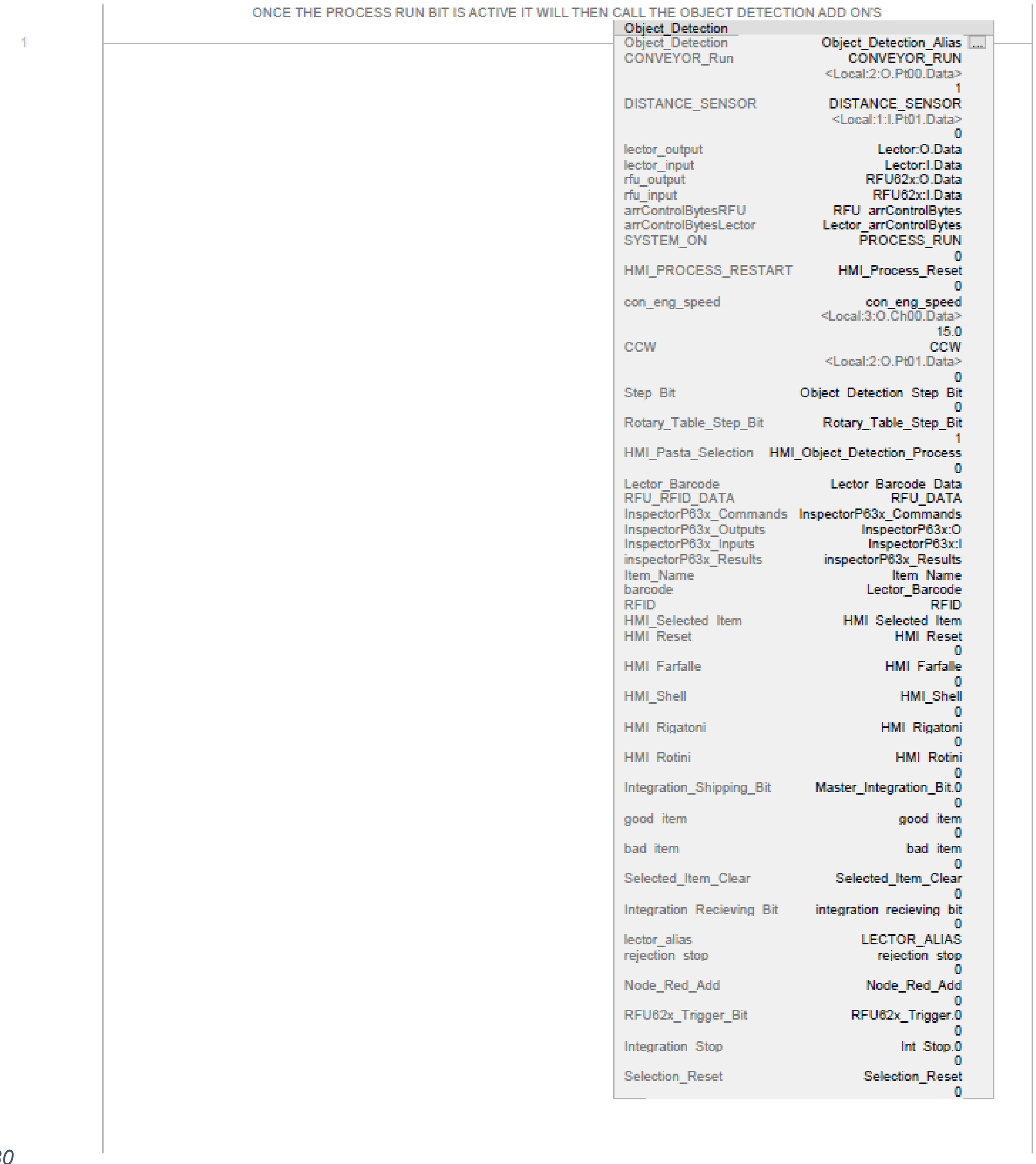


Figure 30

![HUMBER logo]

The second major addon called in rotary operation and it is parametrized in the main routine as follows:

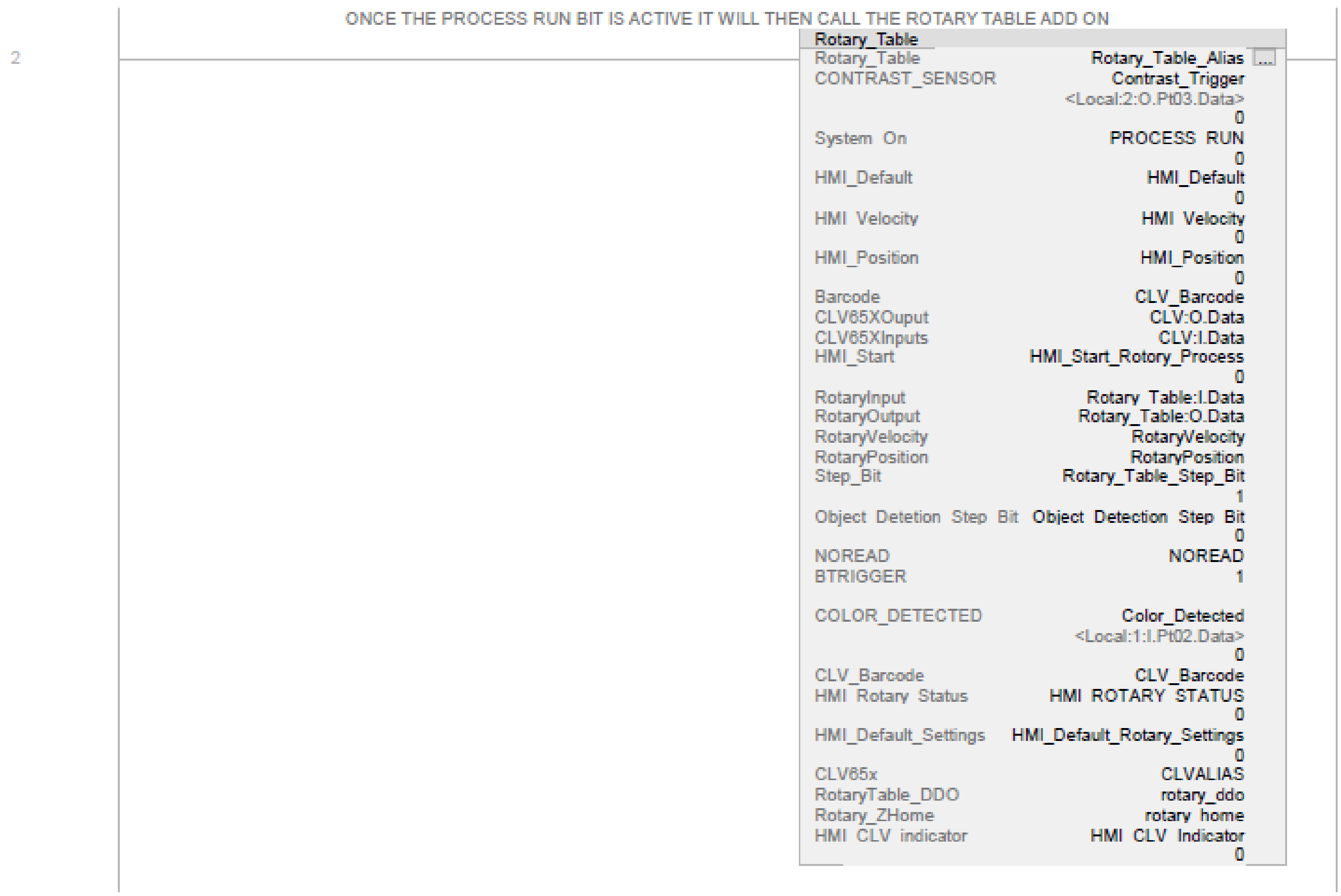


Figure 31

For the object detection process, selecting a pasta type is a necessity which is achieved using the following logic:

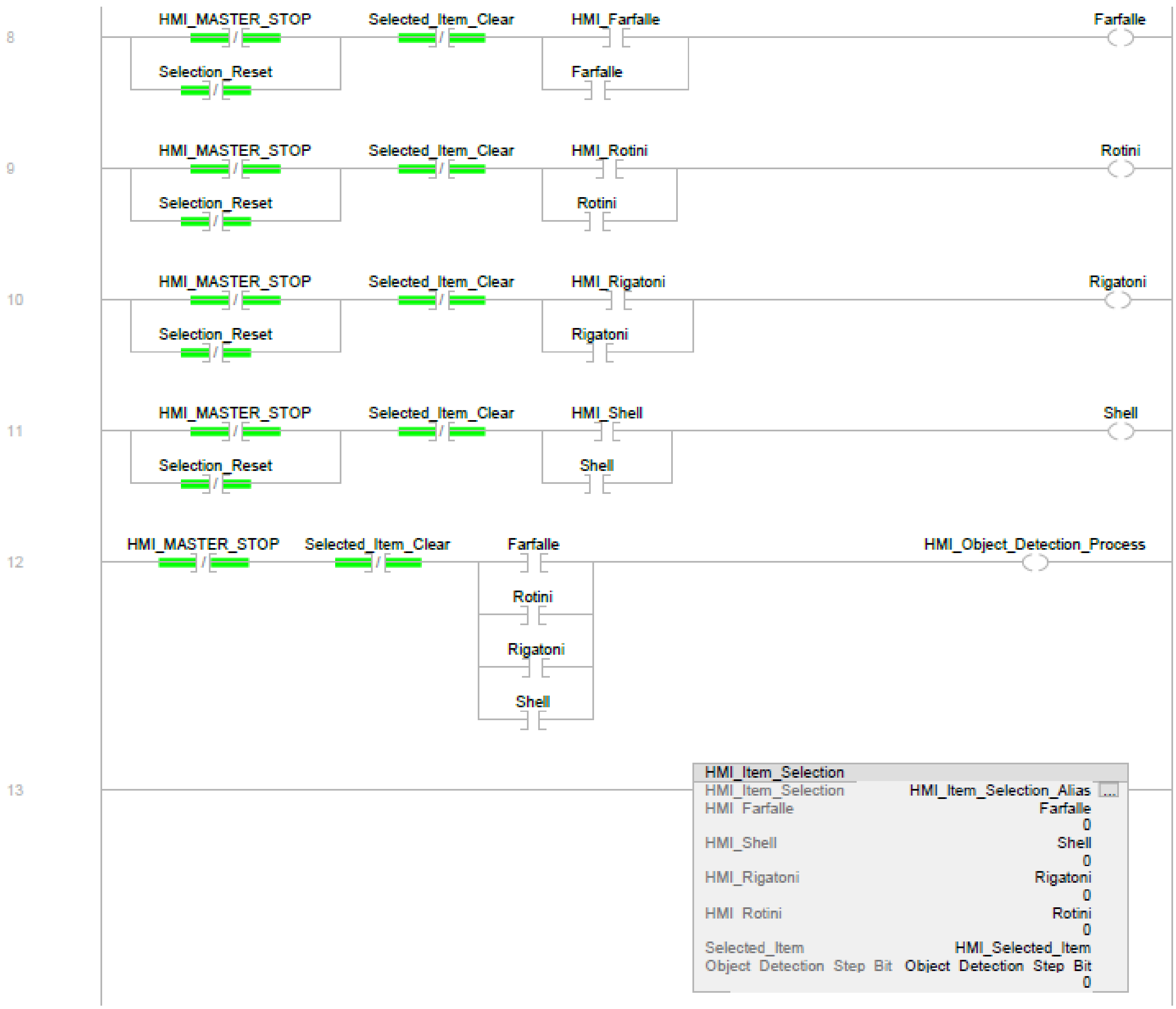


Figure 32

To control the stopping of the conveyor we made a logic that took the size of the object and max speed to calculate stopping time. A snippet of the code has been attached below:

```
Con_Max_Speed := 1.67;
Item_Size := 184.15;

if step_0 or step_105 then
    Stop_Time := (Item_Size/2)/((Con_Max_Speed*1000*(1/60000))*(Con_Eng_Speed/100))/10;
end_if;

if step_4 then
    Stop_time1 := 330.2/((Con_Max_Speed*1000*(1/60000))*(Con_Eng_Speed/100))/10;
end_if;
```

Figure 33

To push the selected item into the object detection bit we used the following routine to move a string value into the selected item bit of the add on using an HMI selection button, a snippet of the code has been attached below:

```
if Object_Detection_Step_Bit then
    if HMI_Farfalle then
        Selected_Item := 'FARFALLE';
    elsif HMI_Rigatoni then
        Selected_Item := 'RIGATONI';
    elsif HMI_Rotini then
        Selected_Item := 'ROTINI';
    elsif HMI_Shell then
        Selected_Item := 'SHELL';
    end_if;
end_if;
```

Figure 34

To compare the selected item with the actually loaded item we came up with a logic that had predefined barcode data and linked string data for Lector P63 barcode reading and compare those to the Inspector P63x job ID output string, a snippet of the code has been attached below:

```
rigatoni_inspector := 'RIGATONI';
rigatoni_lector := '076808011111';
rotini_inspector := 'ROTINI';
rotini_lector := '076808011104';
shell_inspector := 'SHELL';
shell_lector := '076808517989';
farfalle_inspector := 'FARFALLE';
farfalle_lector := '076808011128';

if (step_bit) then
    reject := 0;
    approved := 0;
end_if;

if (step_5) then
    if(selected_item = item) then
        if (item = farfalle_inspector) then
            barcode_data := farfalle_lector;
            approved := 1;
        elsif (item = shell_inspector) then
            barcode_data := shell_lector;
            approved := 1;
            elsif (item = rotini_inspector) then
            barcode_data := rotini_lector;
            approved := 1;
            elsif (item = rigatoni_inspector) then
            barcode_data := rigatoni_lector;
            approved := 1;
        end_if;
    else
        reject := 1;
    end_if;
end_if;

if (step_8) then
    if (lector_barcode_data = barcode_data) then
        approved := 1;
    else
        reject := 1;
    end_if;
end_if;

if approved and step_6 or step_9 then
    approved := 0;
end_if;


if reject then
        conveyor_energize := 1;
        conveyor_direction := 1;
end_if;


if step_bit then
    conveyor_energize := 0;
    conveyor_direction := 0;
    reject := 0;
end_if;
```

Figure 35

There are a total of 11 steps for our stand-alone cell, 3 error steps, 10 integration intervention bits, the step logic for the main step bit has been explained below:

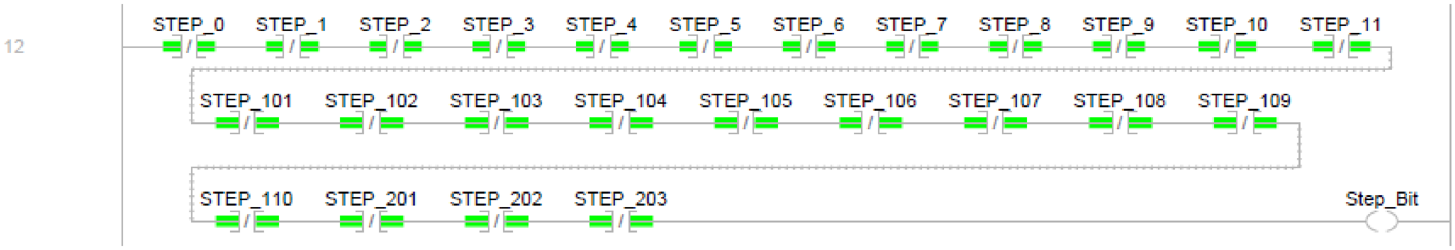


Figure 36

Step 0 activates once the item has been selected and the step bit is active while integration bit is deactivated, a snipped of the code is attached below:

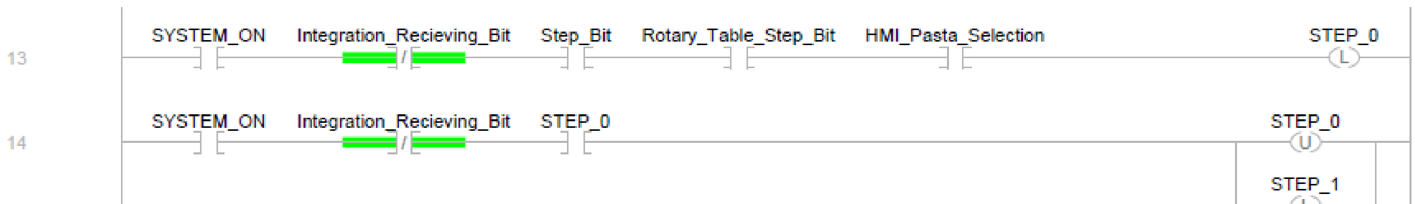


Figure 37

Once the distance sensor is broken and the encoder simulation timer is done, step 3 is latched which triggers Inspector P63x to take a picture of the product, once inspector data storage is accomplished an item storage timer is activated, a snippet of the code is attached below:

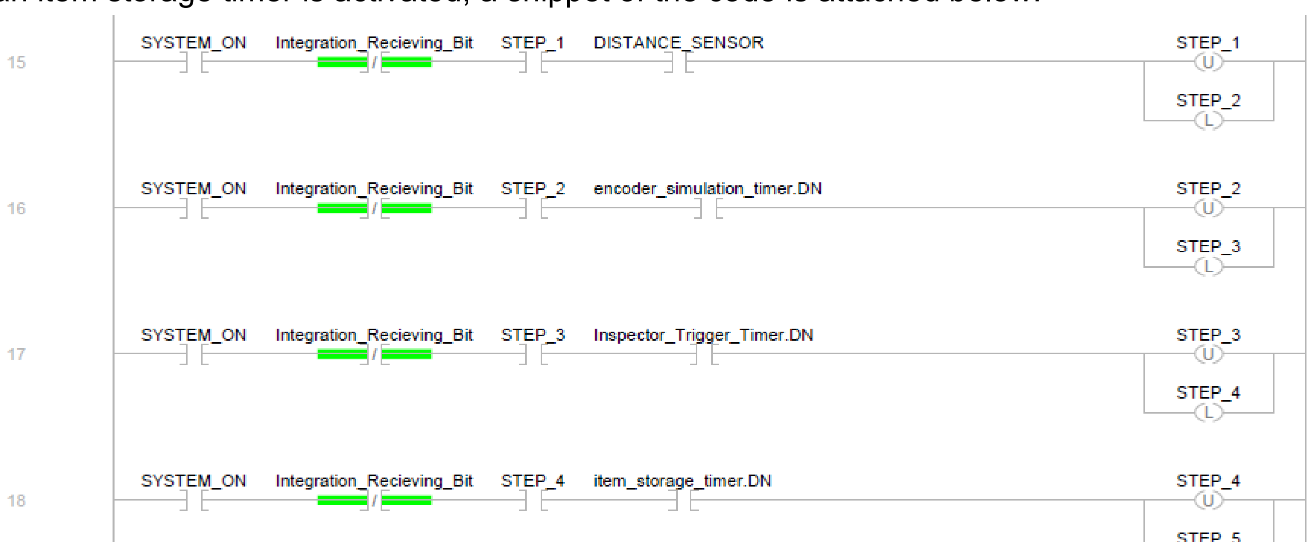


Figure 38

After inspector is done, lector gets triggered to collect the barcode data, once the barcode data has been collected a barcode storage timer is activated which then reactivates the good item bit which triggers RFU 620 to collect RFID data, a snippet of the code has been provided below:

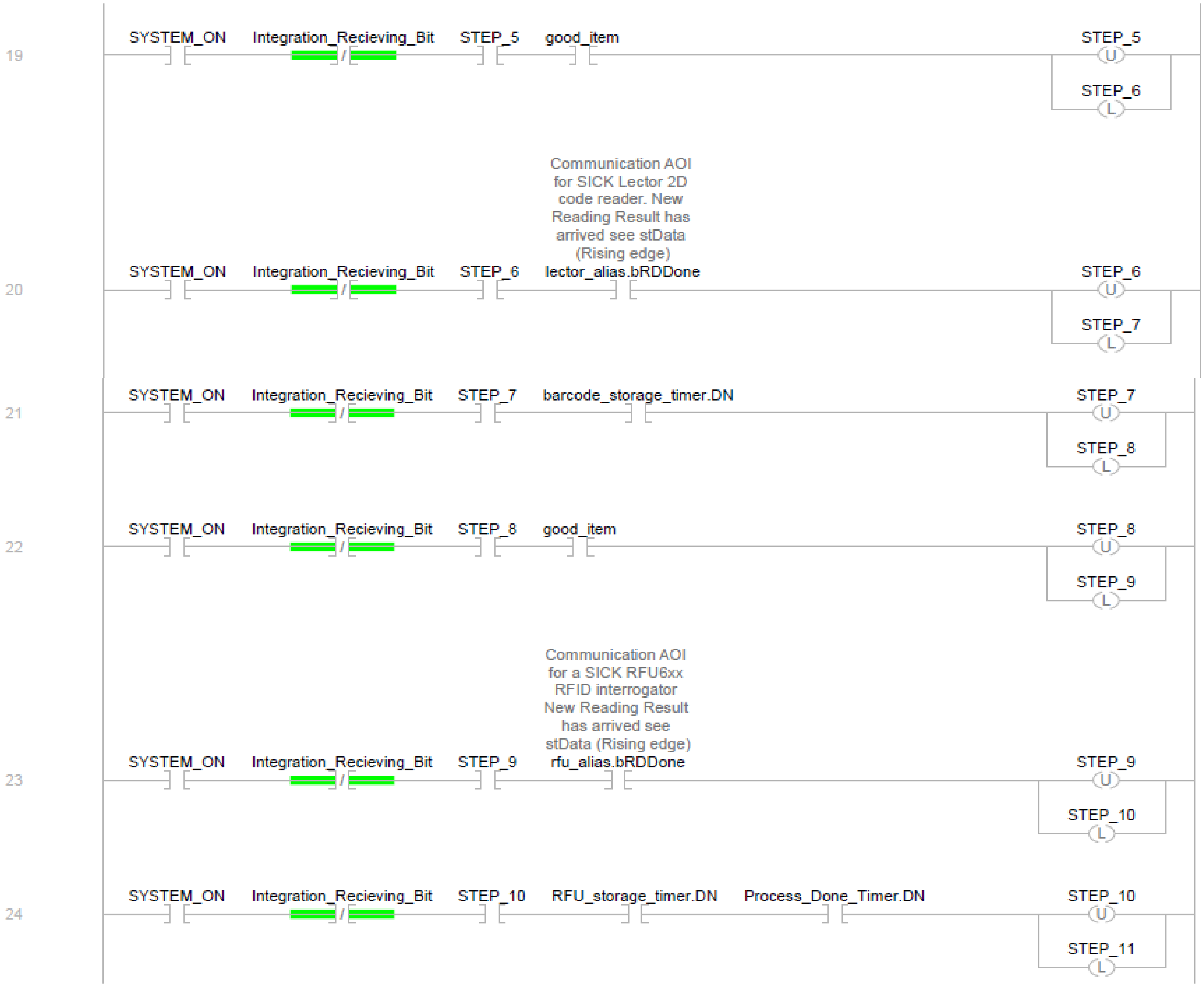
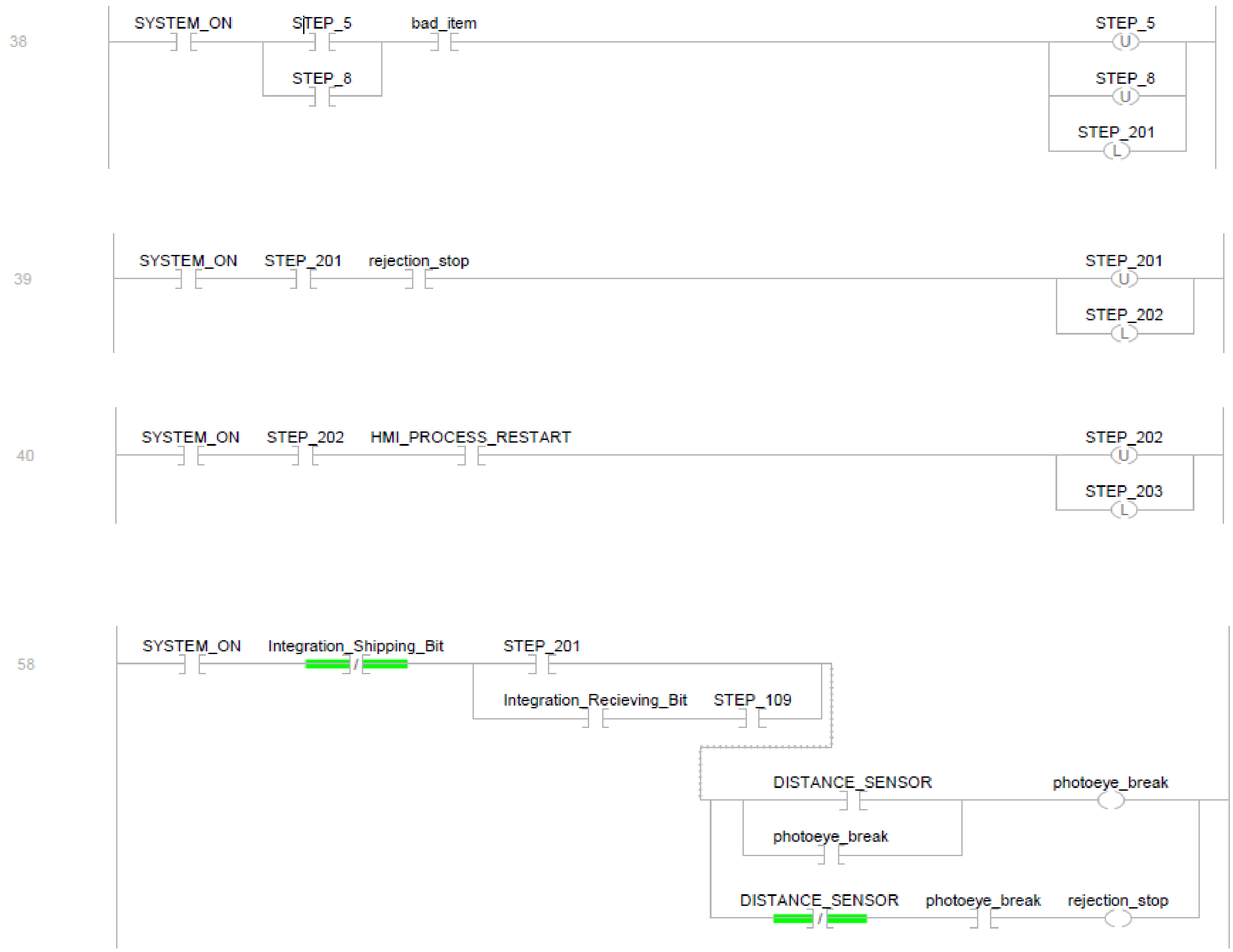


Figure 39

Once the process is complete an HMI reset needs to be pressed to reset the process and enable product selection on the HMI.

If the product is identified to be a bad item by inspector a bad item bit is triggered which is aliased to a rejected bit on the controller, it unlatches the lector barcode collection and RFU data collection steps and latches an error bit which reverses the conveyor direction and energizes it until the photoeye is broken and a new product is selected, a snippet of the logic is provided below:



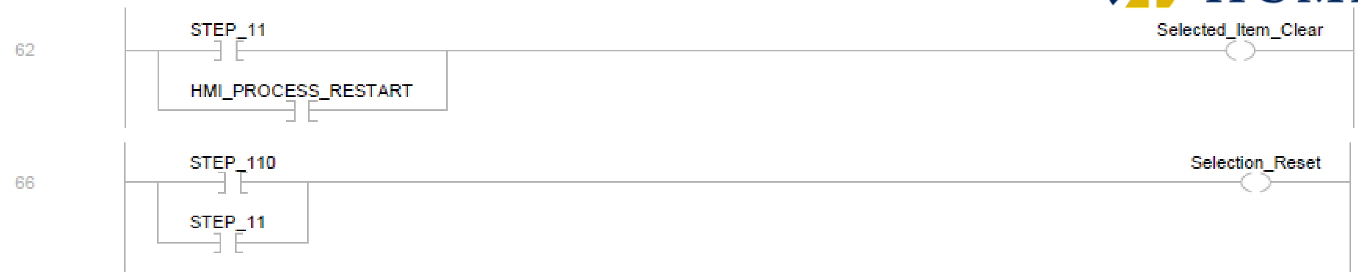


Figure 40

provided below is the logic snippet for all conditions that energize the conveyor and also provide directional control to the conveyor

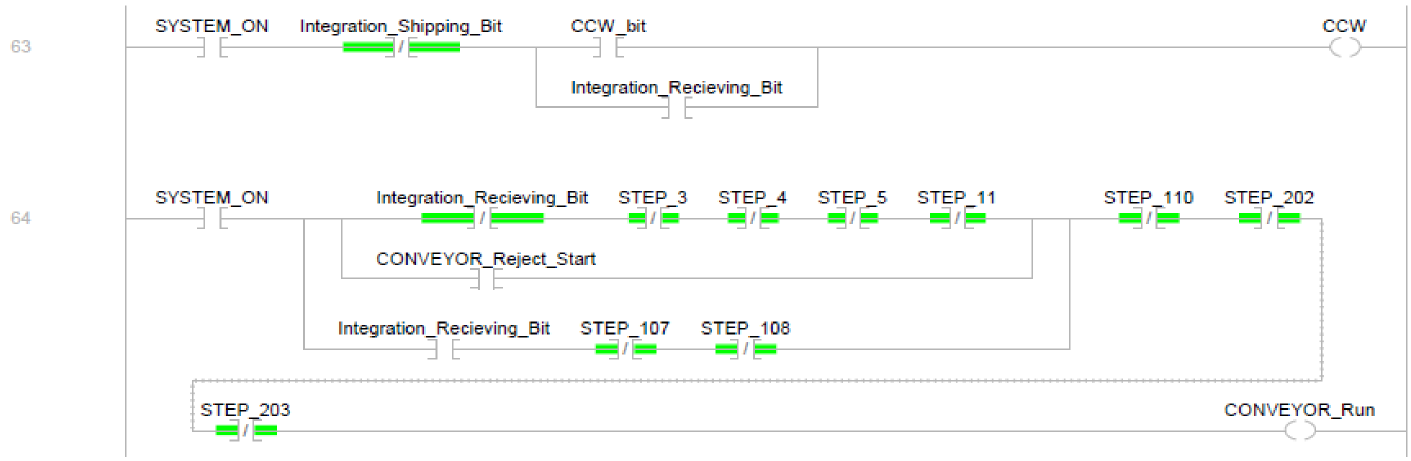


Figure 41

the step bits used to trigger inspector, lector and RFU are referenced from the EDS file taken from SICK's website, a snippet of the logic has been provided below:

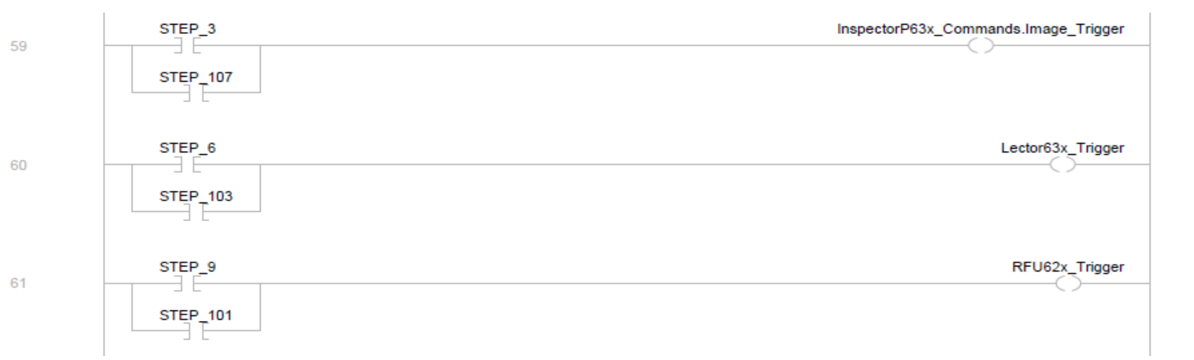


Figure 42

A code snippet for the encoder simulation timer is provided below:

Figure 43

Figure 44

Timer logic for our whole operation is interconnected with values moving around among the sensors, a snippet of the code is provided below:

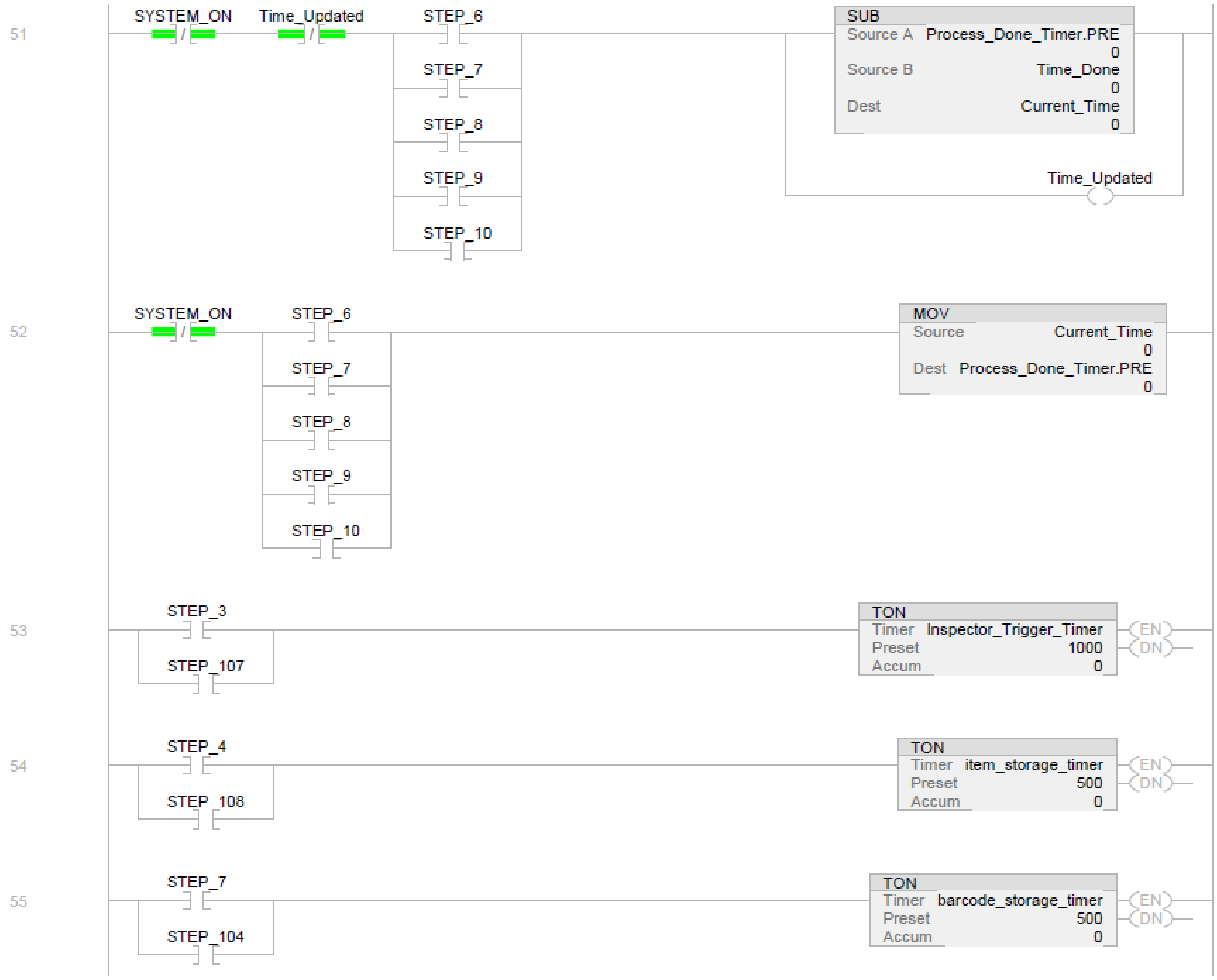


Figure 45

For integration of all the three cells a produced/consume tag logic was used to manipulate bits within cells, an integration shipping and integration receiving bit was added in parallel to every bit that was involved in the integration process. For the receiving process of the integration with the robot guidance cell being the master PLC, we used a reverse logic by making RFU the first sensor to trigger after the photoeye on I4.0 cell was broken, a snippet of the receiving code has been provided below:

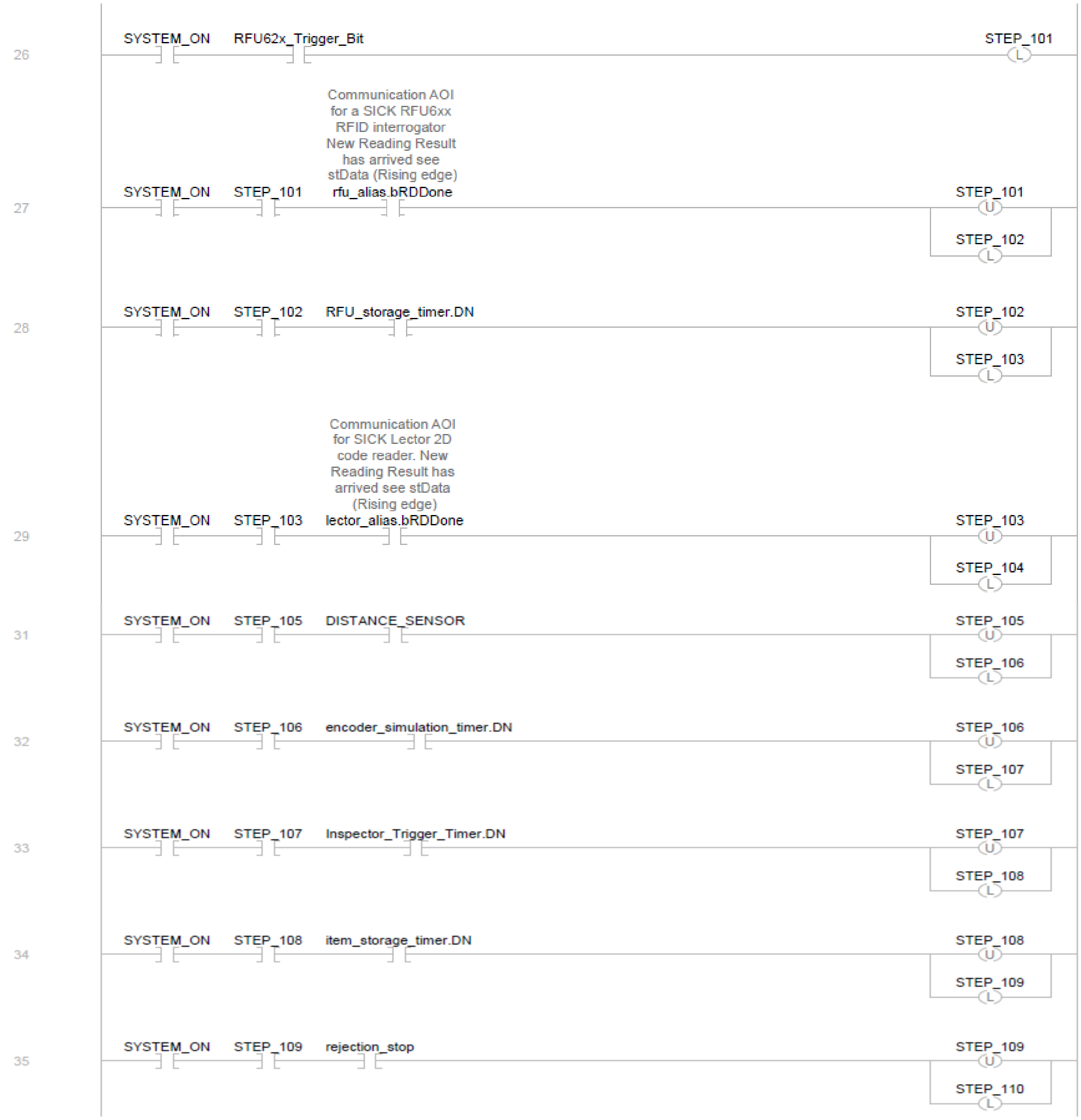


Figure 46

In order to start the shipping process of the integration, our cell acts as a master PLC and master tag producer which turns on the other two conveyors and good or bad item data is sent to the other cell for the processes to take place, due to trispector's hardware limitation on the robot guidance cell a move command moves a value of 15% into the conveyor speed during integration, in order to have the robot on the robot guidance cell not enter an infinite loop, we had to make sure all the bits are unlatched for the product quality, a snippet of the code has been provided below:

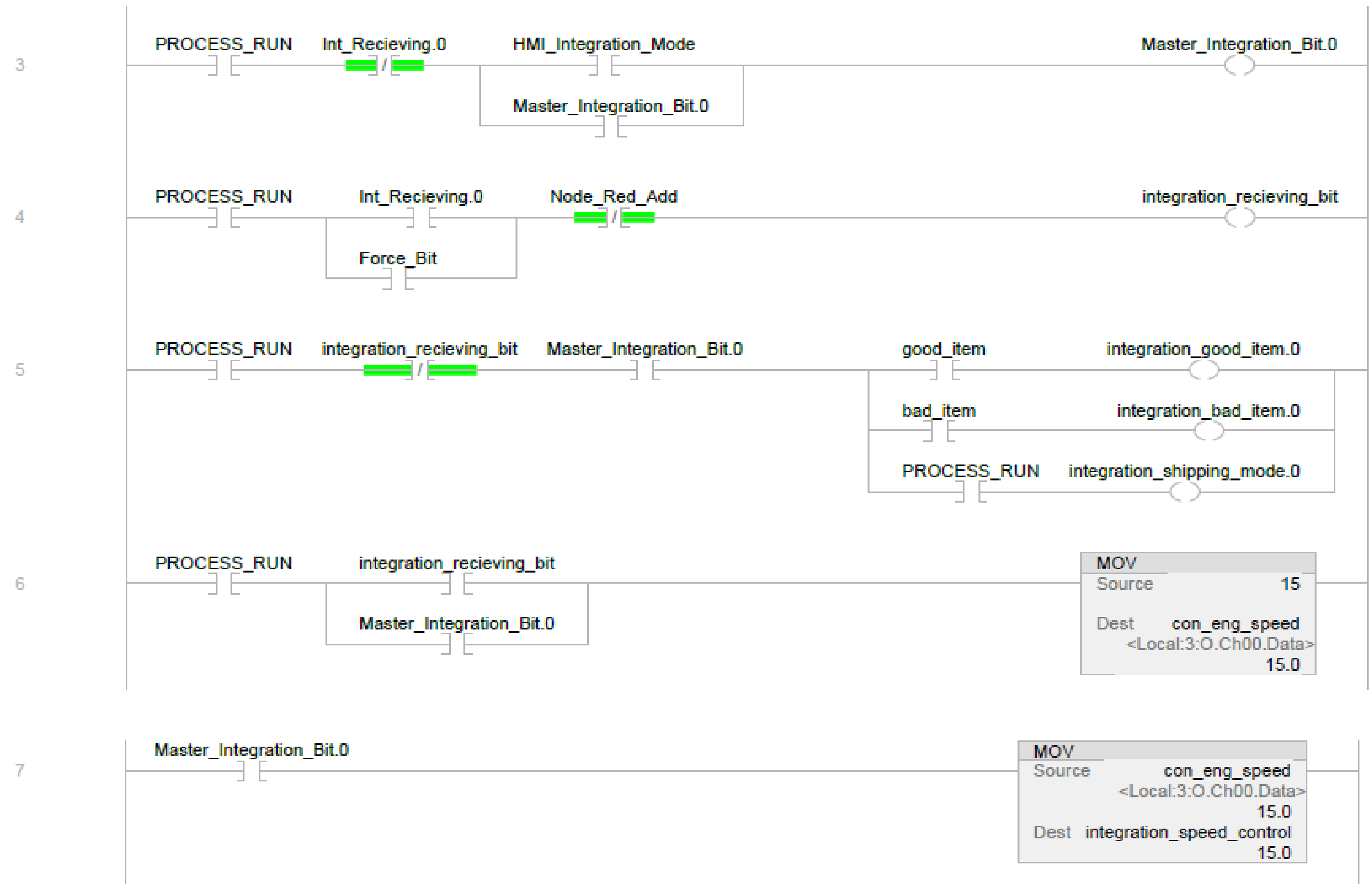


Figure 47

For the Rotary operation once KTS gets triggered form the set color we latch the activated bit for use to start the main process, if the system is not on we move a no read value into the CLV barcode reading result, a snippet of the code has been provided below:

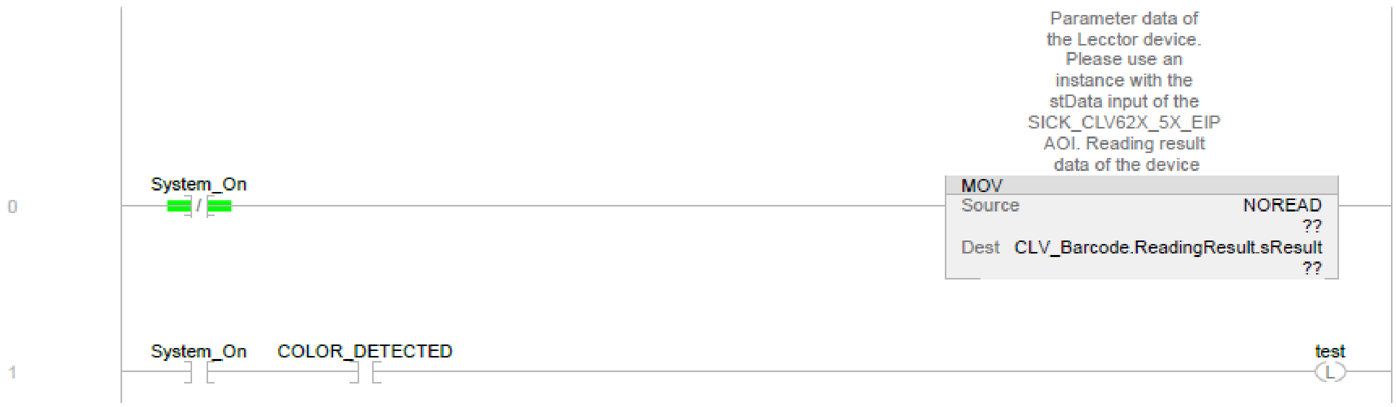


Figure 48

In order to control the stopping and starting of the hollow rotary actuator and home position assignment we assign use status done bits and set execution bit to instantly stop the rotary from running, doing this may cause the rotary to torque out which would trigger a DDO error bit on the AOI. A snippet for the logic has been provided below:

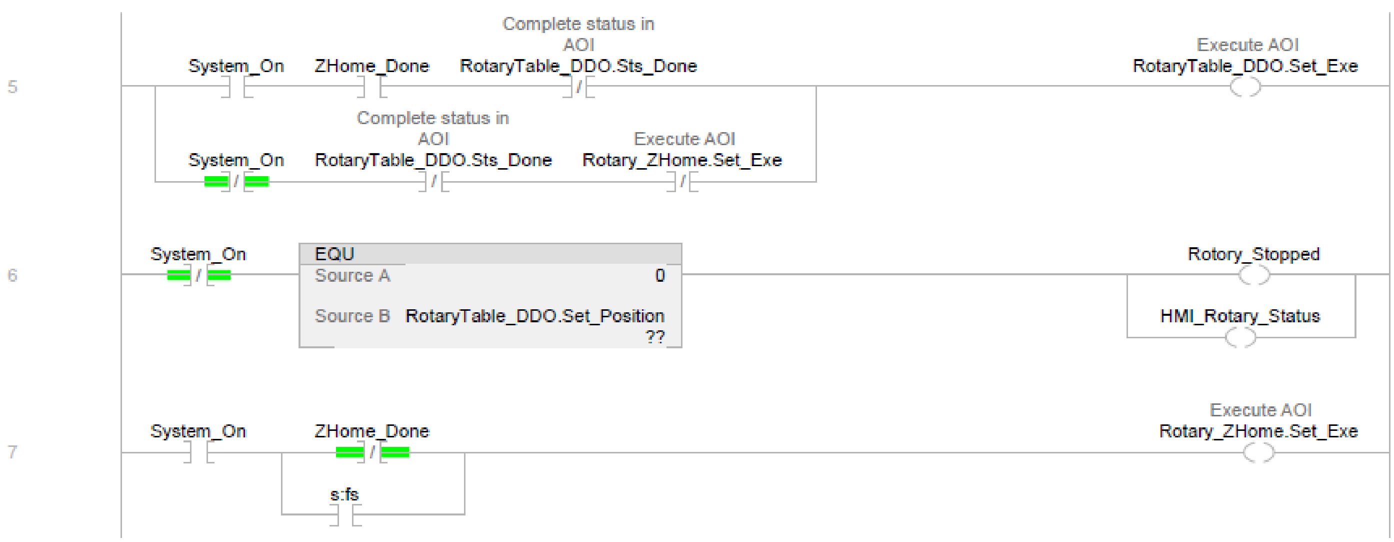


Figure 49

In order to move default speed and displacement values into the rotary DDO set position and set velocity bit, we use a move command, we move a value of 10000 to the velocity bit on the add on and a value of 1000000 into the displacement of the AOI bit, a code snippet for the operation is provided below:

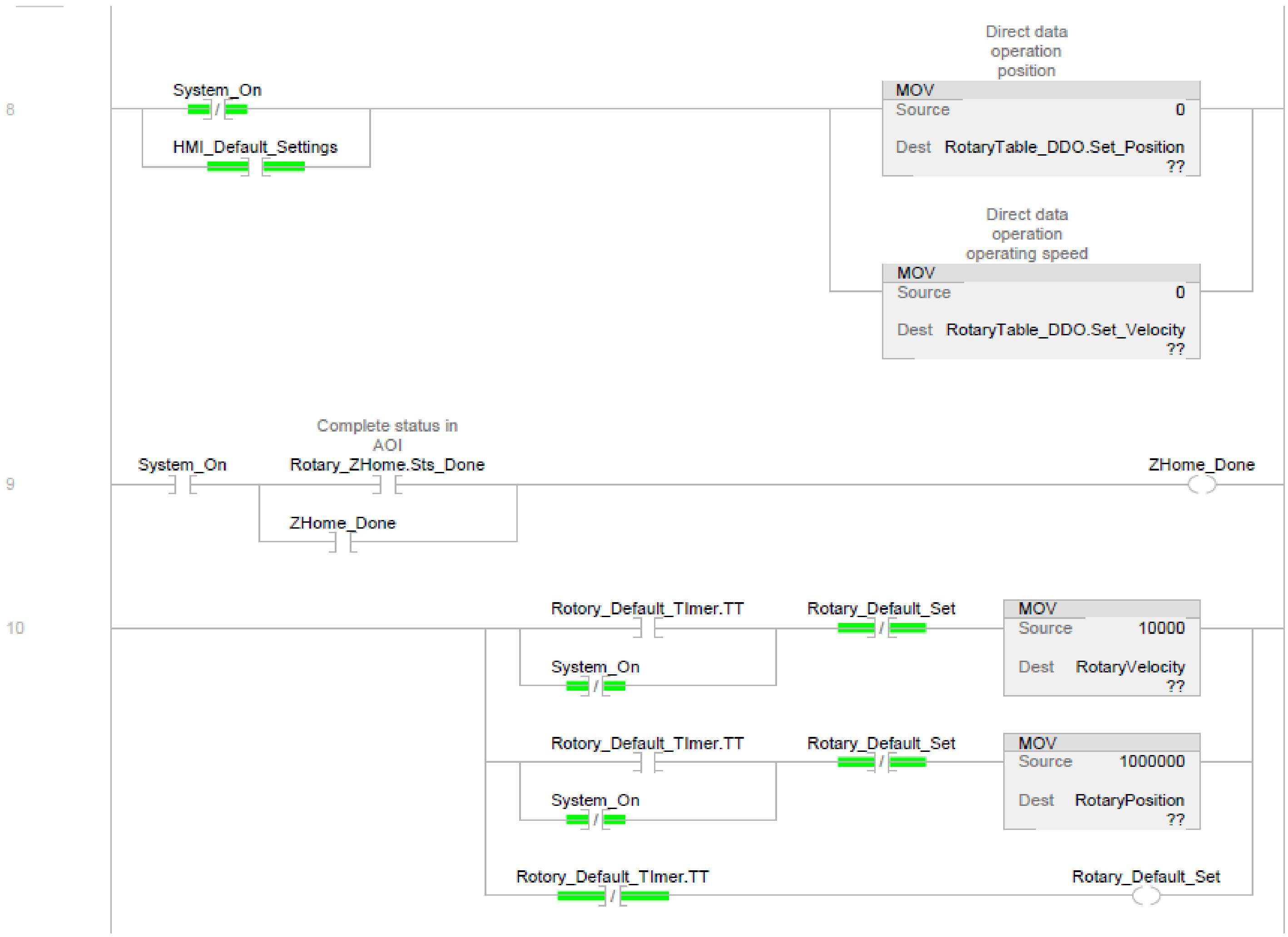


Figure 50

In order to manually send enter a value into the velocity and displacement parameter of the rotary we use a simple piece of move logic to move values input into the HMI to the AOI bits, in order to prevent the motor from torquing out by suddenly switching speeds, a wait timer has been added to wait for 2 seconds before restarting the motor with default speed and displacement values, a snippet of the code has been provided below:

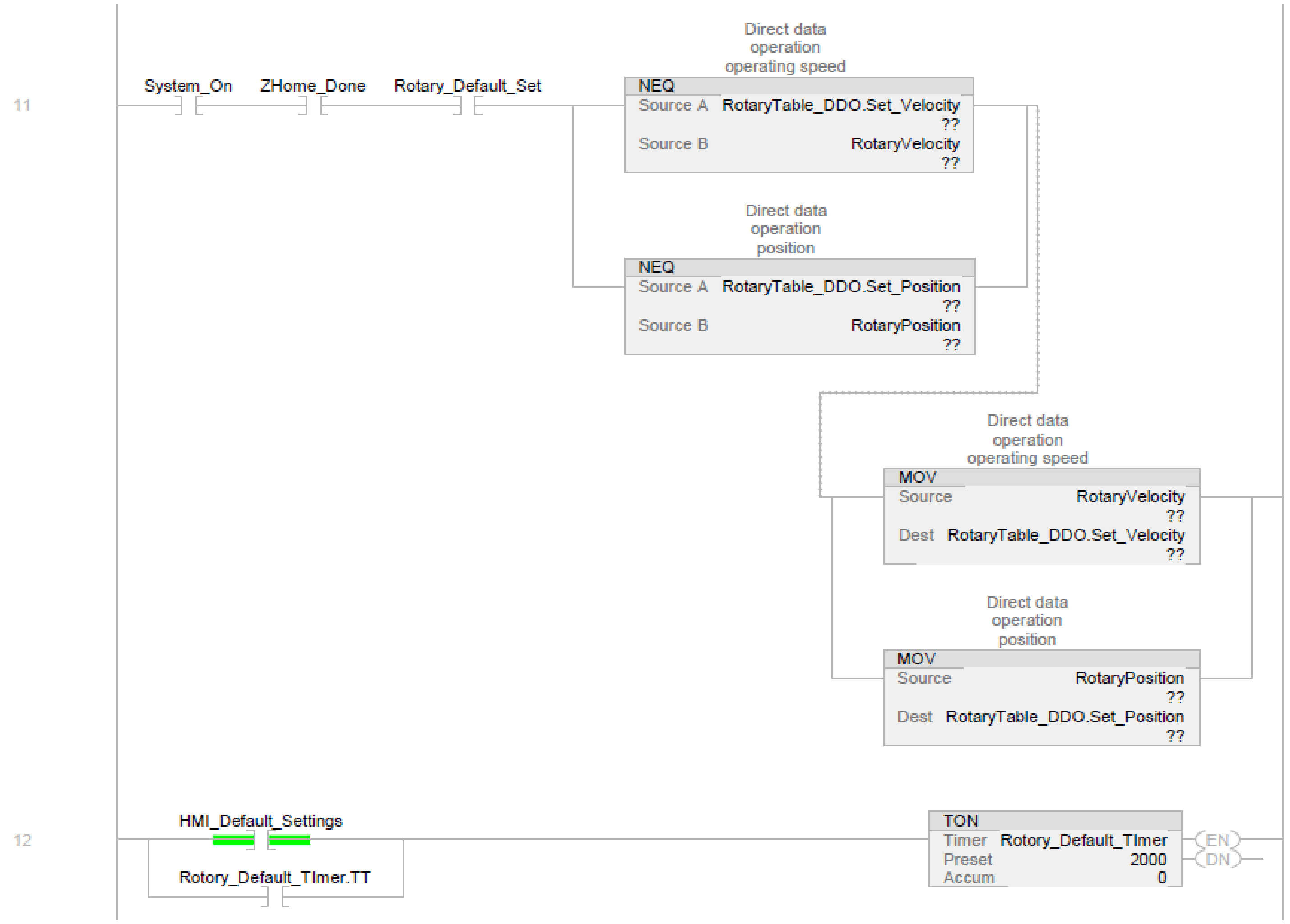


Figure 51

Step logic is used to control the high-speed barcode collection, once a color is detected and HMI button is pressed to trigger a read cycle on the CLV, once the data has been collected for the barcode, it is then sent to a barcode storage bit from where it is then cleaned up, a snippet of the step logic has been provided below:

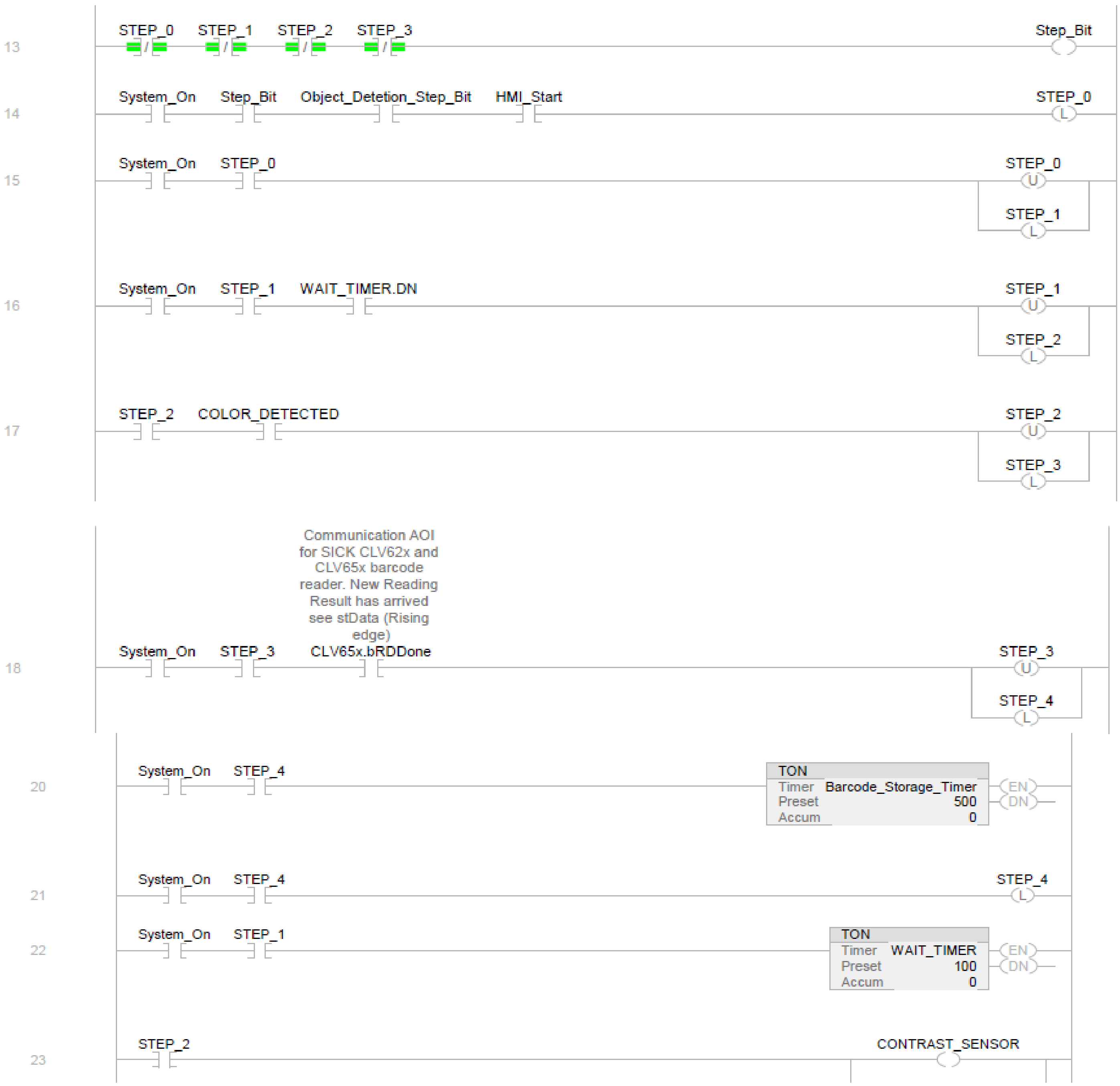


Figure 52

In order to clean up the garble data collected alongside the regular barcode and RFID data we added a filter logic alongside the data collection logic on the PLC, it runs by collecting the length data and isolating a certain length based on manual counting, the remainder garble data is removed and the clean barcode, RFID and Inspector job string data is stored, a snippet for the garble data collection has been shown below for all sensor data:

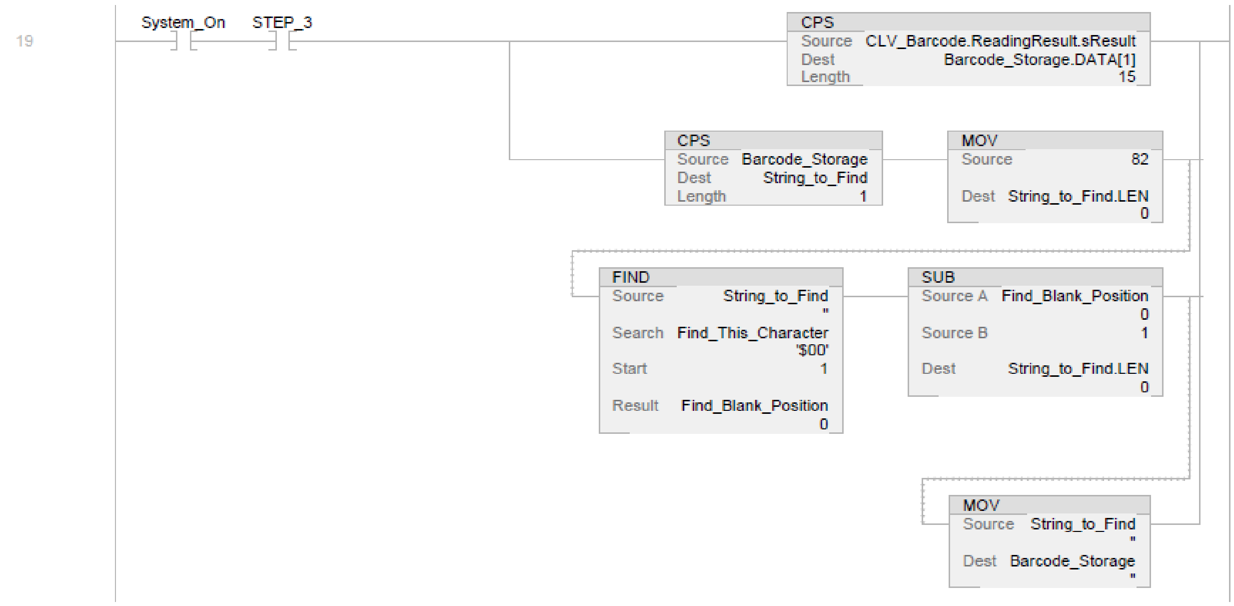


Figure 53

Inspector P63x string garble data collection code snippet:

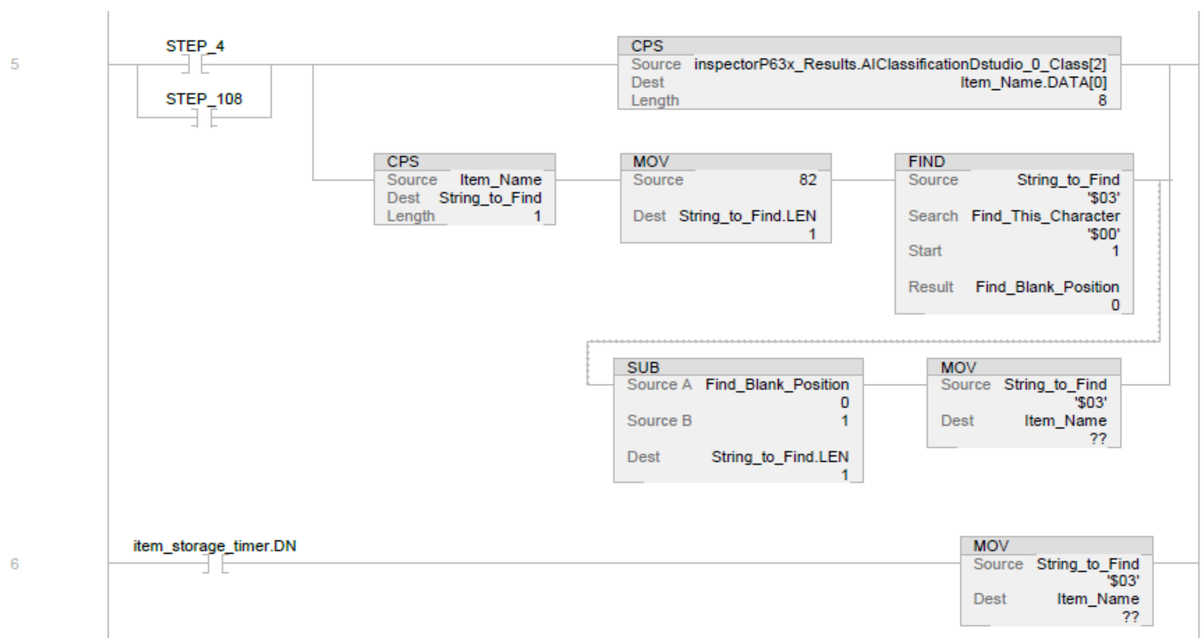


Figure 54

Lector P63 string garble data collection code snippet:

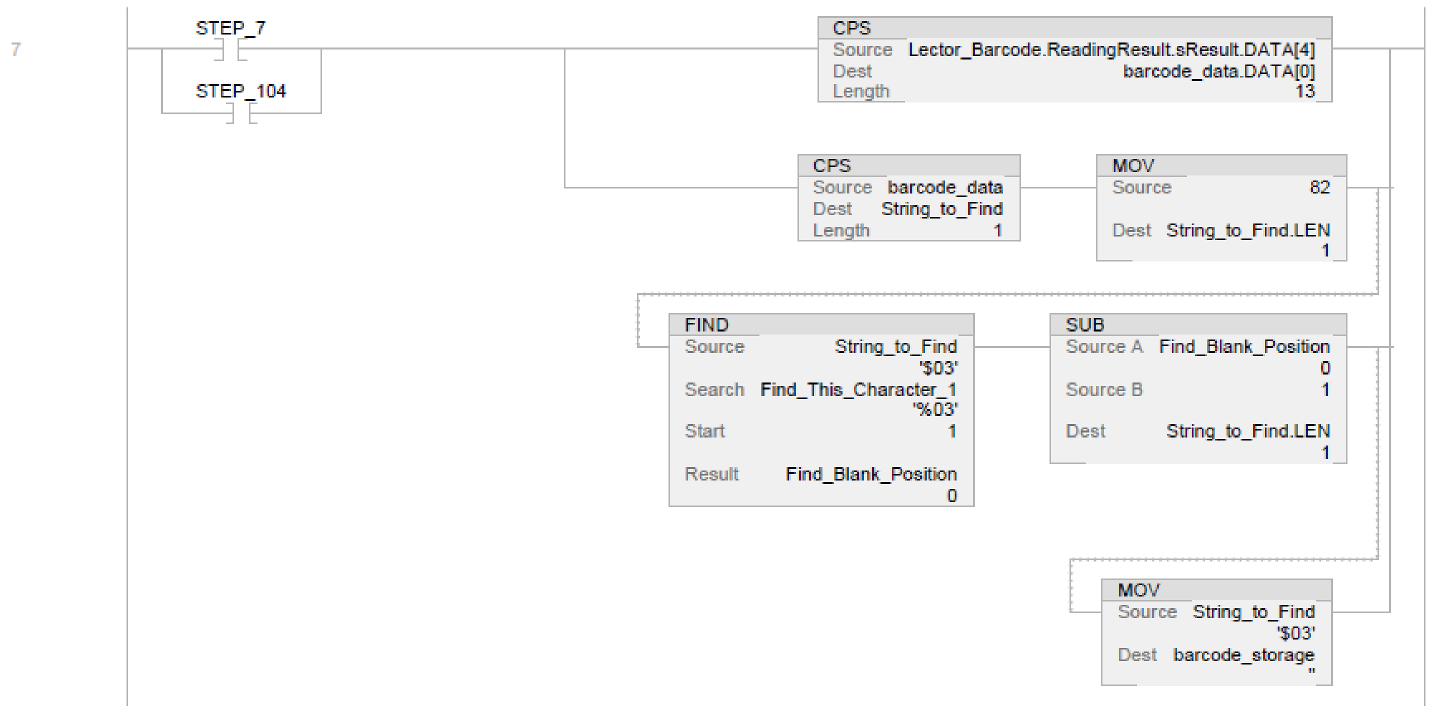


Figure 55

RFU 620 string garble data collection code snippet:

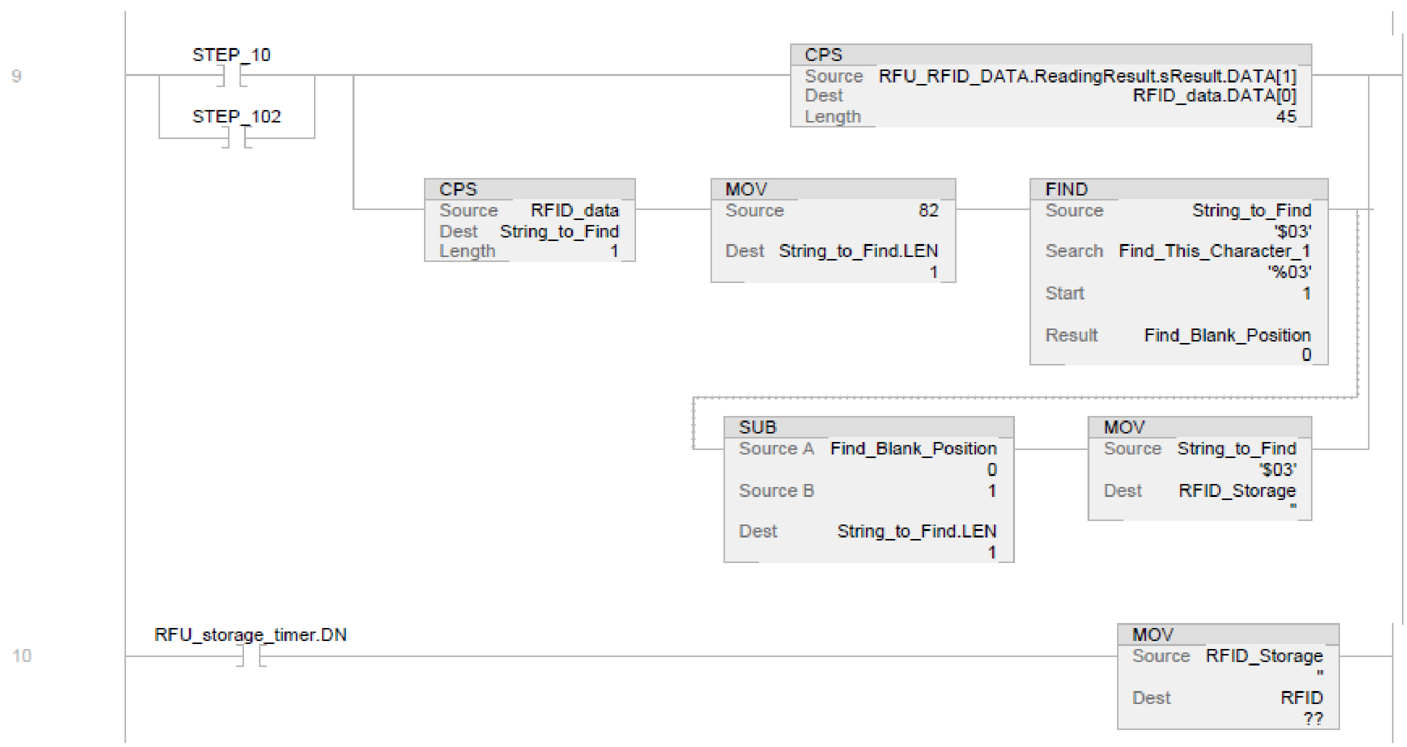


Figure 56

There was an alarm routine dedicated to different conditions on the PLC code, different alarms were activated at different times in the cycle, all sensor error alarms were tied to the bError bit referenced from the AOI instruction, a snippet of error alarms for Lector, Inspector, RFU, CLV, and rotary motor is attached below:

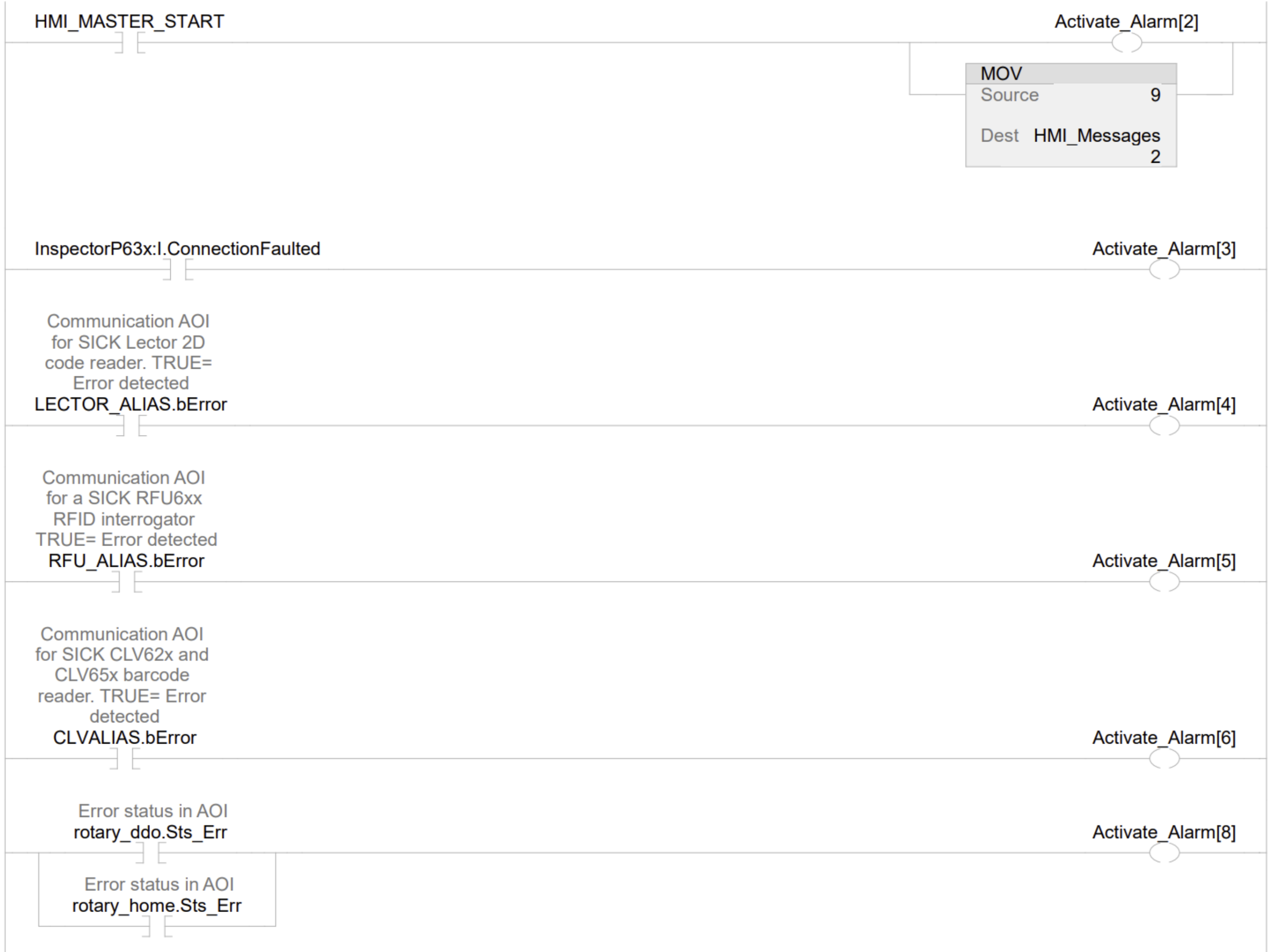
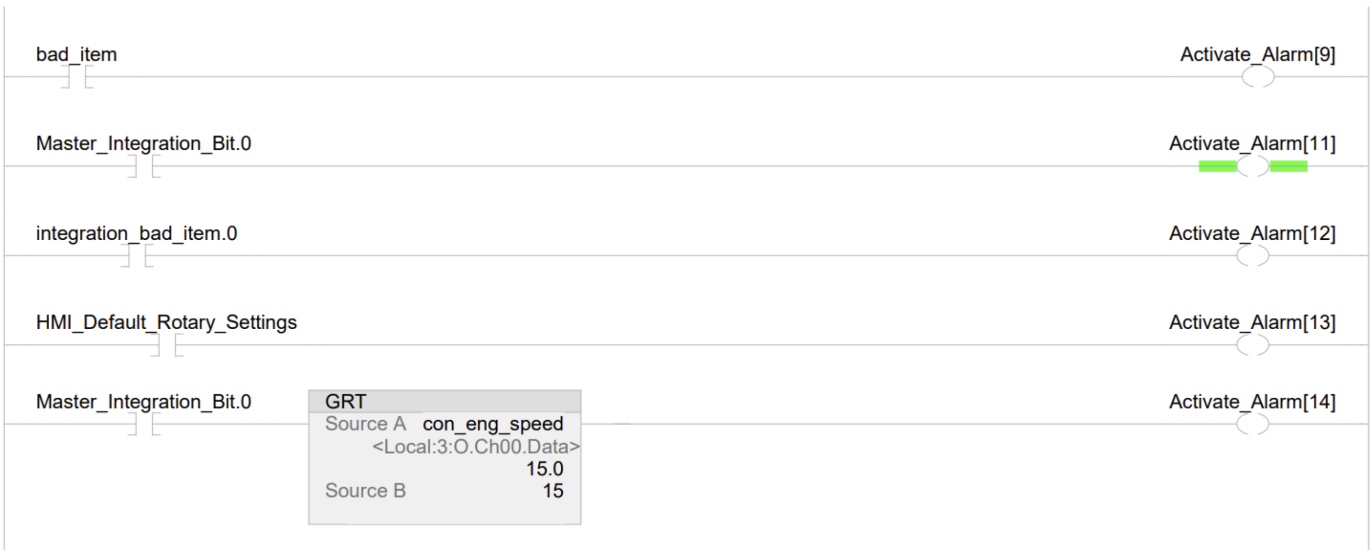


Figure 57: Sensor error alarms

Another set of alarms was added for the integration portion of the project and the item detection part, if the item was good then an alarm would prompt a user to check the HMI for more information, if the product was bad then an alarm would request the operator to load a piece that was selected. One of the alarms is for the condition of the conveyor speed exceeding 15% during the integration portion.



To trigger the HMI project events we used a message bit that would be a DINT binded to a certain value and would trigger an event action in case that event happened in the HMI.

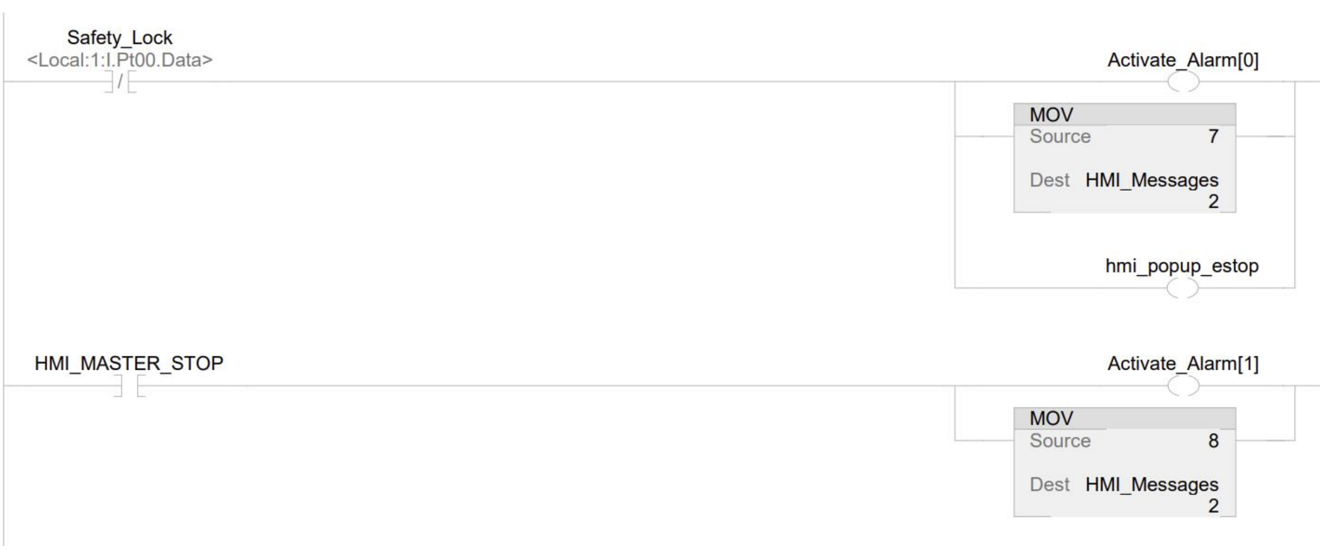


Figure 58

Inspector P63x- Vision System

The main camera for the object detection process was the SICK inspector P63x which was used to identify different kinds of pasta, it is a 2D black and white camera with deep learning abilities, a deep learning model needs to be trained on a platform called SICK DStudio which is then deployed onto the camera.

In order to train the AI model, we create a dataset for pasta and add all 4 different classes namely Rigatoni, Rotini, Shell and Farfalle and upload 100 items (pictures in different configurations) for each of these classes, then we proceed to freeze the data set and create a project out of it which can be trained to identify those products and output different job D’s and a string associated to the job ID.

An example of an evaluation done by inspector is show in the picture below:

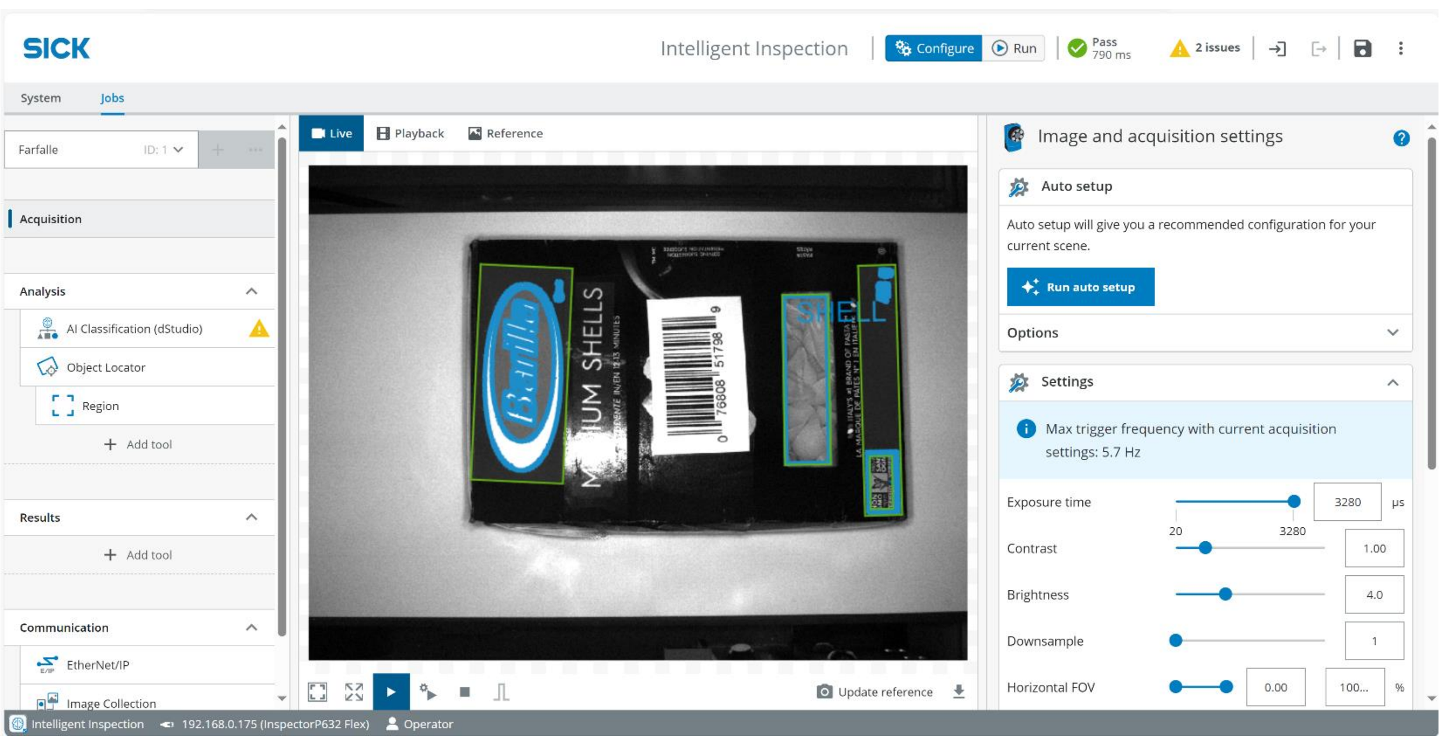


Figure 59: Shell Evaluation

Figure 60: Rigatoni Evaluation

The figure 58 shows an evaluation for rigatoni being loaded on the conveyor belt while inspector was on configure mode and the camera already had a deep learning model deployed onto it. The camera identifies the object inside the region that was taught using the region tool on the configuration menu of the camera.

SOPAS air was used to set up the physical parameters for the camera like contrast, brightness etc. images were taught to the camera using an FTP server made by us and by adding the image collection tool onto the camera configuration.

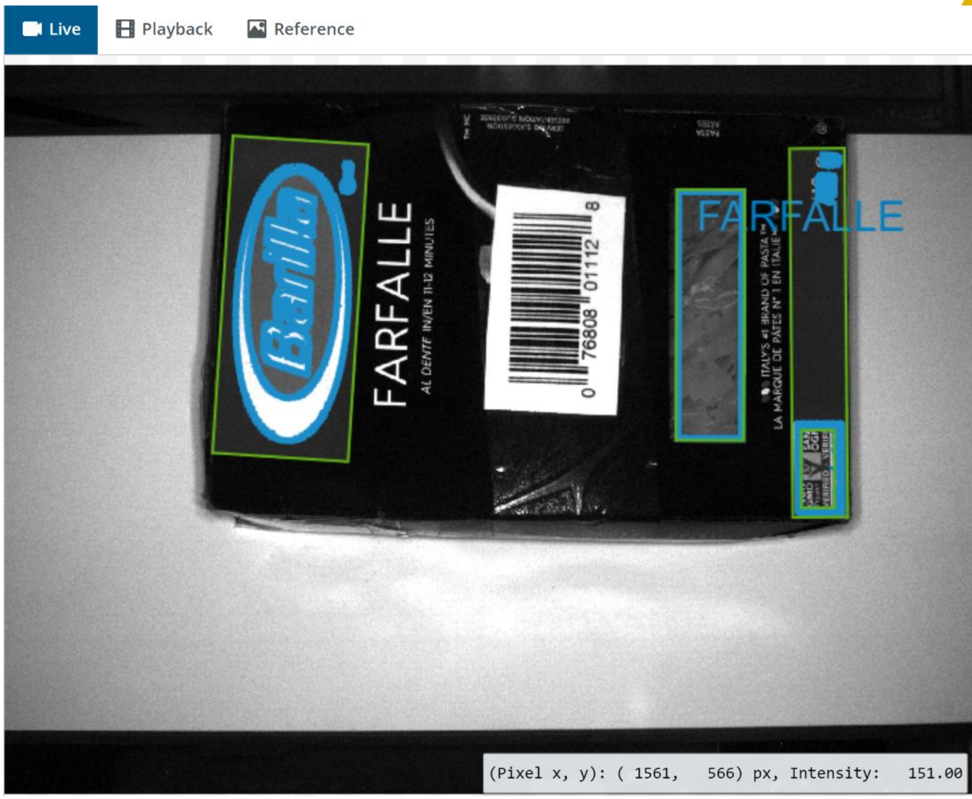


Figure 61: Farfalle Evaluation

The tools deployed on inspector configuration were Nova 2D, OCR, Region, AI classification dstudio string results and object locator.

If a certain job is selected and the camera is triggered to take a picture, both of them are compared for evaluation, if they match a inspector output byte is sent to the PLC to trigger a good item bit, if the item fails inspection, inspector result failed bit is activated.

Conclusion

In conclusion our cell demonstrates a vast variety of SICK sensors and their capabilities in an eye-catching manner. One of our challenges was getting confirmation on the parts that are needed to be provided by SICK as they can tend to change at a moment's notice. Our solution was to sit down with SICK at the beginning of the build phase to finalize our parts list so we could focus on compiling the cell and have more time to produce a great project that succeeds as a stand-alone industrial environment emulator and also as a part of a grand integration scheme with the other 2 major industrial components, namely Robot Guidance and Industry 4.0 which in harmony with Machine Vision and Auto ID cell can streamline any production process.

We successfully demonstrated the stand-alone ability of the cell and also delivered on the integration portion of the project by accomplishing both shipping and receiving sequences using the 3 cells. We could easily deduce that the amount of learning we did during this project supersedes all the other courses we did combined.

Recommendations

Some improvements that can be made on the project are:

- Adding a pneumatic component onto our cell to push off a rejected item into a separate bin or conveyor belt.
- During integration we could have had a setup that would have all the conveyors in perfect contact using roller conveyors.
- On our own cell we could interface MSC-800 with the other components which we could partially achieve due lack of revised or relevant documentation and lack of availability of the SICK representative who is comfortable with the system
- On our own cell we wanted to add more items to inspector’s database just to add more weight and emphasis on the power of the camera.

Bibliography

A lot of sources were referred to in order to make final version of the cell, links to those references are attached below:

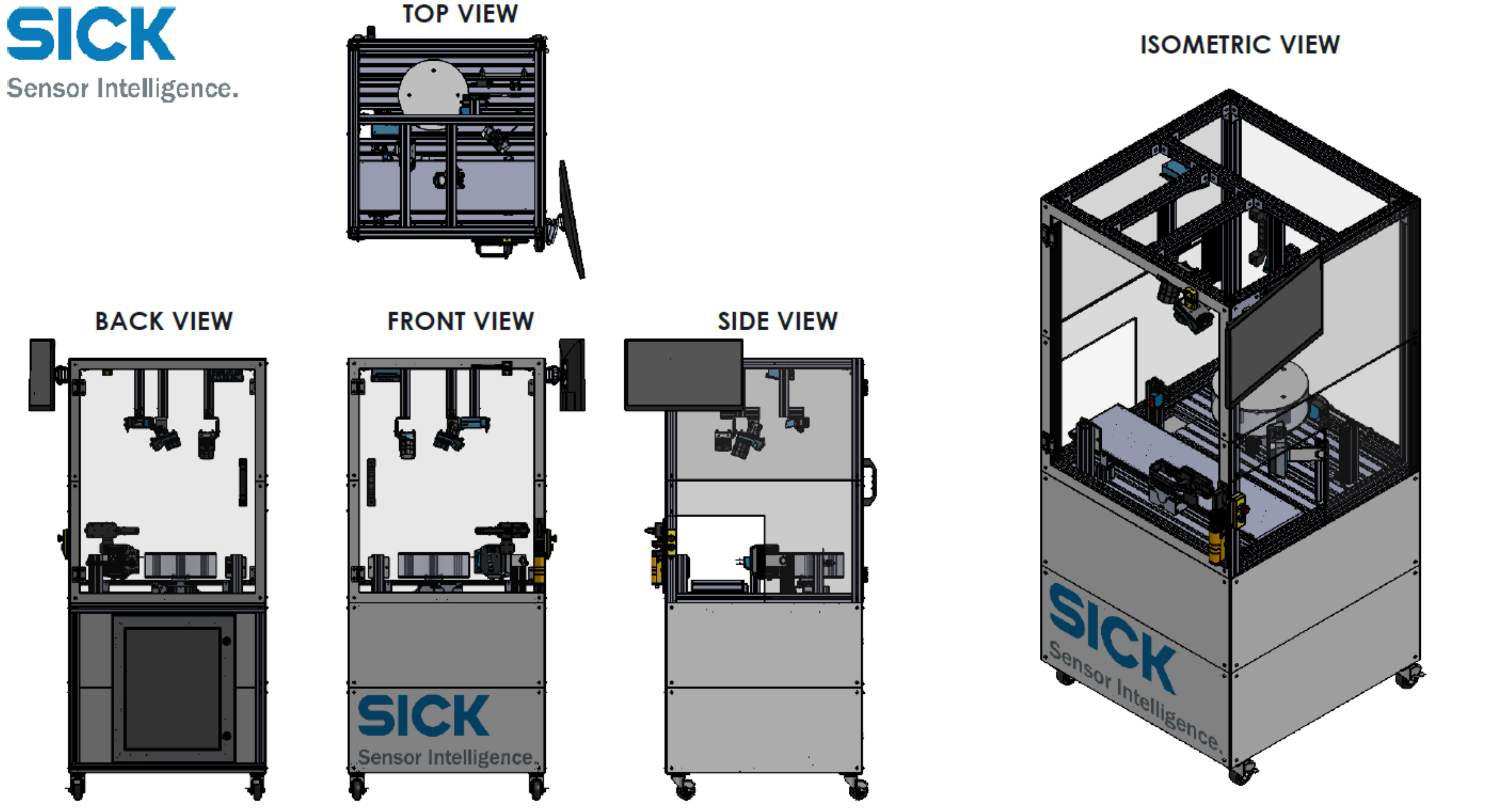
- SICK Support Portal - https://supportportal.sick.com/login/?next=%2F
- SICK USA - https://www.sick.com/us/en/
- Tim Wilborne YouTube Chanel - https://www.youtube.com/@TimWilborne
- Profinet_and_EtherNet_IP_on_Quality_Inspection.pdf
- Application-Note-Rockwell-EtherNetIP (002).pdf
- file:///D:/Sem%206/PROJECT%20PROGRAMMING/Inspector%20Final%20Folder/Getting%20Started%20-%20Deep%20Learning%20-%20mosaic+.pdf
- https://apppool.cloud.sick.com/publications/c122d48d-4b0b-4cb5-b2ea-494b00714082
- https://apppool.cloud.sick.com/publications/b027d4a7-9952-4651-acac-291a3929d3ad

Appendices

List of Illustrations

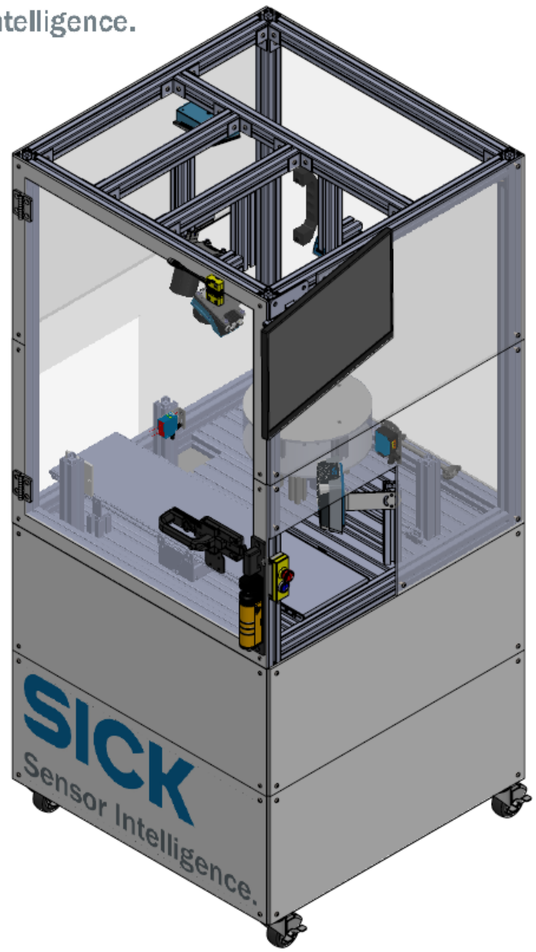
Mechanical Drawings

Attached below are all the mechanical drawings related to the project cell.



TOLERANCE INFORMATION UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN **MM**	PART NUMBER: N/A		**MACHINE VISION AND AUTO ID**
	MATERIAL: N/A		
	HARDNESS: N/A		
	DATE: 29/3/2024		
	DRAWN: PREMANSHU BHAGAT		
	APPROVED: JOSHUA GALTON		
HUMBER Faculty of Applied Sciences & Technology	JOB No: N/A	SCALE: 1:11	B — COMPLETE CELL LAYOUT
	ITEM No: N/A	REV: 7	
	QUANTITY: 1	SHEET: 1 OF 20	

SICK
Sensor Intelligence.



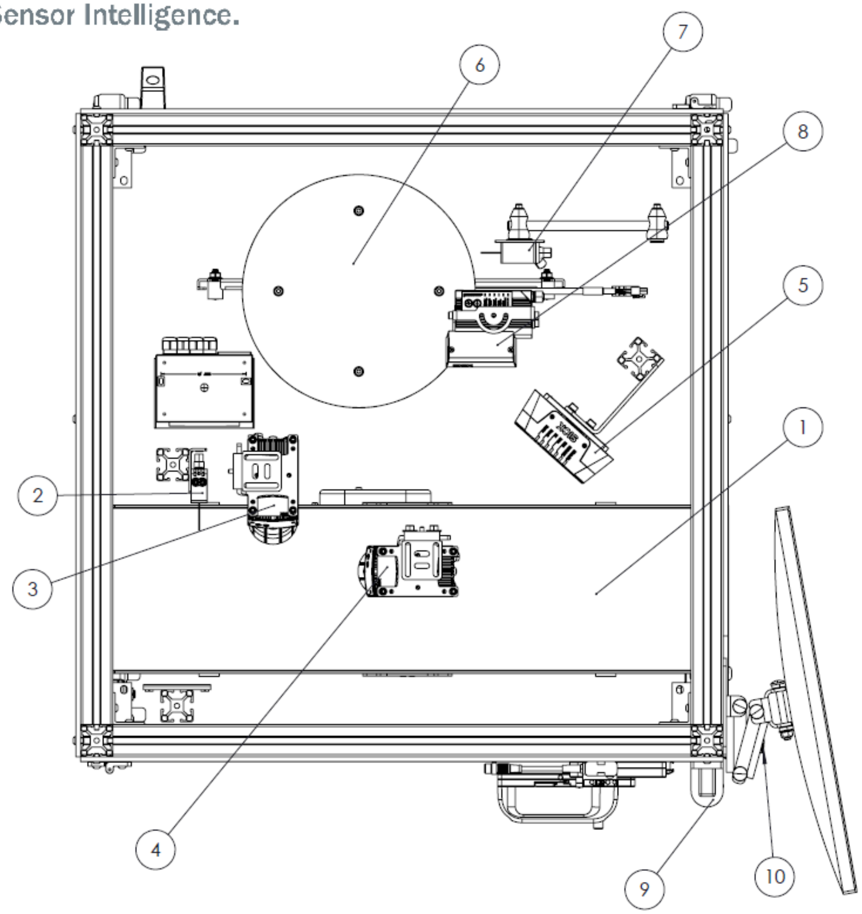
OBJECT DETECTION:

- OPERATOR RESETS THE CELL AND UNTOGGLES THE PHYSICAL E STOP IF REQUIRED AND MASTER START NEEDS TO BE PRESSED ON THE HMI TO ENERGIZE THE WHOLE CELL
- THE CELL STARTS UP, THE CONVEYOR AND THE ROTARY ACTUATOR START RUNNING.
- THE OPERATOR CAN THEN USE THE HMI TO SELECT A PASTA TYPE TO LOAD ON THE CONVEYOR BELT, AS SOON AS THE ITEM IS SELECTED THE STE LOGIC IS ACTIVATED AND WAITING FOR THE PASTA TO BREAK THE PHOTOBEAM.
- ONCE THE PHOTOBEAM IS BROKEN, INSPECTOR TAKES A PICTURE OF THE ITEM AND THE DEEP LEARNING MODEL ONBOARD COMPARES IT TO THE INPUT JOB ID AND GIVES A RESULT.
- IF THE ITEM FAILS EVALUATION, LECTOR TRIGGERS BUT DOES NOT STORE BARCODE DATA AND GOES AHEAD TO RFU WHICH READS THE RFID DATA AND THEN REVERSES THE CONVEYOR DIRECTION BACK TO THE PHOTOEYE AND STOPS THE CONVEYOR AS SOON AS THE PHOTOEYE IS BROKEN AGAIN.
- IF THE ITEM PASSES EVALUATION TEHN LECTOR COLLECTS AND STORES THE BARCODE DATA FOR THE DATABASE AND THEN THE CONVEYOR IS ENABLED TO GO FORWARD TILL THE RFID DATA IS COLLECTED, WHICH THEN STOPS THE CONVEYOR.

ROTARY OPERATION:

- OPERATOR RESETS THE CELL AND UNTOGGLES THE PHYSICAL E STOP IF REQUIRED AND MASTER START NEEDS TO BE PRESSED ON THE HMI TO ENERGIZE THE WHOLE CELL
- THE CELL STARTS UP, THE CONVEYOR AND THE ROTARY ACTUATOR START RUNNING.
- THE CONTRAST SENSOR KEEPS TRIGGERING AT THE SET COLOR EVERY REVOLUTION.
- THE OPERATOR CAN THEN TOGGLE A 'START READ' BUTTON ON THE HMI WHICH TRIGGERS CLV TO READ THE BARCODE DATA ON THE TOP PLATE OF THE ROTARY TABLE.
- ONCE THE BARCODE DATA IS COLLECTED, IT IS THEN STORED INSIDE A VARIABLE THAT CAN BE DISPLAYED ON THE HMI.

TOLERANCE INFORMATION UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN **MM**	PART NUMBER:		**MACHINE VISION AND AUTO ID**
	MATERIAL: N/A		
	HARDNESS: N/A		
	DATE: 18/3/2024		
	DRAWN: PREMANSHU BHAGAT		
	APPROVED: JOSHUA GALTON		
HUMBER Faculty of Applied Sciences & Technology	JOB No: N/A	SCALE: 1:9	B SEQUENCE OF OPERATION
	ITEM No: N/A	REV: 3	
	QUANTITY: 1	SHEET: 2 OF 20	



COMPONENT NUMBER	COMPONENT NAME	DESCRIPTION
1	DORNER CONVEYOR BELT	MID DRIVE CONVEYOR BELT
2	PHOTOEYE	DISTANCE SENSOR
3	INSPECTOR P63X	2D MACHINE VISION CAMERA - WITH DEEP LEARNING ABILITIES
4	LECTOR P63	2D BARCODE SCANNER
5	RFU 620	RFID READ/WRITE DEVICE(UHF)
6	ROTARY TABLE	EQUIPPED WITH A ORIENTAL MOTOR HOLLOW ROTARY ACTUATOR
7	KTS PRIME	CONTRAST SENSOR
8	CLV 650	HIGH SPEED BARCODE SCANNER
9	FLEXI LOCK	ELECTROMECHANICAL INTERLOCK
10	ESTOP - RESET BLOCK	PHYSICAL ESTOP AND RESET BUTTONS

TOLERANCE INFORMATION

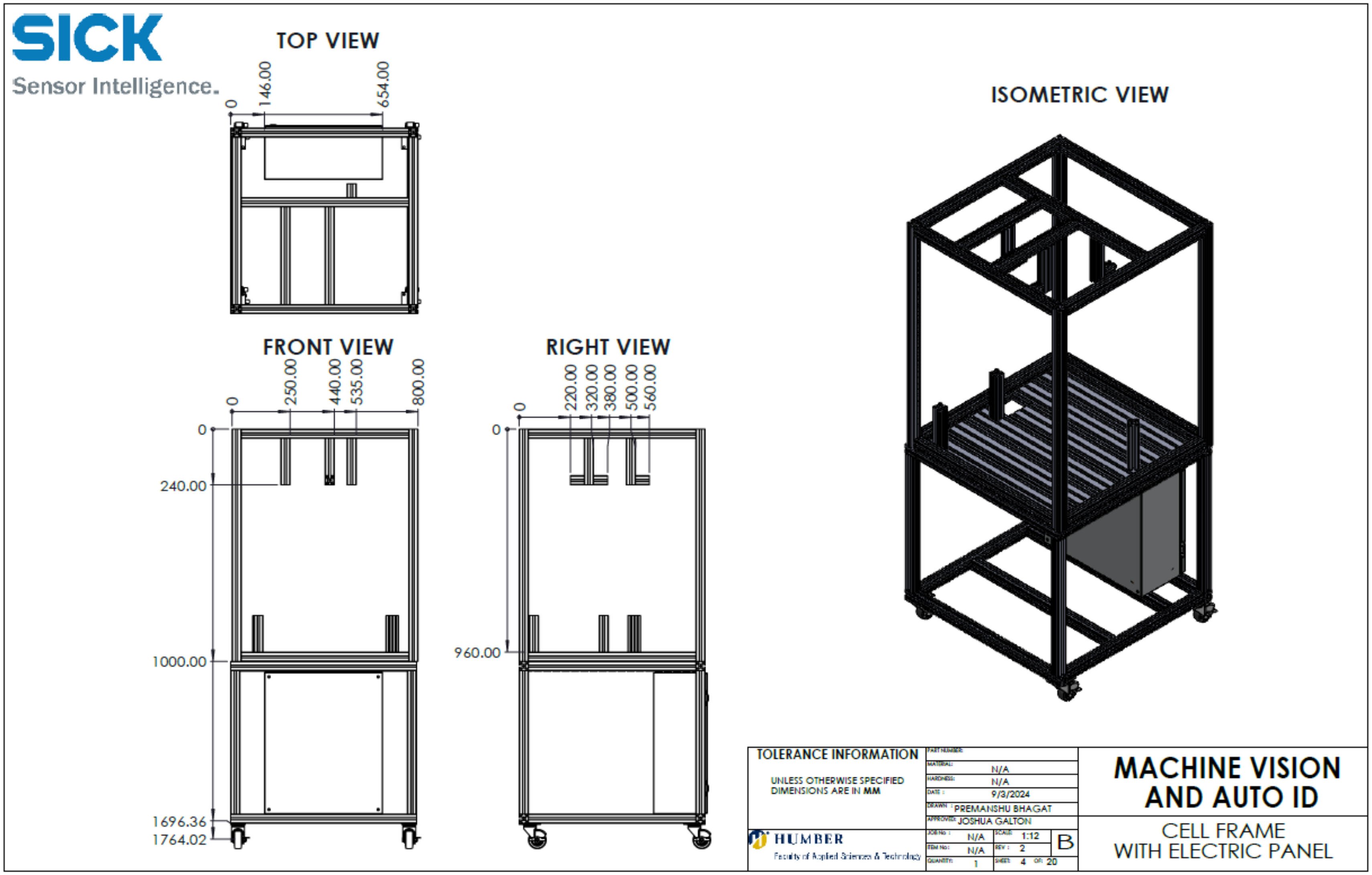
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN **MM**

HUMBER
Faculty of Applied Sciences & Technology

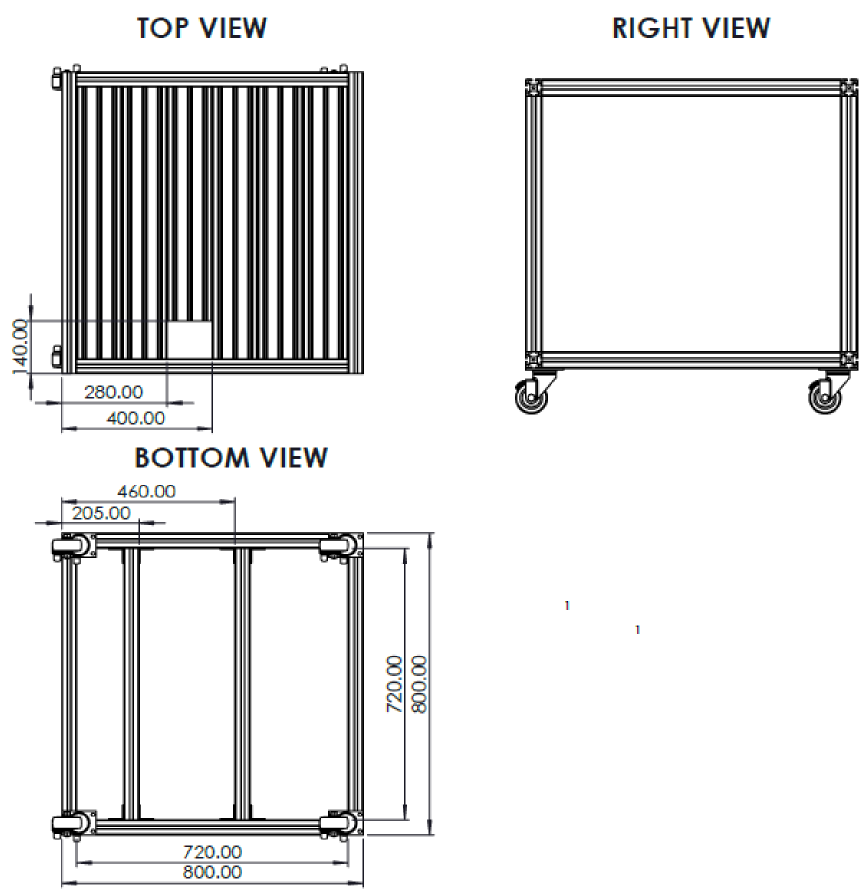
PART NUMBER:	
MATERIAL:	N/A
HARDNESS:	N/A
DATE:	9/3/2024
DRAWN:	PREMANSHU BHAGAT
APPROVED:	JOSHUA GALTON
JOB No: N/A	SCALE: 1:5
ITEM No: N/A	REV: 3
QUANTITY: 1	SHEET: 3 OF 20
	B

MACHINE VISION AND AUTO ID

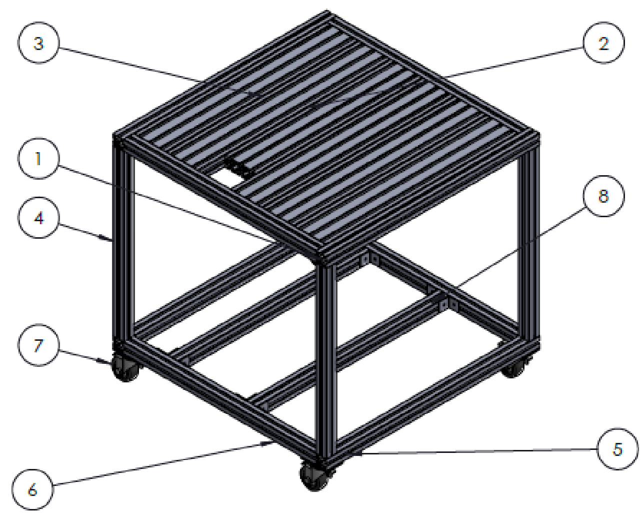
MAJOR COMPONENTS


SICK
Sensor Intelligence.
TOP VIEW
0
146.00
654.00
FRONT VIEW
0
250.00
440.00
535.00
800.00
240.00
1000.00
1696.36
1764.02
RIGHT VIEW
0
220.00
320.00
380.00
500.00
560.00
960.00
ISOMETRIC VIEW
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM
HUMBER
Faculty of Applied Sciences & Technology
MATERIAL: N/A
HARDNESS: N/A
DATE: 9/3/2024
DRAWN: PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
JOB No: N/A
SCALE: 1:12
ITEM No: N/A
REV: 2
QUANTITY: 1
SHEET: 4 OF 20
B
MACHINE VISION
AND AUTO ID
CELL FRAME
WITH ELECTRIC PANEL

SICK
Sensor Intelligence.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	800x800MM BASE	BASE MADE OF ALUMINUM EXTRUSIONS	1
2	40-4012-620-CL	620mm - 40x120 Aluminum Base Extrusion	1
3	40-4012-720-CL	720mm - 40x120 Aluminum Base Extrusion	5
4	616.36MM ALUMINUM EXTRUSION	40X40 ALUMINUM EXTRUSION LEGS FOR CELL BASE	4
5	800MM ALUMINUM EXTRUSION	40x40 ALUMINUM EXTRUSION	2
6	720MM ALUMINUM EXTRUSION	40x40 ALUMINUM EXTRUSION	4
7	8359T231	CORROSION-RESISTANT CASTER	4
8	35x39.8MM BRACKET	L BRACKET	8



TOLERANCE INFORMATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM

HUMBER
Faculty of Applied Sciences & Technology

PART NUMBER:	
MATERIAL:	ALUMINUM EXTRUSION
HARDNESS:	N/A
DATE:	9/3/2024
DRAWN:	PREMANSHU BHAGAT
APPROVED:	JOSHUA GALTON
JOB No: N/A	SCALE: 1:11
ITEM No: N/A	REV: 2
QUANTITY: 1	SHEET: 5 OF: 20

B

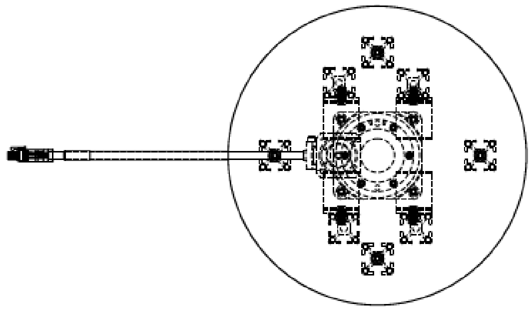
MACHINE VISION AND AUTO ID

CELL BASE STRUCTURE

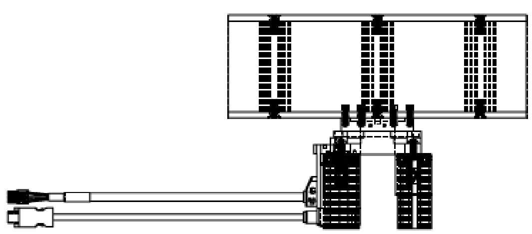
SICK
Sensor Intelligence.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Rotary Table Top Plate	Rotary Table Top Plate	1
2	Rotary Table Plate - Bottom Plate	Rotary Table Plate - Bottom Plate	1
3	91294A239	Black-Oxide Alloy Steel Hex Drive Flat Head Screw	8
4	dgm85r-azac	Hollow Rotary Actuator	1
5	Color Strip Rotory	Color Strip for KTS Prime Training	1
6	91290A154	Alloy Steel Socket Head Screw	6
7	L Bracket 35x39.8mm	L Bracket for Actuator Mounting	4
8	92095A238	Button Head Hex Drive Screw	4
9	92095A227	Button Head Hex Drive Screw	4
10	6000N204	T-Slotted Framing Fasteners	4
11	5537T738	T-Slotted Framing	4
12	5537T738	T-Slotted Framing	4

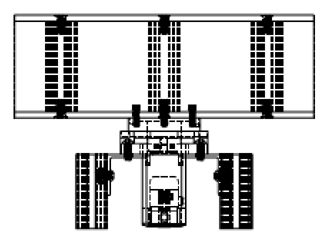
TOP VIEW



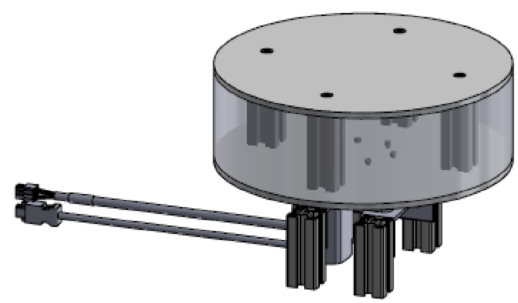
FRONT VIEW



SIDE VIEW



DIMETRIC VIEW



TOLERANCE INFORMATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN **MM**

HUMBER
Faculty of Applied Sciences & Technology

PART NUMBER:
MATERIAL: N/A
HARDNESS: N/A
DATE: 10/3/2024
DRAWN: PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
JOB No.: N/A | SCALE: 1:4 | B
ITEM No.: N/A | REV.: 5
QUANTITY: 1 | SHEET: 6 OF: 20

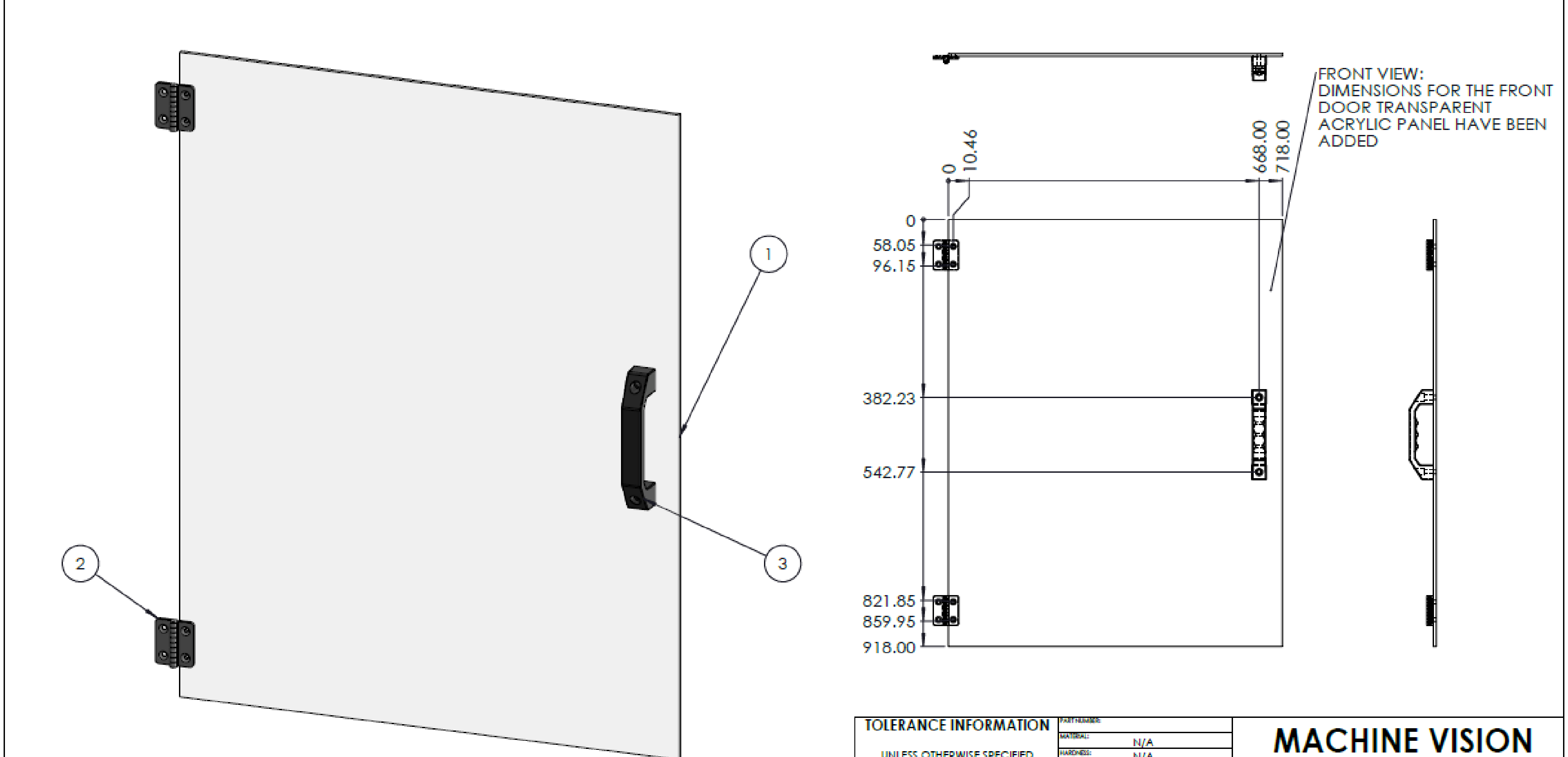
MACHINE VISION AND AUTO ID

Rotary Table Assembly

HUMBER

SICK
Sensor Intelligence.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Back Door Panel	Transparent Acrylic Panel	1
2	1635A501	Plastic Hinge with Holes	2
3	2471N4	Static-Control Unthreaded-Hole Pull Handle	1



TOLERANCE INFORMATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM

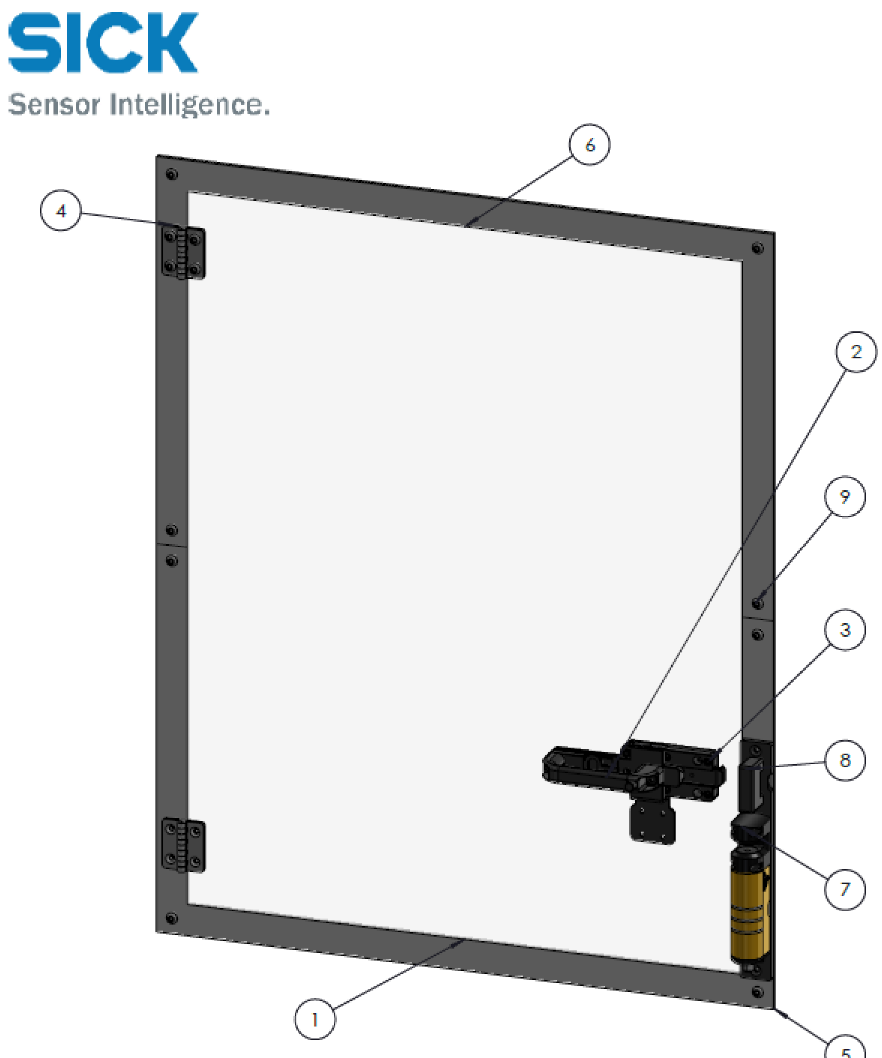
HUMBER
Faculty of Applied Sciences & Technology

PART NUMBER:	
MATERIAL:	N/A
HARDNESS:	N/A
FINISH :	10/3/2024
DRAWN :	PREMANSHU BHAGAT
APPROVED:	JOSHUA GALTON
JOB No : N/A	SCALE: 1:5
ITEM No : N/A	REV : 2
QUANTITY: 1	SHEET: 7 OF 20

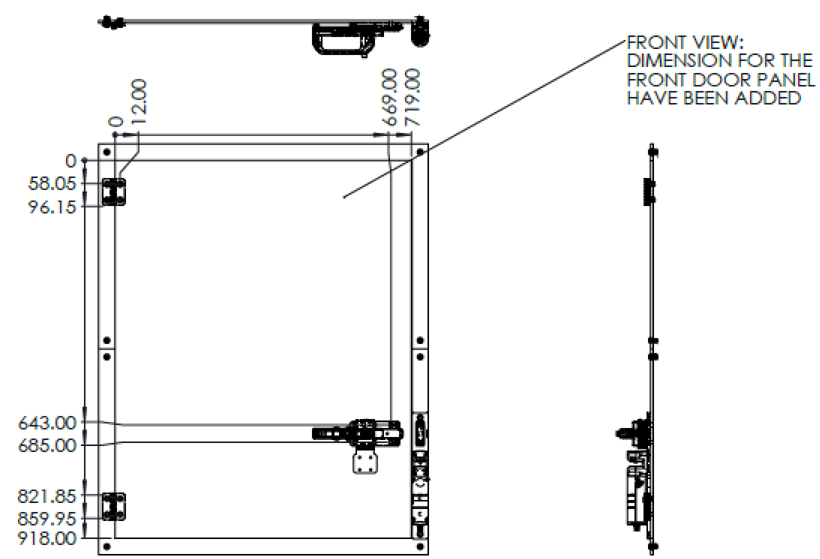
B

MACHINE VISION AND AUTO ID

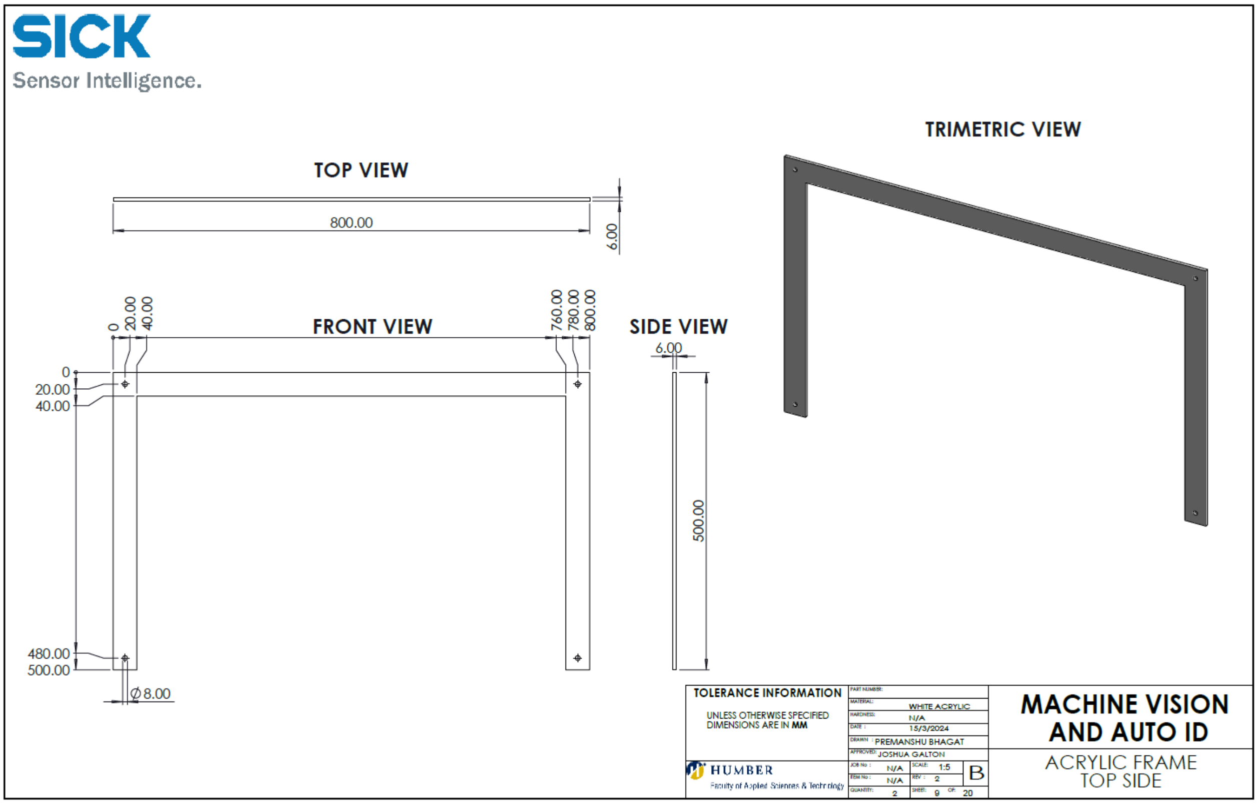
Back Door Assembly

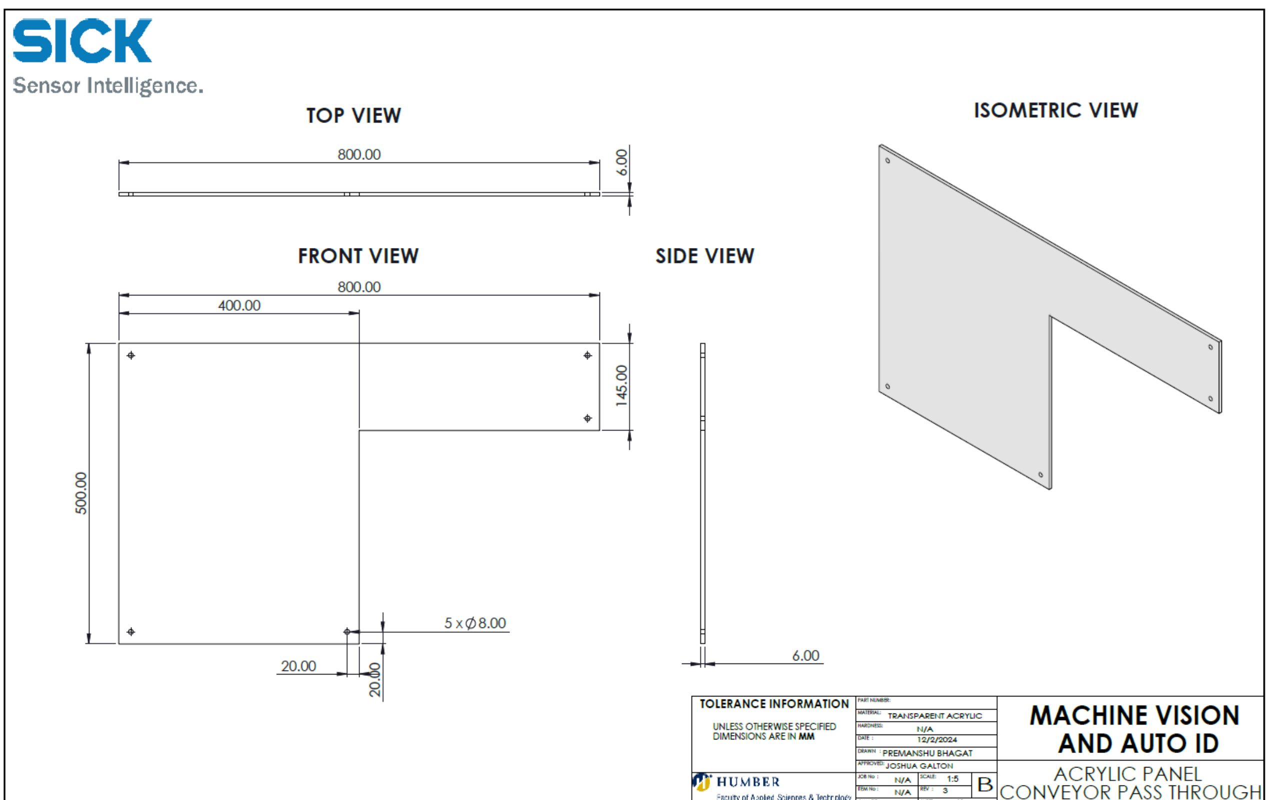


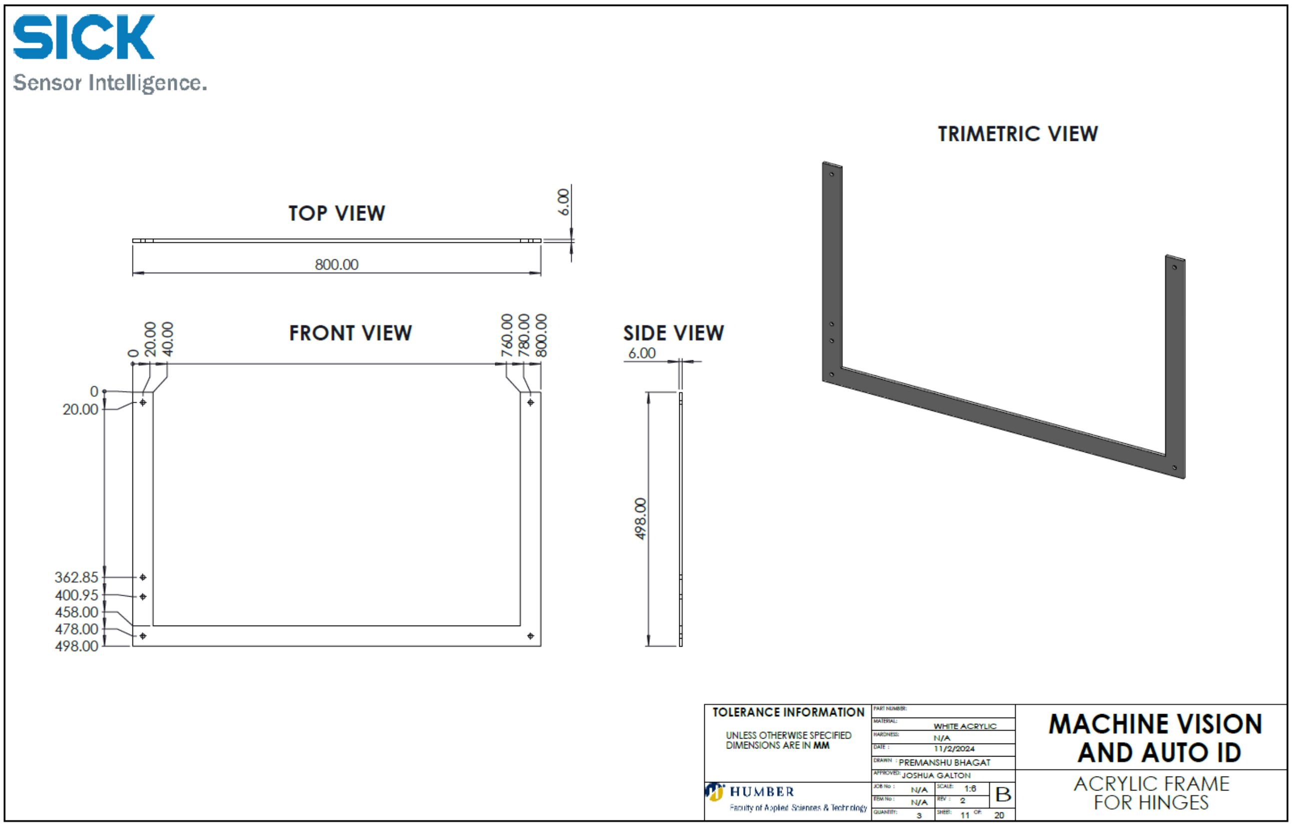
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	FRONT PANEL	TRANSPARENT ACRYLIC PANEL	1
3	Key Part of Lock - Part 1	HANDLE PORTION OF THE DOOR	1
3	Key Part of Lock - Part2	ACTUAL KEY FOR THE INTERLOCK	1
4	1635A501	Plastic Hinge with Holes	2
5	Front Acrylic Frame	WHITE ACRYLIC FRAME 6MM	1
6	Front Acrylic Frame	WHITE ACRYLIC FRAME 6MM	1
7	SICK flexLock - Door Lock	ELECTROMECHANICAL INTERLOCK	1
8	Base of Lock - Split2	KEY FIT	1
9	92095A260	Button Head Hex Drive Screw	12

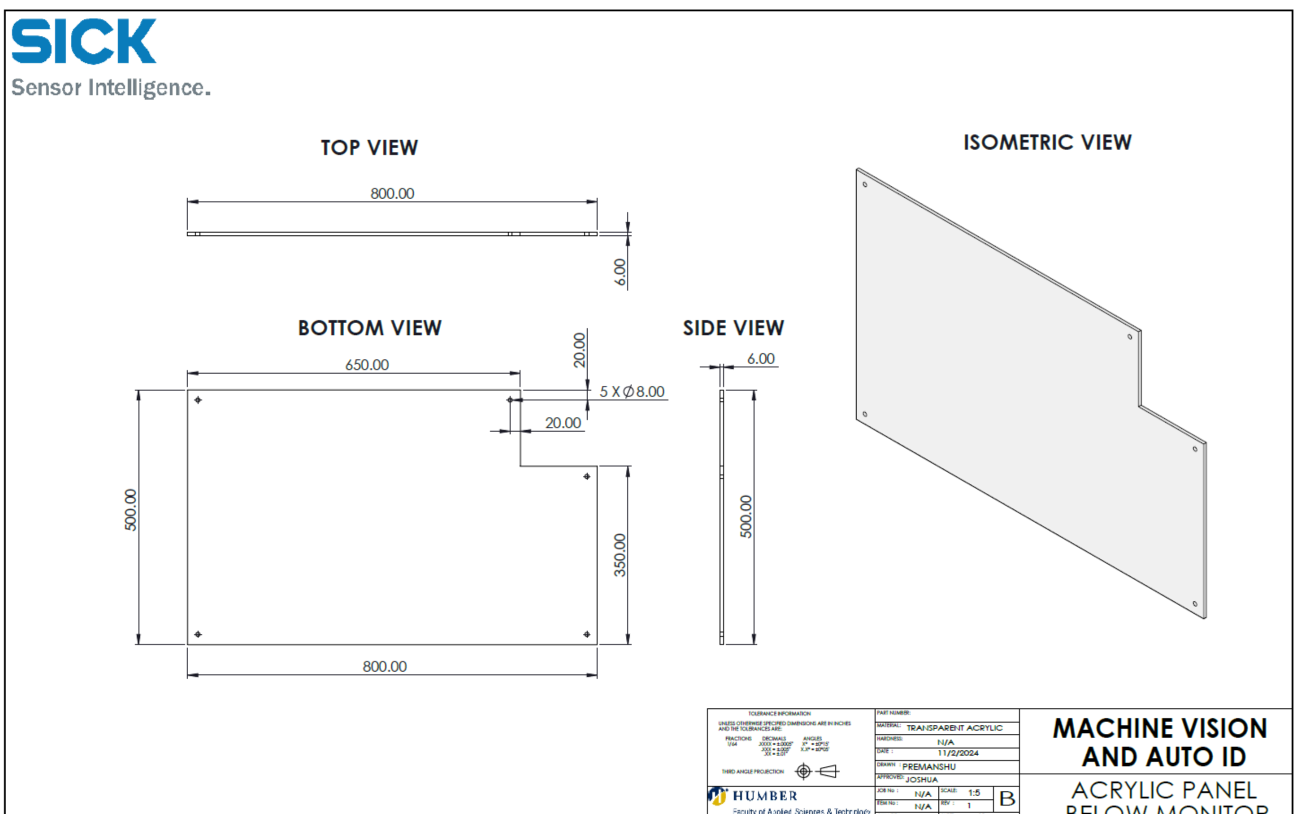


TOLERANCE INFORMATION UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN **MM**	PART NUMBER: MATERIAL: N/A HARDNESS: N/A DATE: 10/3/2024 DRAWN: PREMANSHU BHAGAT APPROVED: JOSHUA GALTON	**MACHINE VISION AND AUTO ID**
HUMBER Faculty of Applied Sciences & Technology	JOB No.: N/A SCALE: 1:5 ITEM No.: N/A REV.: 2 QUANTITY: 1 SHEET: 8 OF 20 B	FRONT DOOR ASSEMBLY

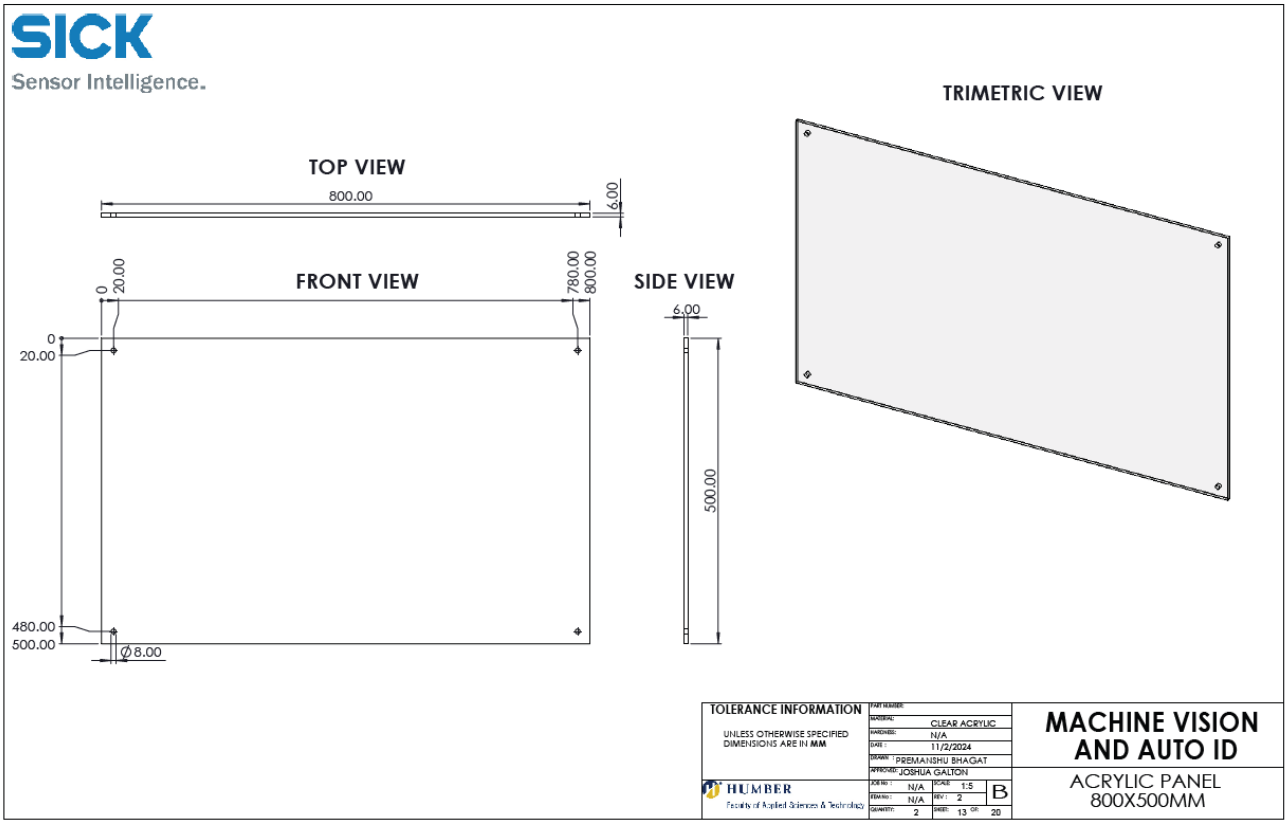

SICK
Sensor Intelligence.
TOP VIEW
800.00
6.00
FRONT VIEW
0
20.00
40.00
760.00
780.00
800.00
480.00
500.00
∅8.00
SIDE VIEW
6.00
500.00
TRIMETRIC VIEW
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
PART NUMBER:
MATERIAL: WHITE ACRYLIC
HARDNESS: N/A
DATE : 15/3/2024
DRAWN : PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
HUMBER
Faculty of Applied Sciences & Technology
JOB No : N/A
SCALE: 1:5
ITEM No : N/A
REV : 2
B
QUANTITY: 2
SHEET: 9 OF: 20
MACHINE VISION AND AUTO ID
ACRYLIC FRAME TOP SIDE

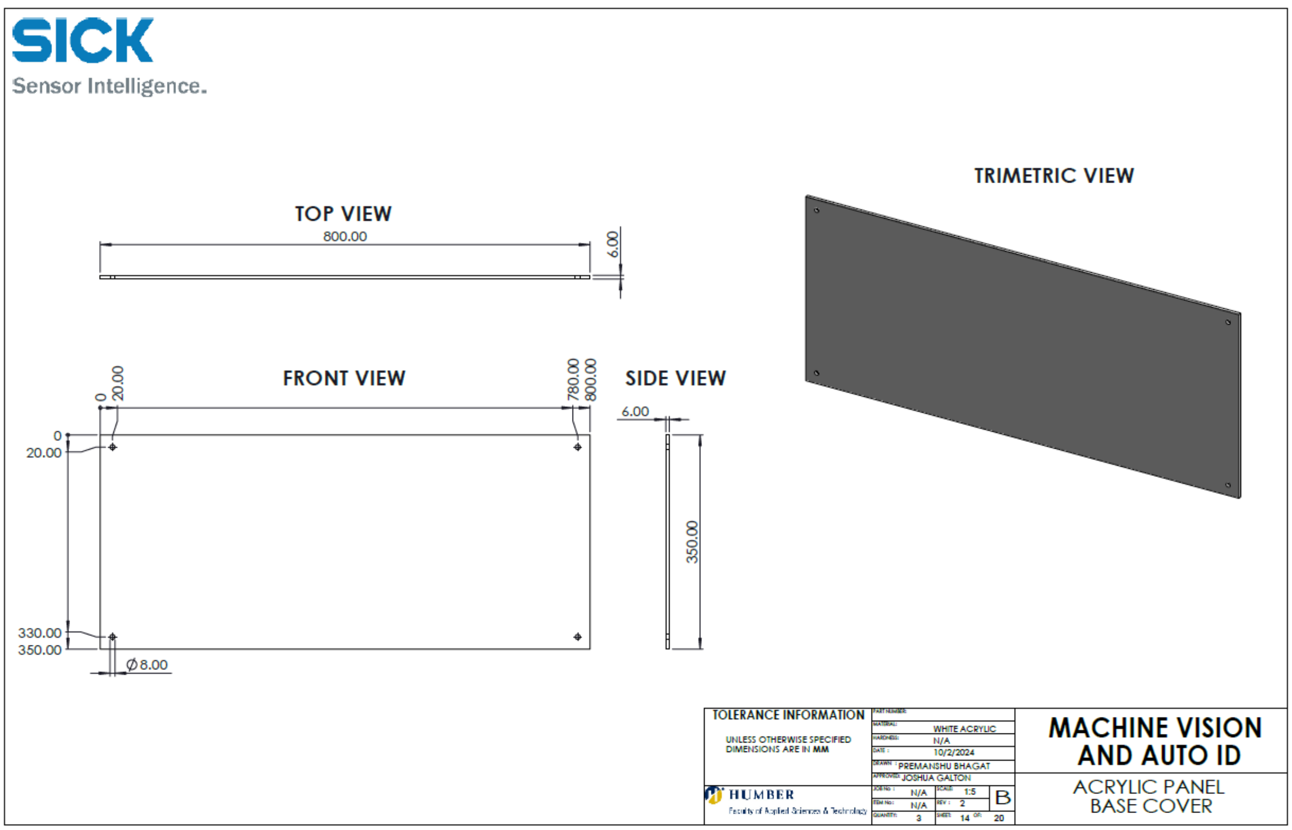

SICK
Sensor Intelligence.
TOP VIEW
800.00
6.00
FRONT VIEW
800.00
400.00
145.00
500.00
5 x ∅8.00
20.00
20.00
SIDE VIEW
6.00
ISOMETRIC VIEW
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
PART NUMBER:
MATERIAL: TRANSPARENT ACRYLIC
HARDNESS: N/A
DATE : 12/2/2024
DRAWN : PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
HUMBER
Faculty of Applied Sciences & Technology
JOB No : N/A
SCALE: 1:5
ITEM No : N/A
REV : 3
B
QUANTITY: 2
SHEET: 10 OF: 20
MACHINE VISION AND AUTO ID
ACRYLIC PANEL CONVEYOR PASS THROUGH

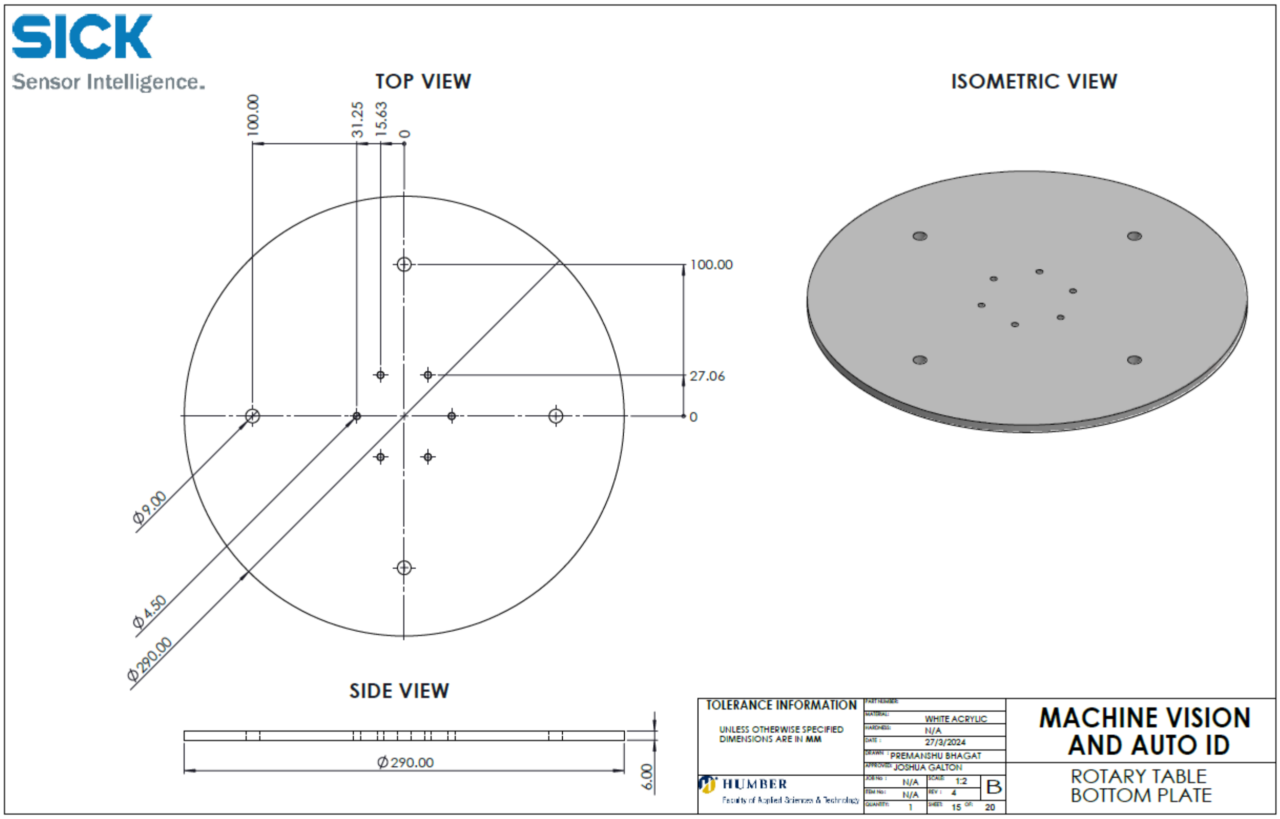

SICK
Sensor Intelligence.
TRIMETRIC VIEW
TOP VIEW
6.00
800.00
FRONT VIEW
0
20.00
40.00
760.00
780.00
800.00
0
20.00
362.85
400.95
458.00
478.00
498.00
SIDE VIEW
6.00
498.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
PART NUMBER:
MATERIAL: WHITE ACRYLIC
HARDNESS: N/A
DATE : 11/2/2024
DRAWN : PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
JOB No : N/A
SCALE: 1:6
ITEM No : N/A
REV : 2
QUANTITY: 3
SHEET: 11 OF: 20
B
HUMBER
Faculty of Applied Sciences & Technology
MACHINE VISION AND AUTO ID
ACRYLIC FRAME FOR HINGES

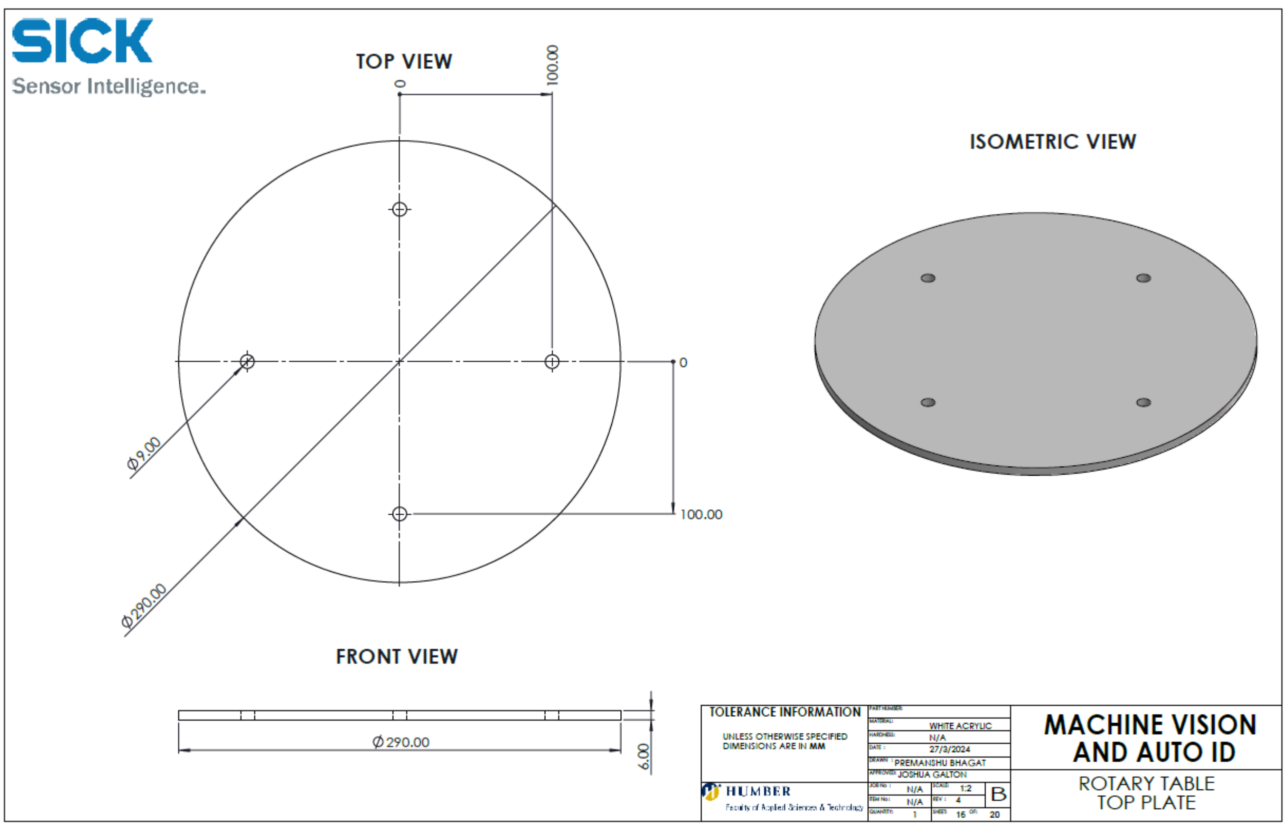

SICK
Sensor Intelligence.
TOP VIEW
800.00
6.00
ISOMETRIC VIEW
BOTTOM VIEW
650.00
20.00
5 X Ø8.00
20.00
500.00
350.00
800.00
SIDE VIEW
6.00
500.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND THE TOLERANCES ARE:
FRACTIONS 1/64
DECIMALS .XXXX = ±.0005" .XXX = ±.005" .XX = ±.01"
ANGLES X° = ±0°15' X.X° = ±0°05'
THIRD ANGLE PROJECTION
PART NUMBER:
MATERIAL: TRANSPARENT ACRYLIC
HARDNESS: N/A
DATE : 11/2/2024
DRAWN : PREMANSHU
APPROVED: JOSHUA
JOB No : N/A
SCALE: 1:5
ITEM No : N/A
REV : 1
QUANTITY: 1
SHEET: 12 OF: 20
B
HUMBER
Faculty of Applied Sciences & Technology
MACHINE VISION AND AUTO ID
ACRYLIC PANEL BELOW MONITOR

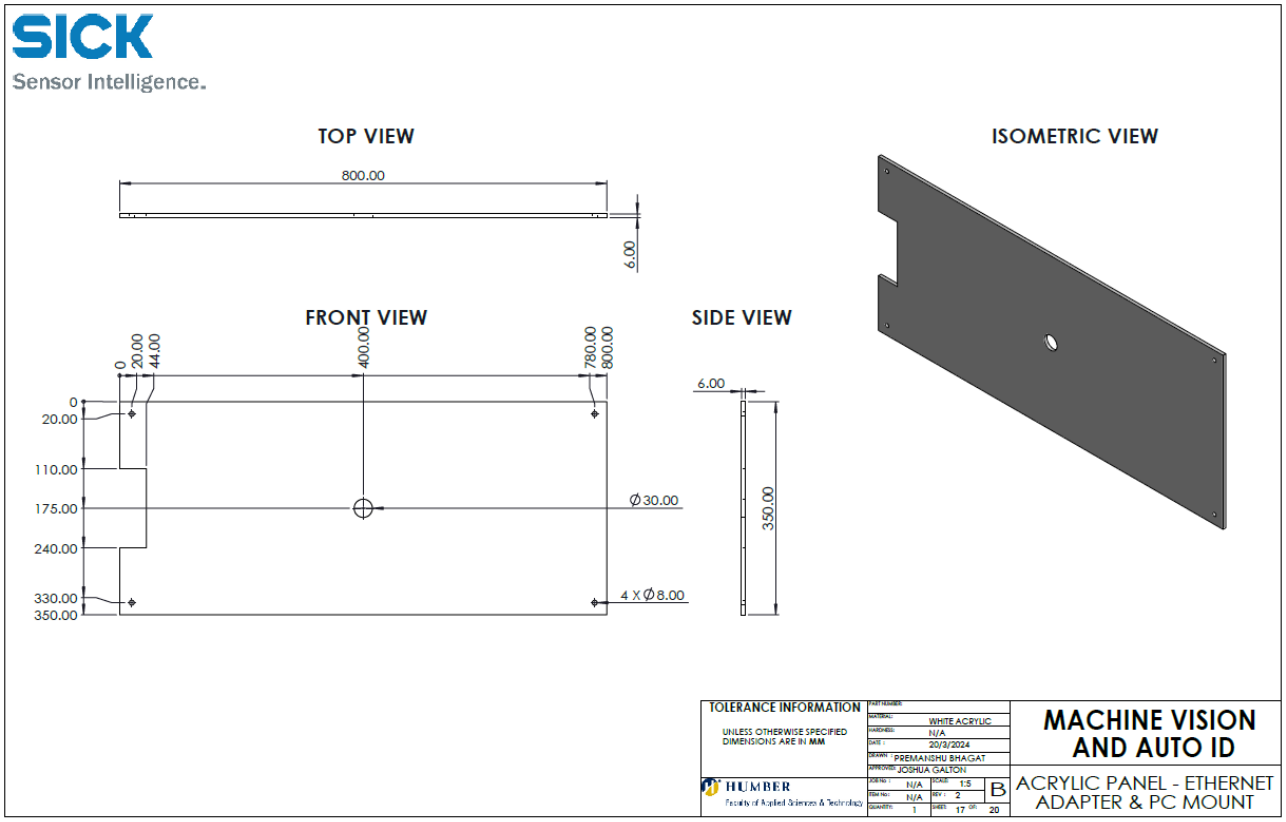
HUMBER

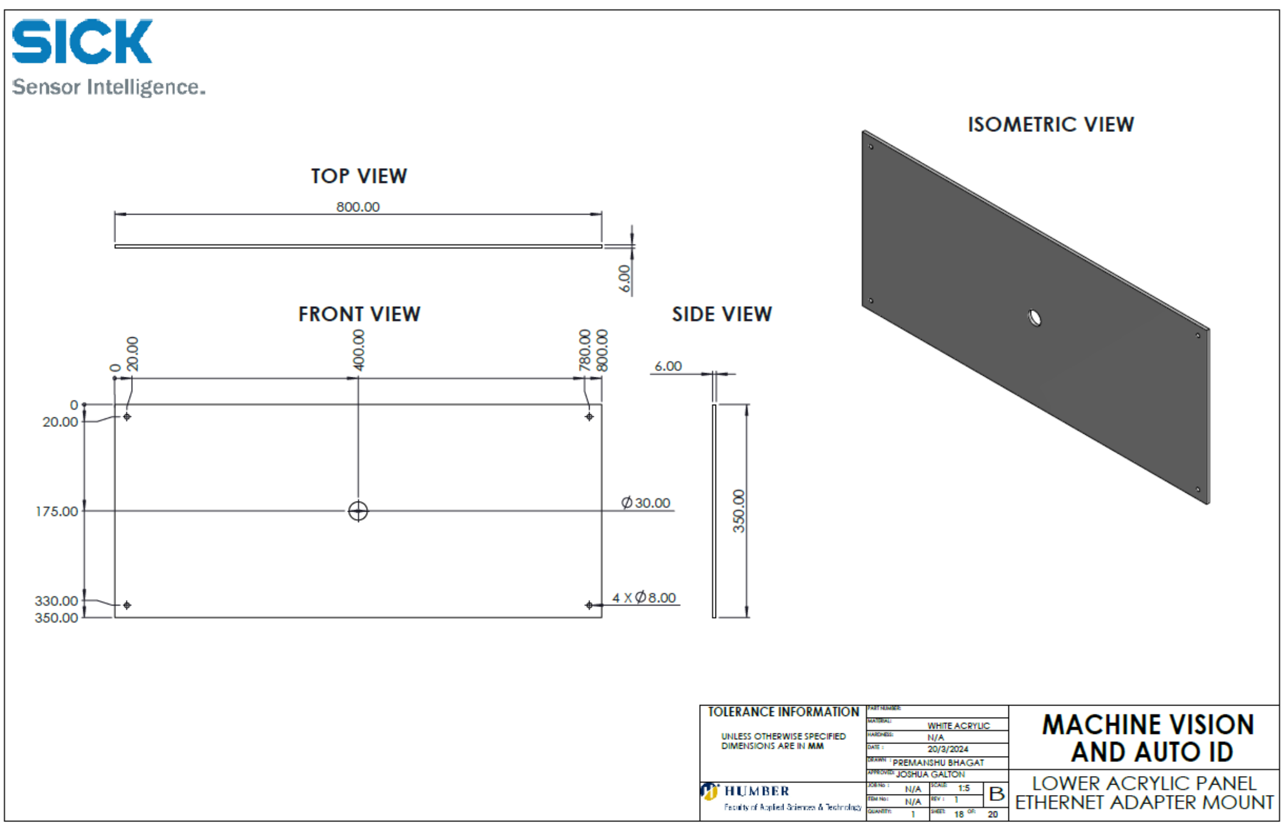

SICK
Sensor Intelligence.
TRIMETRIC VIEW
TOP VIEW
800.00
6.00
FRONT VIEW
0
20.00
780.00
800.00
SIDE VIEW
6.00
0
20.00
480.00
500.00
500.00
Ø8.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM
HUMBER
Faculty of Applied Sciences & Technology
PART NUMBER:
MATERIAL: CLEAR ACRYLIC
HARDNESS: N/A
DATE : 11/2/2024
DRAWN : PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
JOB No : N/A
SCALE: 1:5
ITEM No : N/A
REV : 2
B
QUANTITY: 2
SHEET: 13 OF 20
MACHINE VISION
AND AUTO ID
ACRYLIC PANEL
800X500MM

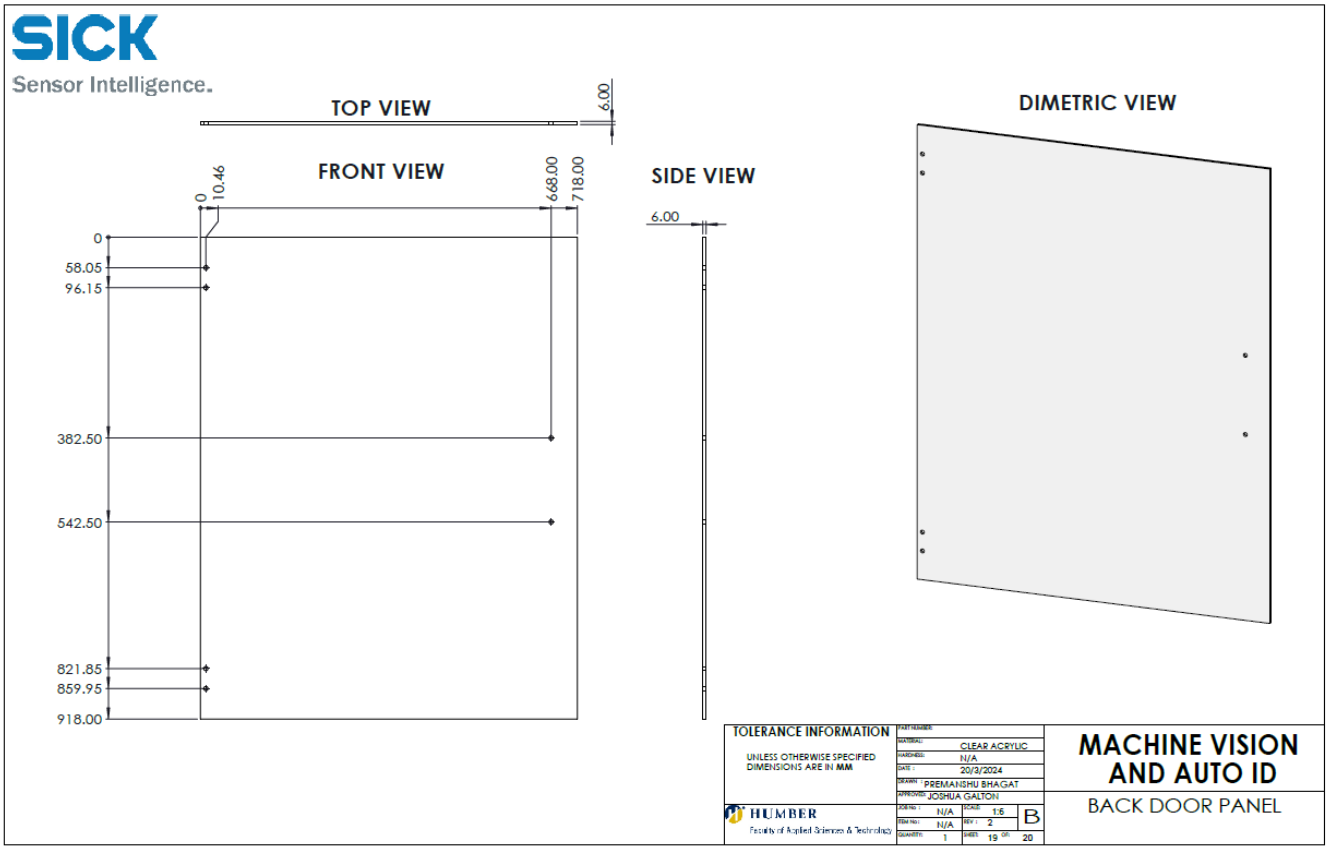

SICK
Sensor Intelligence.
TRIMETRIC VIEW
TOP VIEW
800.00
6.00
FRONT VIEW
0
20.00
780.00
800.00
SIDE VIEW
6.00
0
20.00
330.00
350.00
350.00
Ø8.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM
HUMBER
Faculty of Applied Sciences & Technology
PART NUMBER:
MATERIAL: WHITE ACRYLIC
HARDNESS: N/A
DATE : 10/2/2024
DRAWN : PREMANSHU BHAGAT
APPROVED: JOSHUA GALTON
JOB No : N/A
SCALE: 1:5
ITEM No : N/A
REV : 2
B
QUANTITY: 3
SHEET: 14 OF 20
MACHINE VISION
AND AUTO ID
ACRYLIC PANEL
BASE COVER

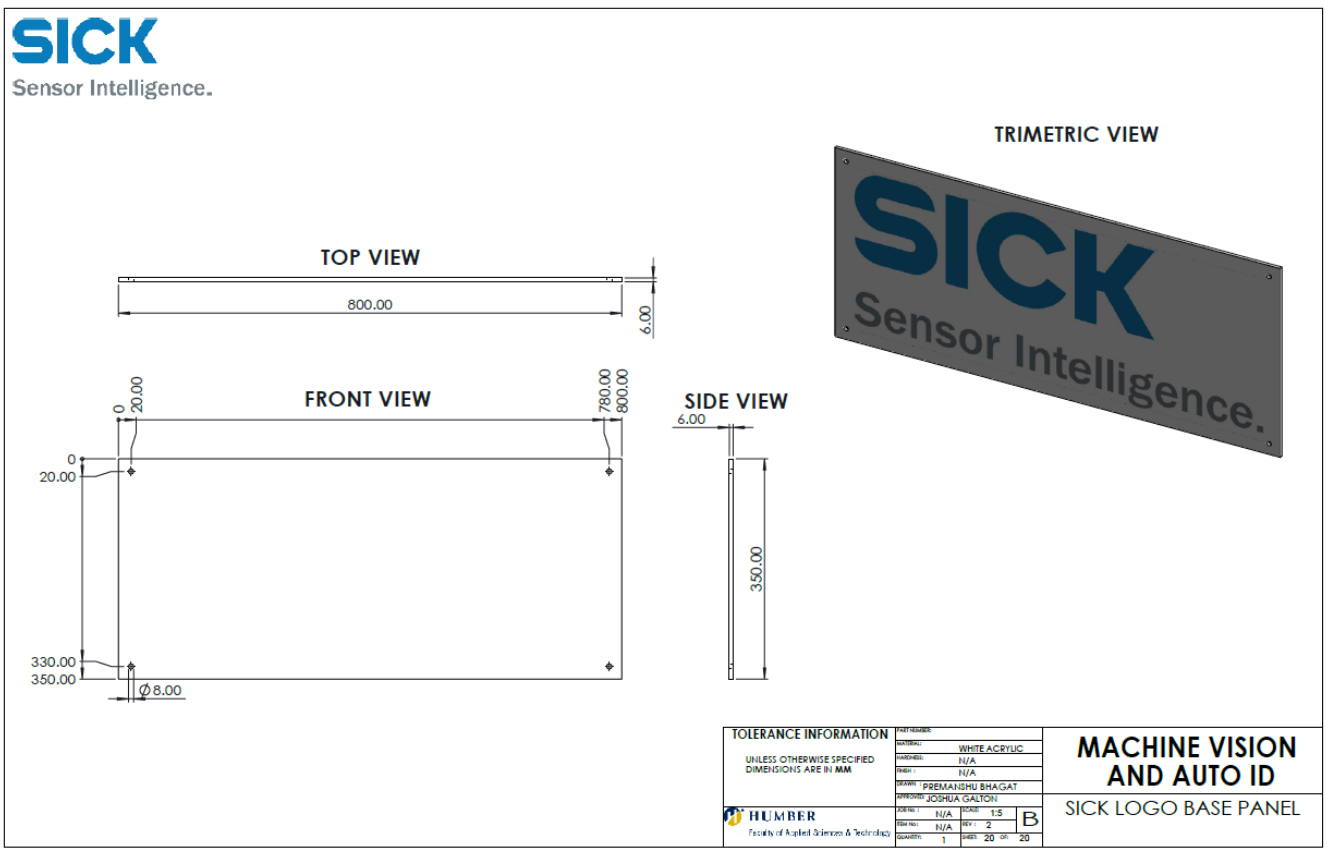

SICK
Sensor Intelligence.
TOP VIEW
ISOMETRIC VIEW
100.00
31.25
15.63
0
100.00
27.06
0
Ø9.00
Ø4.50
Ø290.00
SIDE VIEW
Ø290.00
6.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
WHITE ACRYLIC
N/A
27/3/2024
PREMANSHU BHAGAT
JOSHUA GALTON
HUMBER
Faculty of Applied Sciences & Technology
N/A
1:2
N/A
4
1
15
20
B
MACHINE VISION AND AUTO ID
ROTARY TABLE BOTTOM PLATE


SICK
Sensor Intelligence.
TOP VIEW
0
100.00
ISOMETRIC VIEW
0
100.00
Ø9.00
Ø290.00
FRONT VIEW
Ø290.00
6.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
WHITE ACRYLIC
N/A
27/3/2024
PREMANSHU BHAGAT
JOSHUA GALTON
HUMBER
Faculty of Applied Sciences & Technology
N/A
1:2
N/A
4
1
16
20
B
MACHINE VISION AND AUTO ID
ROTARY TABLE TOP PLATE

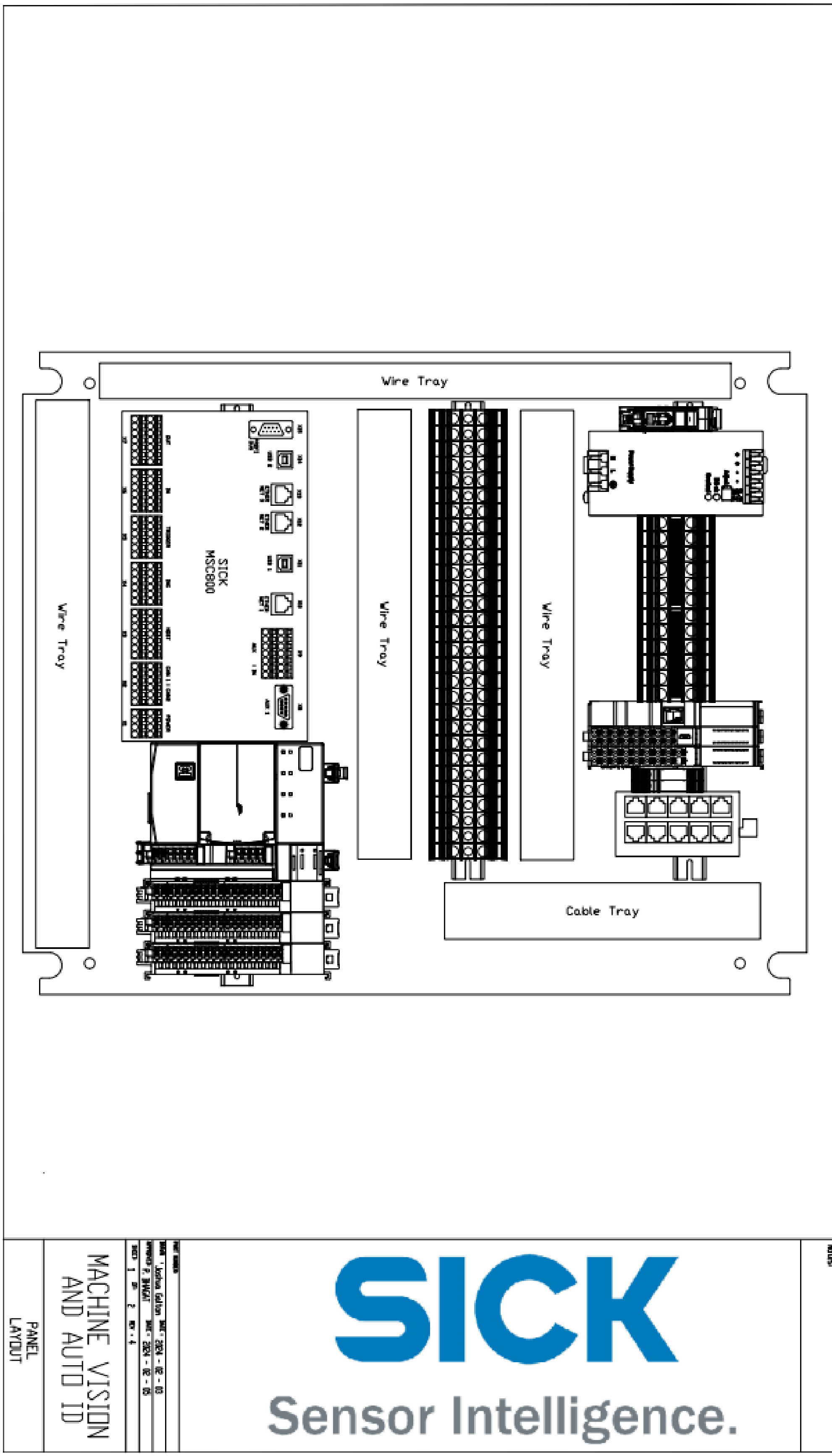

SICK
Sensor Intelligence.
TOP VIEW
800.00
6.00
ISOMETRIC VIEW
FRONT VIEW
0
20.00
44.00
400.00
780.00
800.00
0
20.00
110.00
175.00
240.00
330.00
350.00
Ø30.00
4 X Ø8.00
SIDE VIEW
6.00
350.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
WHITE ACRYLIC
N/A
20/3/2024
PREMANSHU BHAGAT
JOSHUA GALTON
N/A
1:5
N/A
2
1
17
20
B
HUMBER
Faculty of Applied Sciences & Technology
MACHINE VISION AND AUTO ID
ACRYLIC PANEL - ETHERNET ADAPTER & PC MOUNT

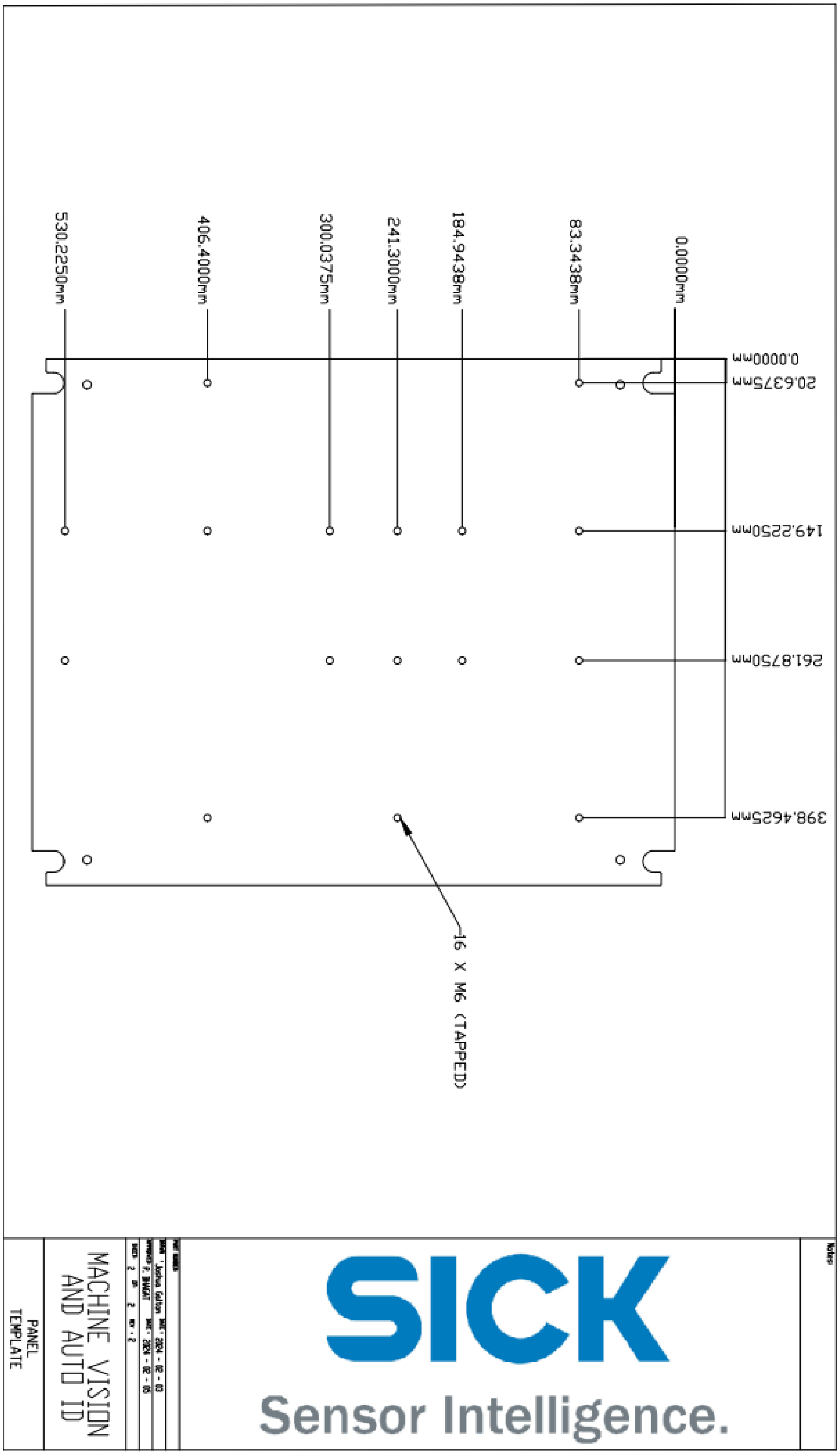

SICK
Sensor Intelligence.
ISOMETRIC VIEW
TOP VIEW
800.00
6.00
FRONT VIEW
SIDE VIEW
0
20.00
400.00
780.00
800.00
0
20.00
175.00
330.00
350.00
Ø30.00
4 X Ø8.00
6.00
350.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM
WHITE ACRYLIC
N/A
20/3/2024
PREMANSHU BHAGAT
JOSHUA GALTON
N/A
1:5
N/A
1
1
18
20
B
HUMBER
Faculty of Applied Sciences & Technology
MACHINE VISION AND AUTO ID
LOWER ACRYLIC PANEL ETHERNET ADAPTER MOUNT

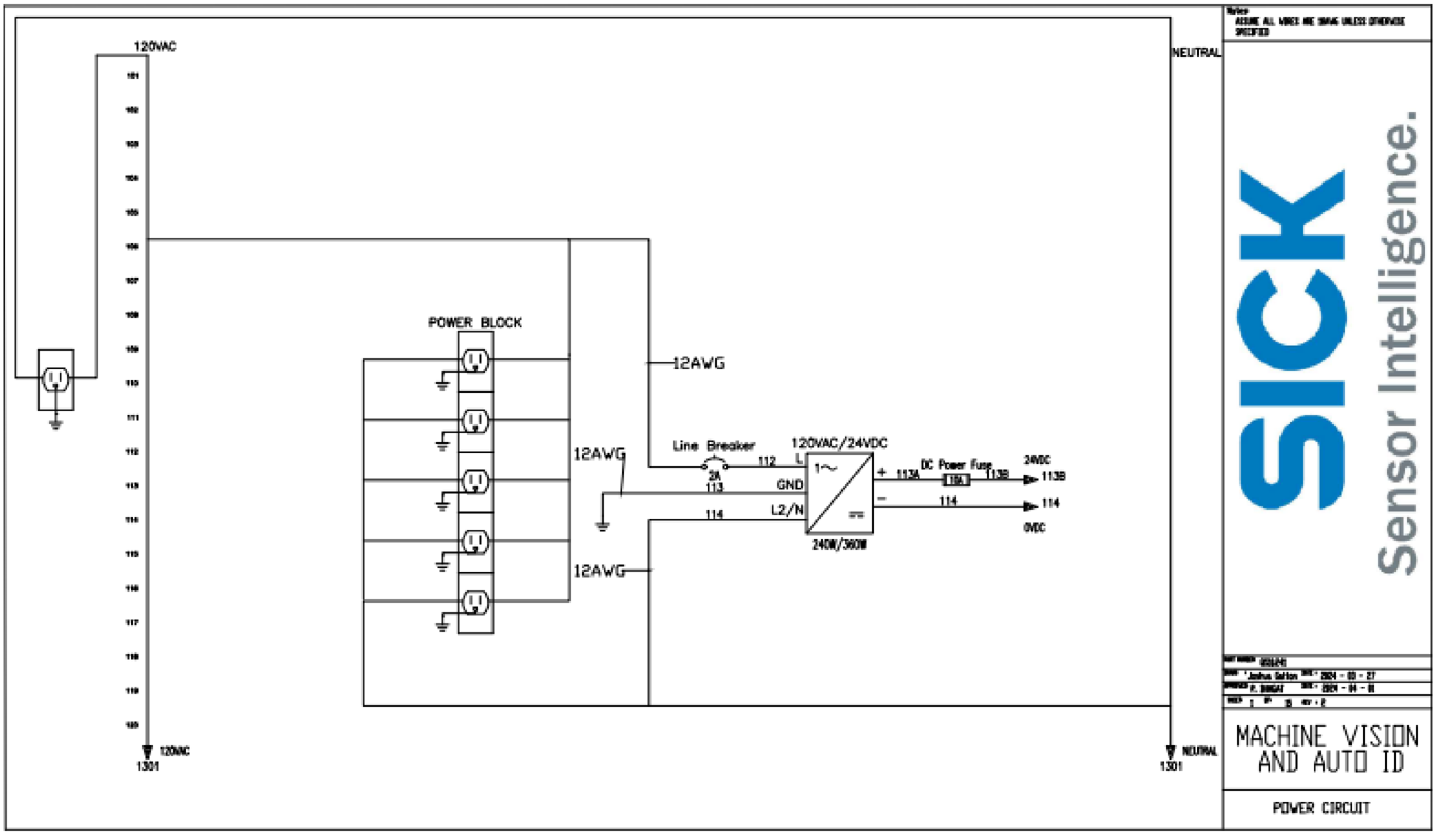

SICK
Sensor Intelligence.
TOP VIEW
6.00
FRONT VIEW
0
10.46
668.00
718.00
0
58.05
96.15
382.50
542.50
821.85
859.95
918.00
SIDE VIEW
6.00
DIMETRIC VIEW
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM
CLEAR ACRYLIC
N/A
20/3/2024
PREMANSHU BHAGAT
JOSHUA GALTON
N/A
1:6
N/A
2
B
1
19
20
HUMBER
MACHINE VISION
AND AUTO ID
BACK DOOR PANEL

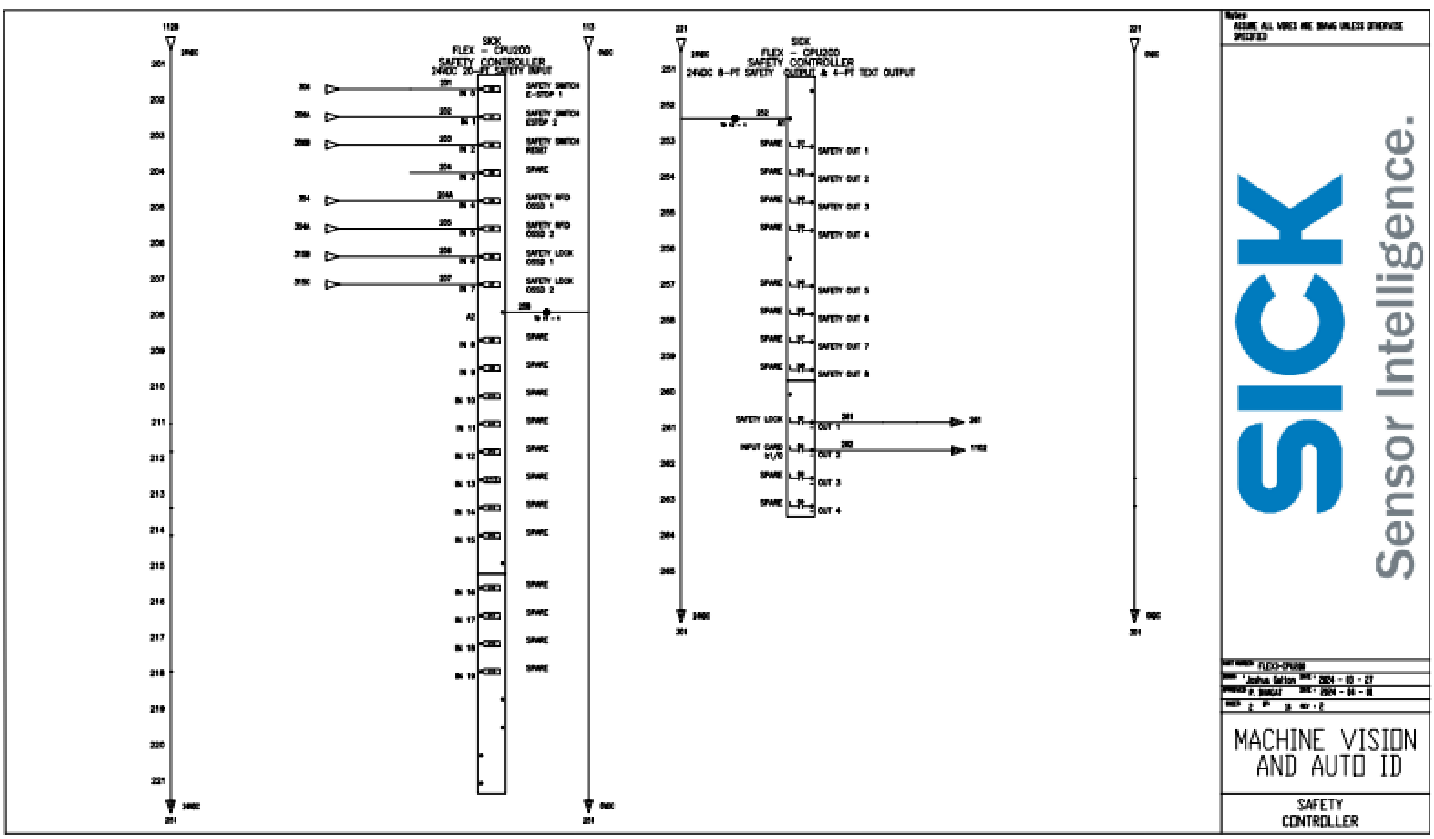

SICK
Sensor Intelligence.
TRIMETRIC VIEW
SICK
Sensor Intelligence.
TOP VIEW
800.00
6.00
FRONT VIEW
0
20.00
780.00
800.00
0
20.00
330.00
350.00
⌀8.00
SIDE VIEW
6.00
350.00
TOLERANCE INFORMATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MM
WHITE ACRYLIC
N/A
N/A
PREMANSHU BHAGAT
JOSHUA GALTON
N/A
1:5
N/A
2
B
1
20
20
HUMBER
MACHINE VISION
AND AUTO ID
SICK LOGO BASE PANEL

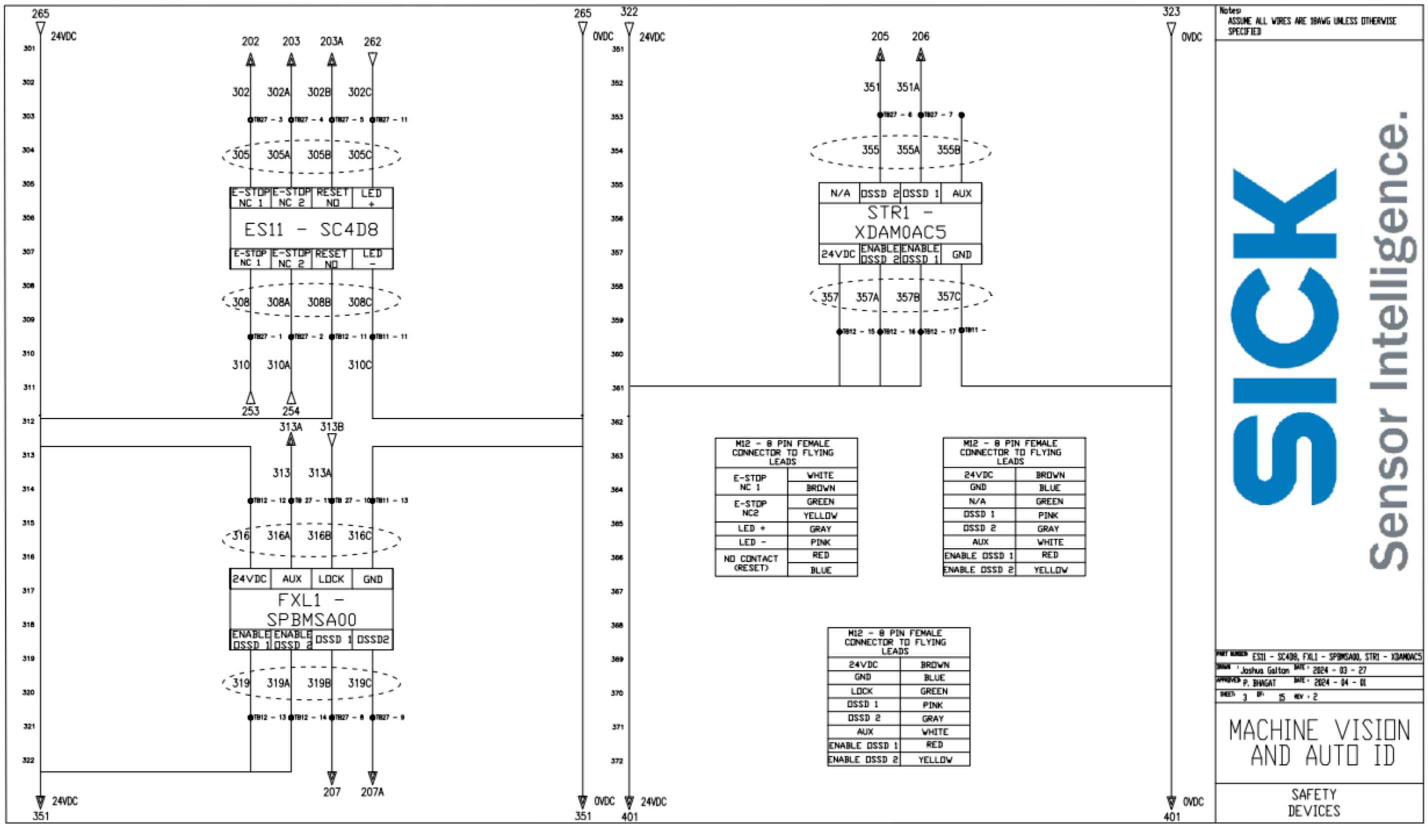
Attached below are all the electrical drawings related to the project cell.

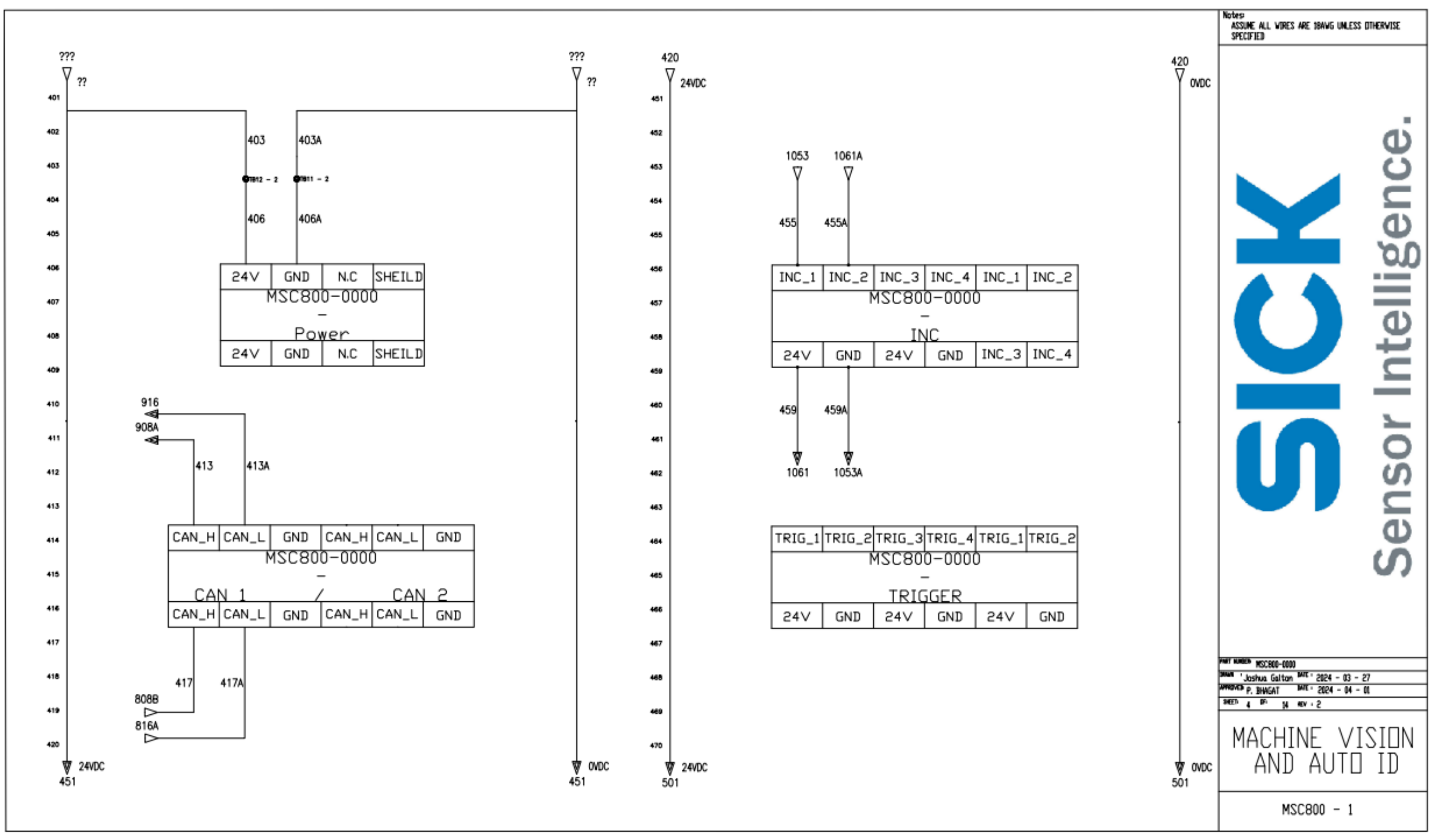

Wire Tray
Wire Tray
SICK
MSC800
Wire Tray
Wire Tray
Cable Tray
MACHINE VISION
AND AUTO ID
PANEL
LAYOUT
SICK
Sensor Intelligence.

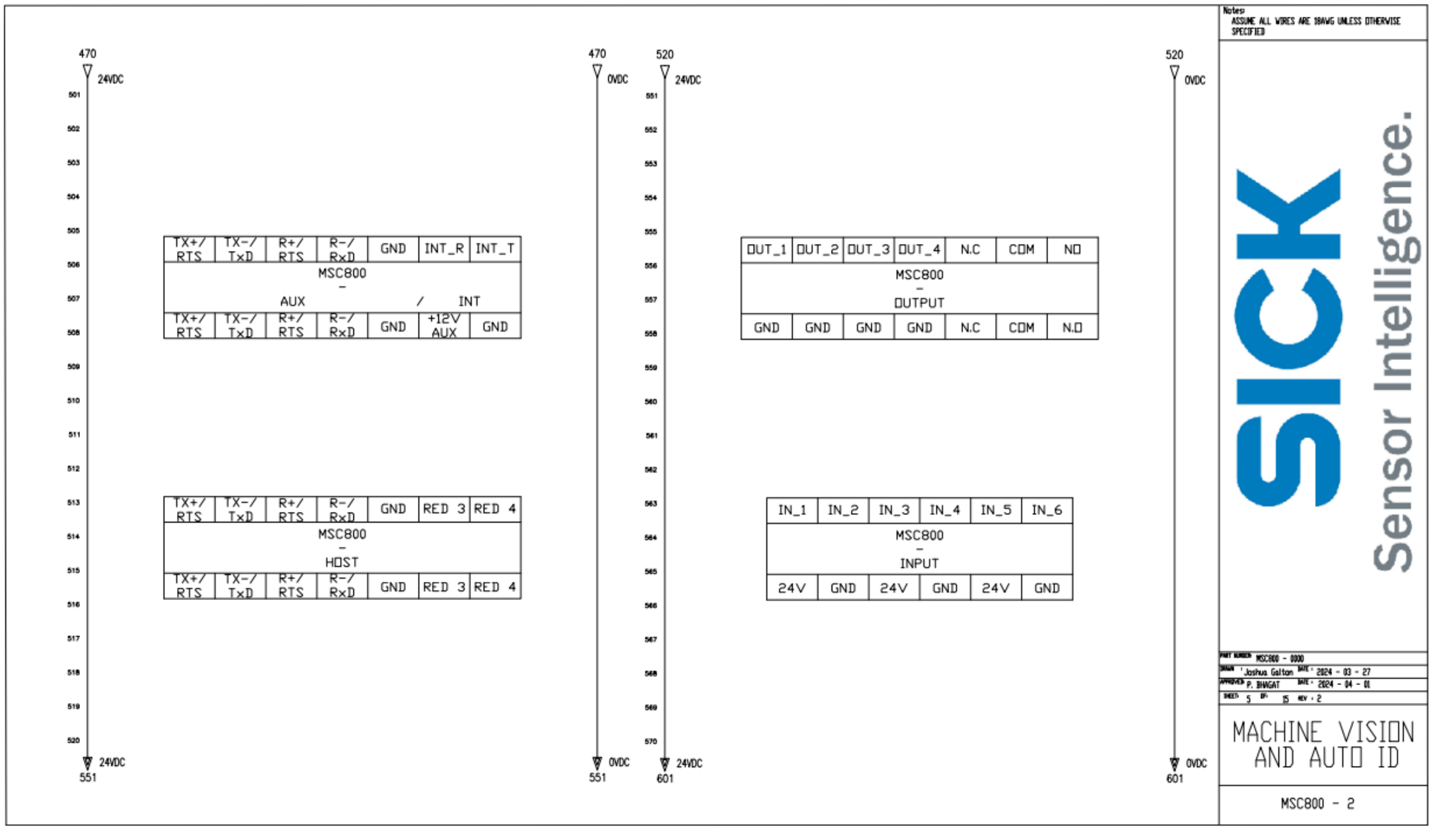

530.2250mm
406.4000mm
300.0375mm
241.3000mm
184.9438mm
83.3438mm
0.0000mm
0.0000mm
20.6375mm
149.2250mm
261.8750mm
398.4625mm
16 X M6 (TAPPED)
MACHINE VISION AND AUTO ID
PANEL TEMPLATE
SICK
Sensor Intelligence.

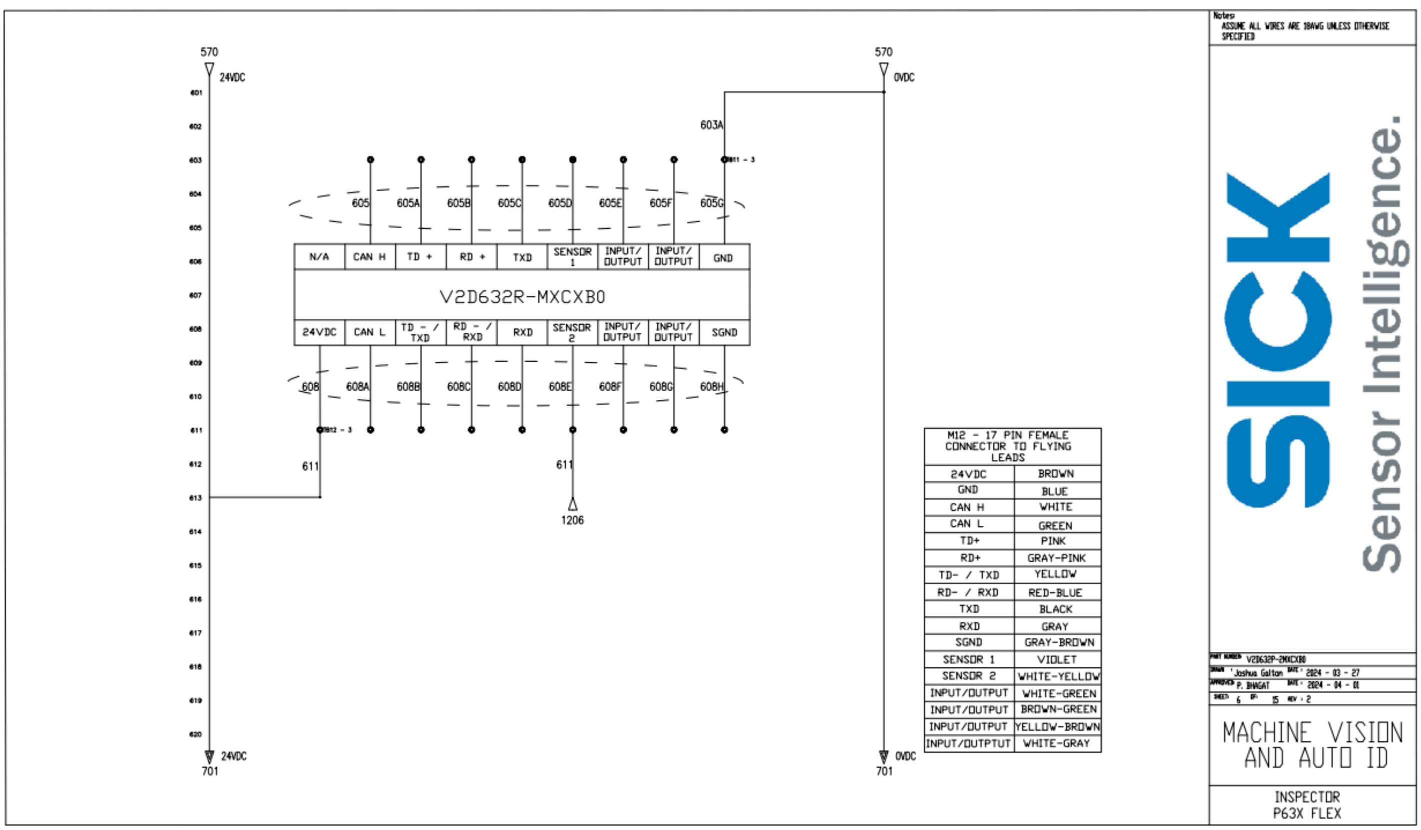

120VAC
NEUTRAL
POWER BLOCK
12AWG
12AWG
12AWG
Line Breaker
2A
112
113
114
120VAC/24VDC
L
GND
L2/N
240W/360W
DC Power Fuse
113A
113B
24VDC
114
0VDC
120VAC
1301
NEUTRAL
1301
SICK
Sensor Intelligence.
MACHINE VISION
AND AUTO ID
POWER CIRCUIT


SICK
FLEX - CPU200
SAFETY CONTROLLER
24VDC 20-PT SAFETY INPUT
SICK
FLEX - CPU200
SAFETY CONTROLLER
24VDC 8-PT SAFETY OUTPUT & 4-PT TEST OUTPUT
SICK
Sensor Intelligence.
MACHINE VISION
AND AUTO ID
SAFETY
CONTROLLER

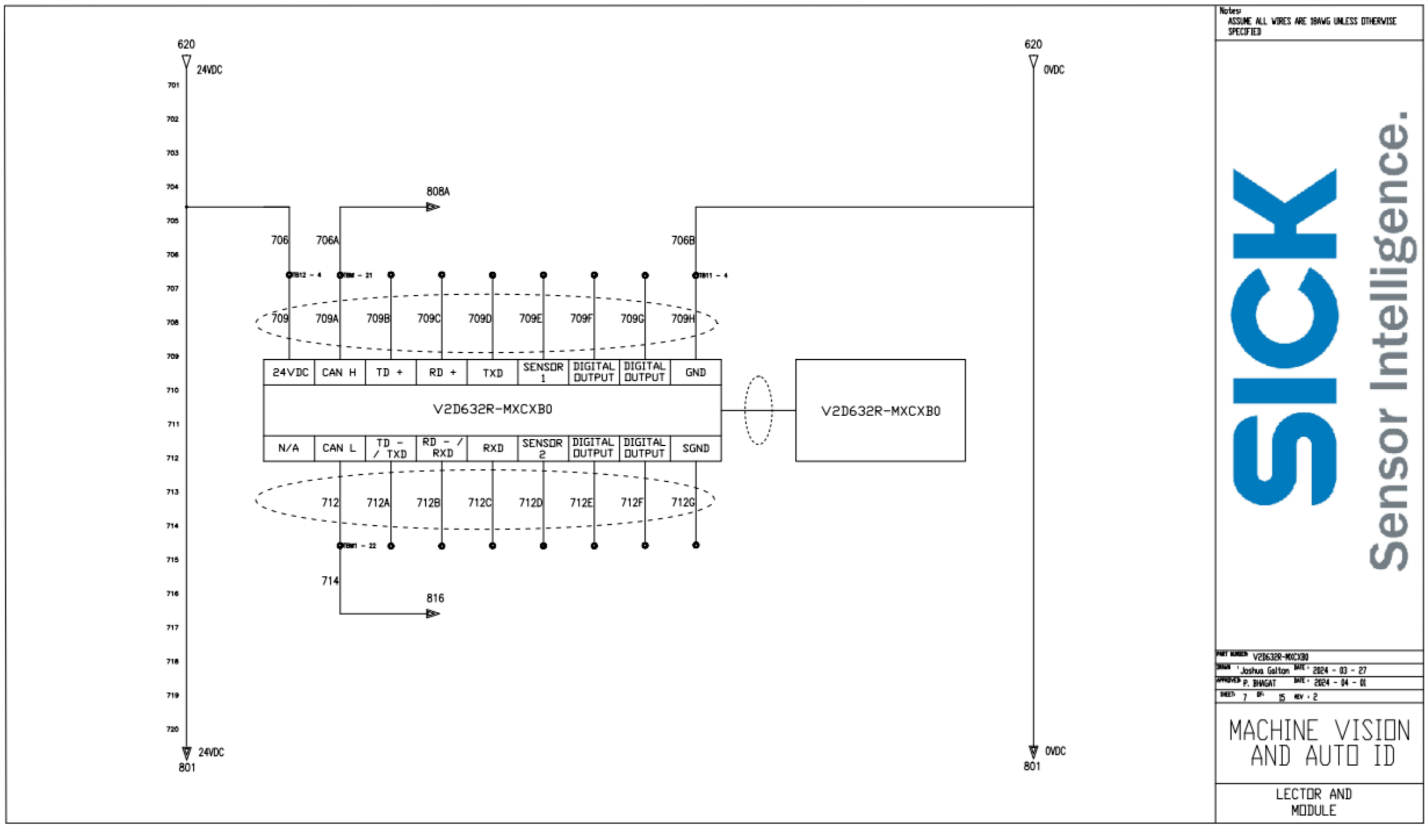

Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
ES11 - SC4D8
FXL1 - SPBMSA00
STR1 - XDAM0AC5
M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS
E-STOP NC 1 WHITE
BROWN
E-STOP NC2 GREEN
YELLOW
LED + GRAY
LED - PINK
NO CONTACT (RESET) RED
BLUE
M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS
24VDC BROWN
GND BLUE
N/A GREEN
OSSD 1 PINK
OSSD 2 GRAY
AUX WHITE
ENABLE OSSD 1 RED
ENABLE OSSD 2 YELLOW
M12 - 8 PIN FEMALE CONNECTOR TO FLYING LEADS
24VDC BROWN
GND BLUE
LOCK GREEN
OSSD 1 PINK
OSSD 2 GRAY
AUX WHITE
ENABLE OSSD 1 RED
ENABLE OSSD 2 YELLOW
SICK Sensor Intelligence.
PART NUMBER ES11 - SC4D8, FXL1 - SPBMSA00, STR1 - XDAM0AC5
DRAWN Joshua Galton DATE 2024 - 03 - 27
APPROVED P. BHAGAT DATE 2024 - 04 - 01
SHEET 3 OF 15 REV 2
MACHINE VISION AND AUTO ID
SAFETY DEVICES


Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
MSC800-0000 - Power
MSC800-0000 - CAN 1 / CAN 2
MSC800-0000 - INC
MSC800-0000 - TRIGGER
SICK Sensor Intelligence.
PART NUMBER MSC800-0000
DRAWN Joshua Galton DATE 2024 - 03 - 27
APPROVED P. BHAGAT DATE 2024 - 04 - 01
SHEET 4 OF 14 REV 2
MACHINE VISION AND AUTO ID
MSC800 - 1

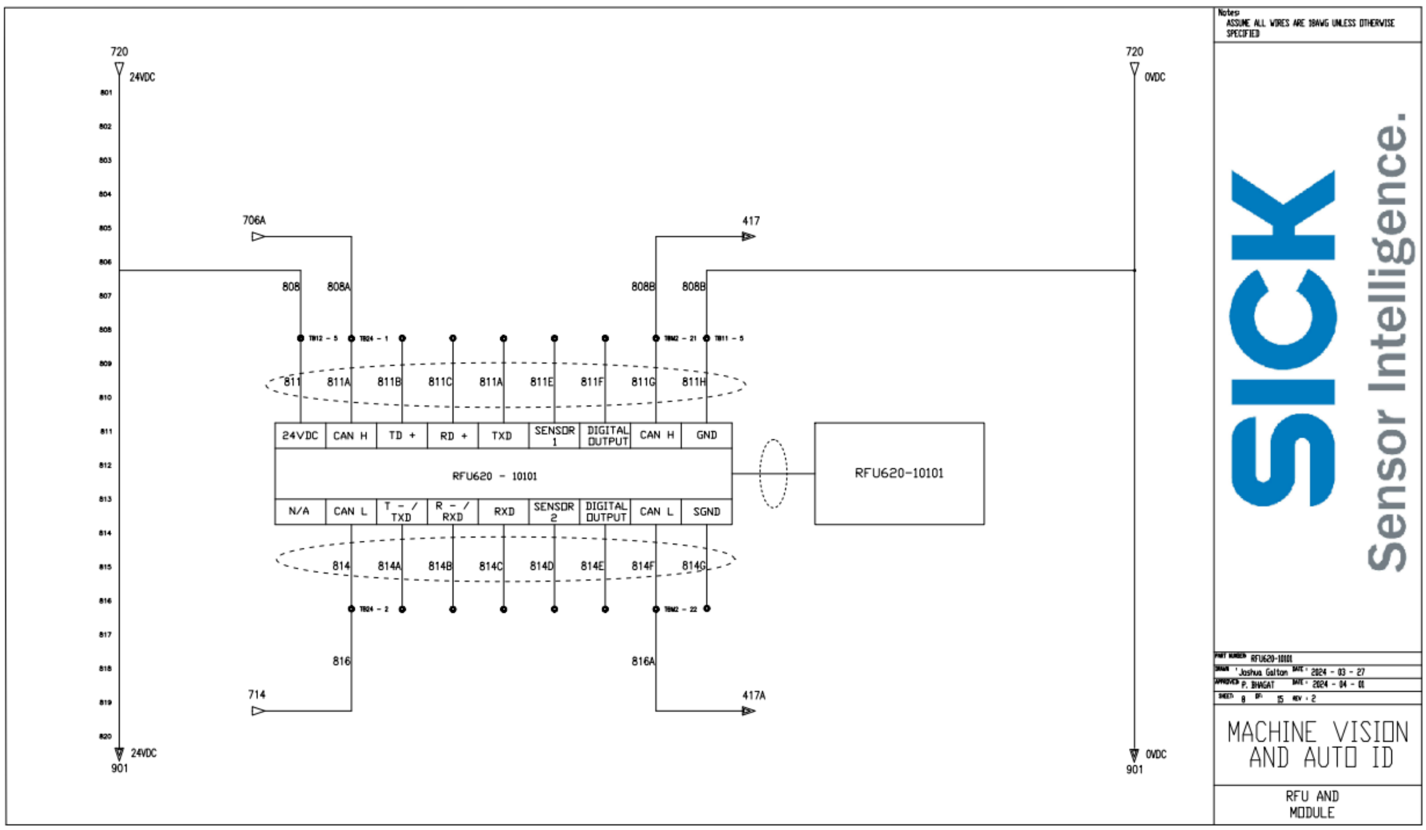




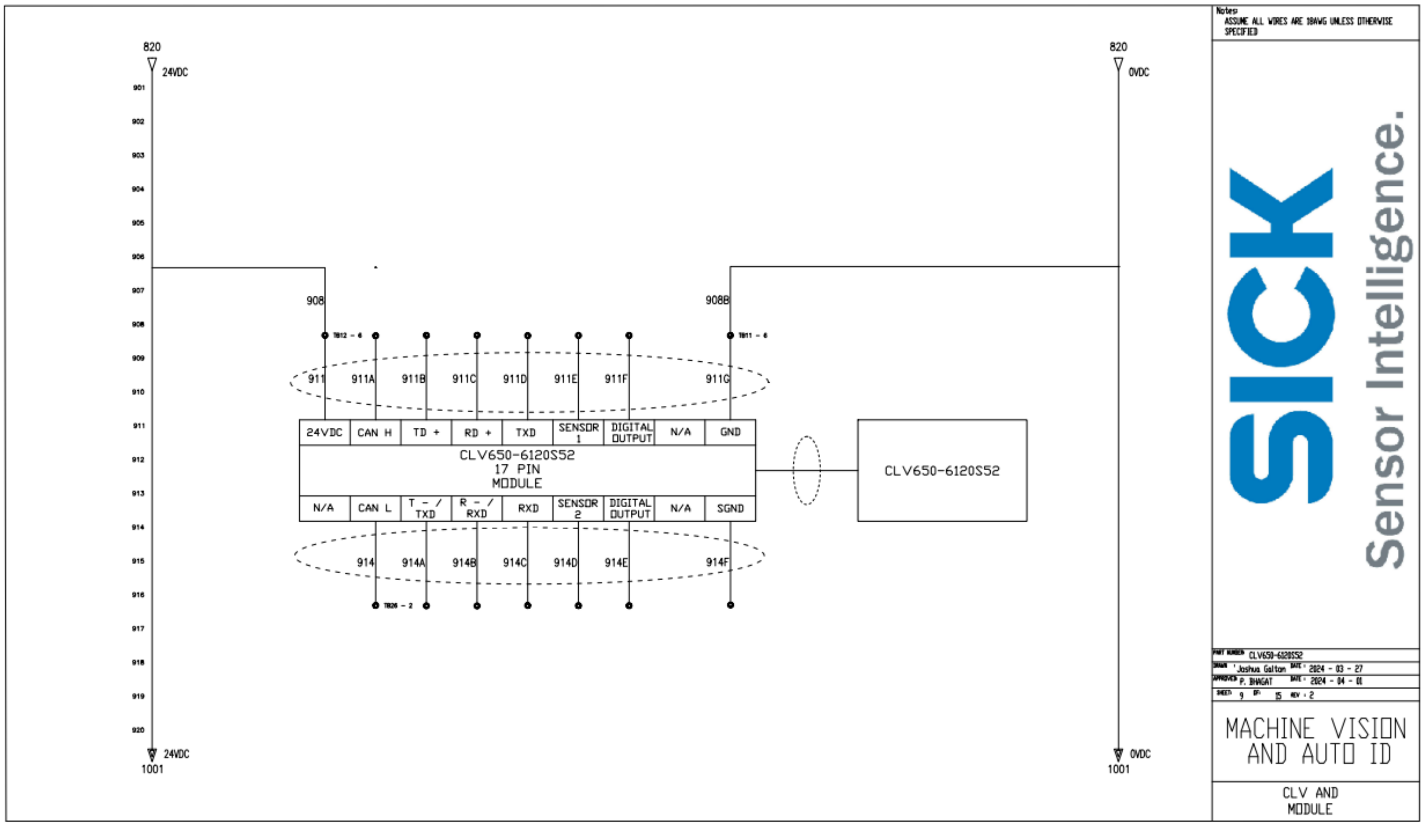
M12 - 17 PIN FEMALE CONNECTOR TO FLYING LEADS	
24VDC	BROWN
GND	BLUE
CAN H	WHITE
CAN L	GREEN
TD+	PINK
RD+	GRAY-PINK
TD- / TXD	YELLOW
RD- / RXD	RED-BLUE
TXD	BLACK
RXD	GRAY
SGND	GRAY-BROWN
SENSOR 1	VIOLET
SENSOR 2	WHITE-YELLOW
INPUT/OUTPUT	WHITE-GREEN
INPUT/OUTPUT	BROWN-GREEN
INPUT/OUTPUT	YELLOW-BROWN
INPUT/OUTPUT	WHITE-GRAY

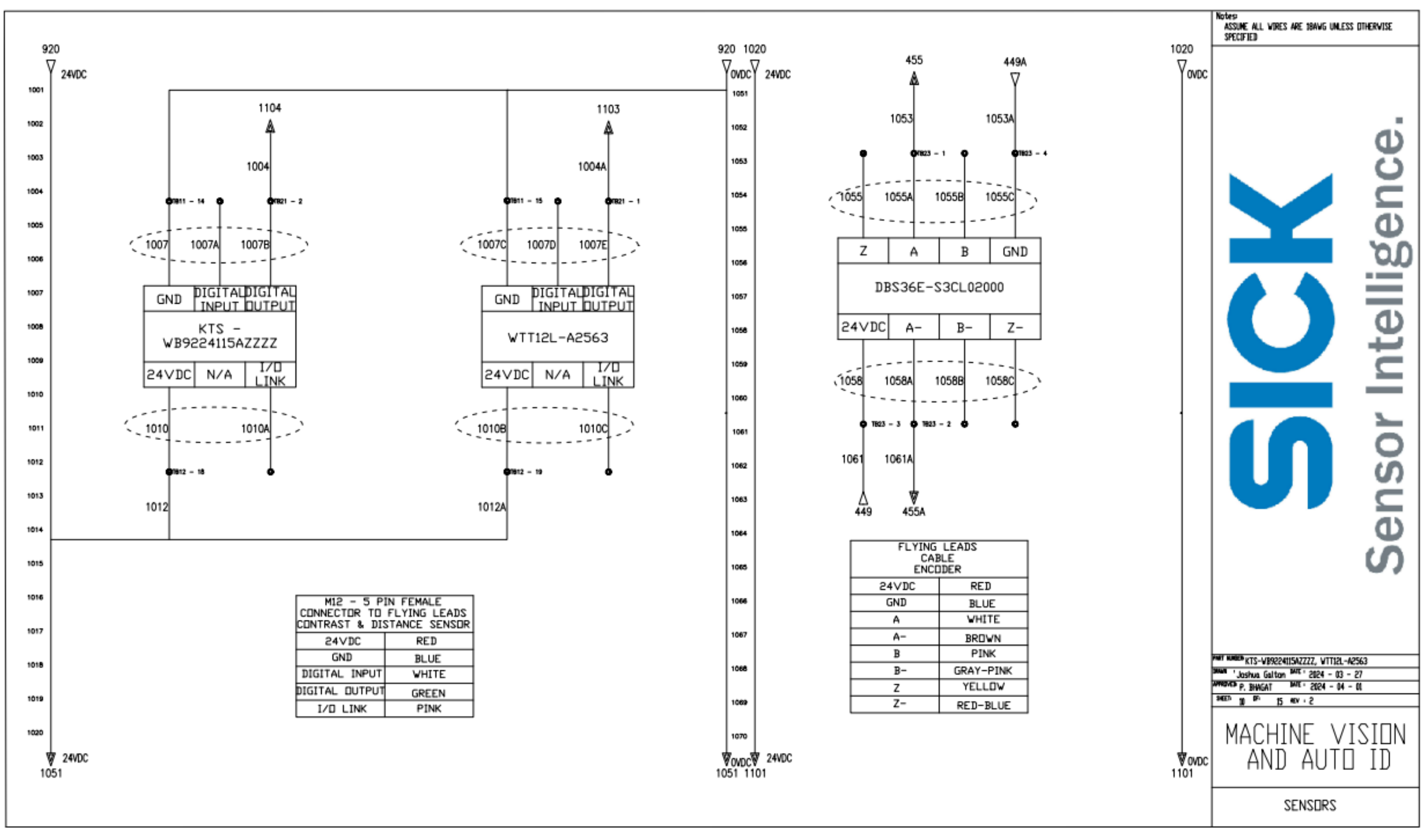


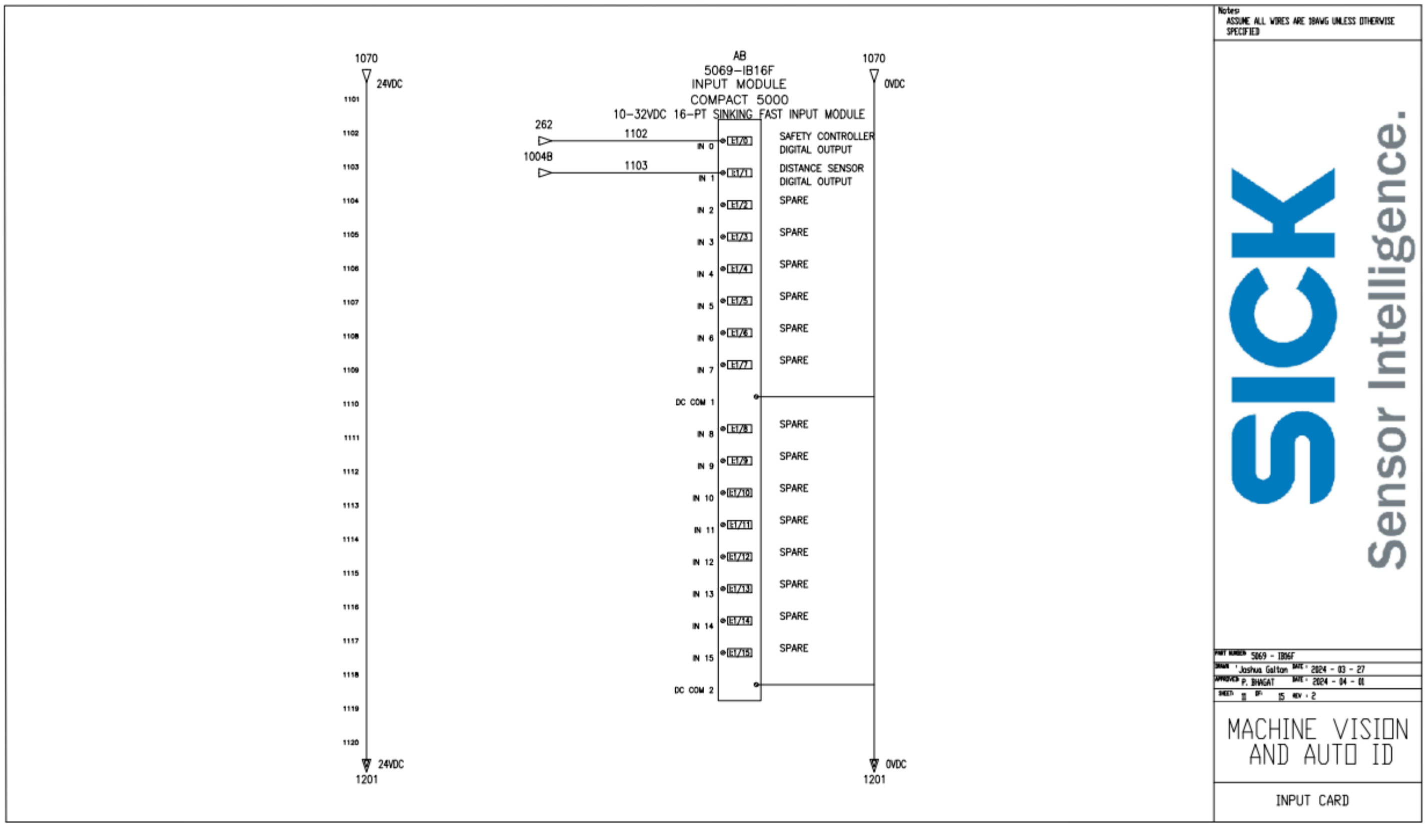
Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
24VDC
0VDC
V2D632R-MXCXB0
24VDC
CAN H
TD +
RD +
TXD
SENSOR 1
DIGITAL OUTPUT
GND
N/A
CAN L
TD - / TXD
RD - / RXD
RXD
SENSOR 2
SGND
SICK
Sensor Intelligence.
PART NUMBER V2D632R-MXCXB0
DRAWN Joshua Galton DATE 2024 - 03 - 27
APPROVED P. BHAGAT DATE 2024 - 04 - 01
SHEET 7 OF 15 REV 2
MACHINE VISION AND AUTO ID
LECTOR AND MODULE

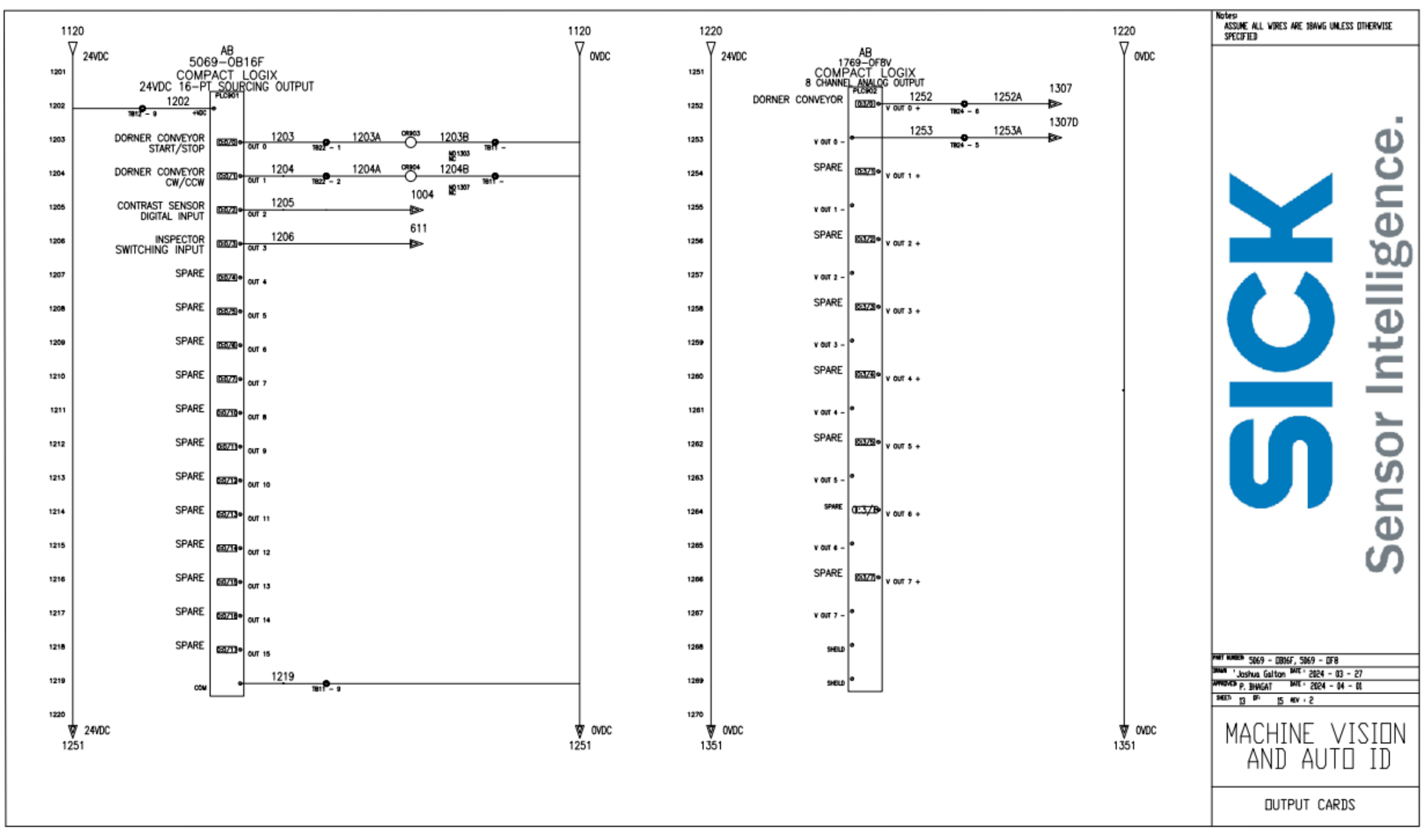


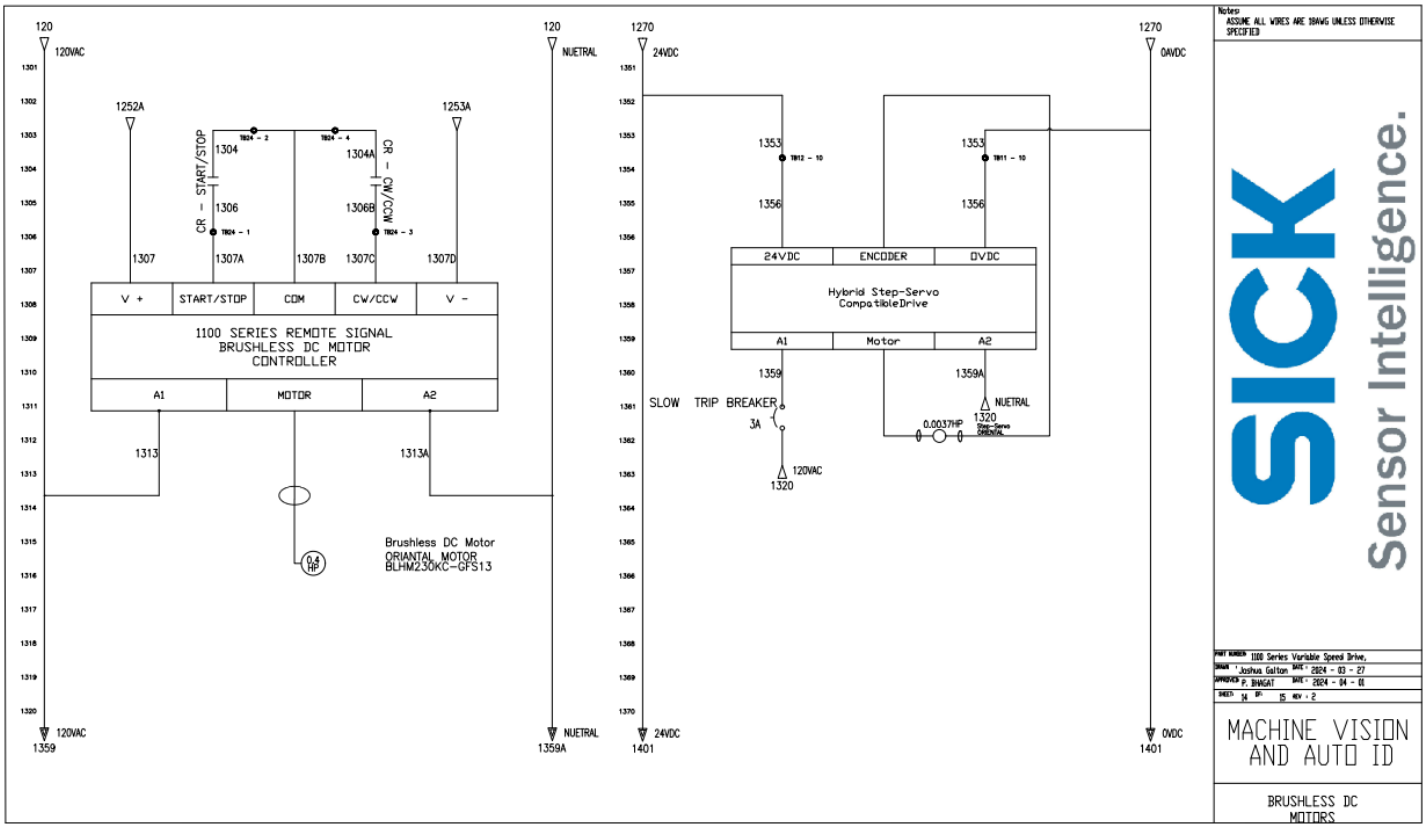
Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
24VDC
0VDC
RFU620 - 10101
RFU620-10101
24VDC
CAN H
TD +
RD +
TXD
SENSOR 1
DIGITAL OUTPUT
GND
N/A
CAN L
T - / TXD
R - / RXD
RXD
SENSOR 2
CAN L
SGND
SICK
Sensor Intelligence.
PART NUMBER RFU620-10101
DRAWN Joshua Galton DATE 2024 - 03 - 27
APPROVED P. BHAGAT DATE 2024 - 04 - 01
SHEET 8 OF 15 REV 2
MACHINE VISION AND AUTO ID
RFU AND MODULE


Notes: ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
820
24VDC
0VDC
908
908B
911 911A 911B 911C 911D 911E 911F 911G
24VDC CAN H TD + RD + TXD SENSOR 1 DIGITAL OUTPUT N/A GND
CLV650-6120S52
17 PIN
MODULE
N/A CAN L T - / TXD R - / RXD RXD SENSOR 2 DIGITAL OUTPUT N/A SGND
914 914A 914B 914C 914D 914E 914F
CLV650-6120S52
1001
SICK
Sensor Intelligence.
PART NUMBER: CLV650-6120S52
DRAWN: Joshua Galton DATE: 2024 - 03 - 27
APPROVED: P. BHAGAT DATE: 2024 - 04 - 01
SHEET: 9 OF: 15 REV: 2
MACHINE VISION AND AUTO ID
CLV AND MODULE

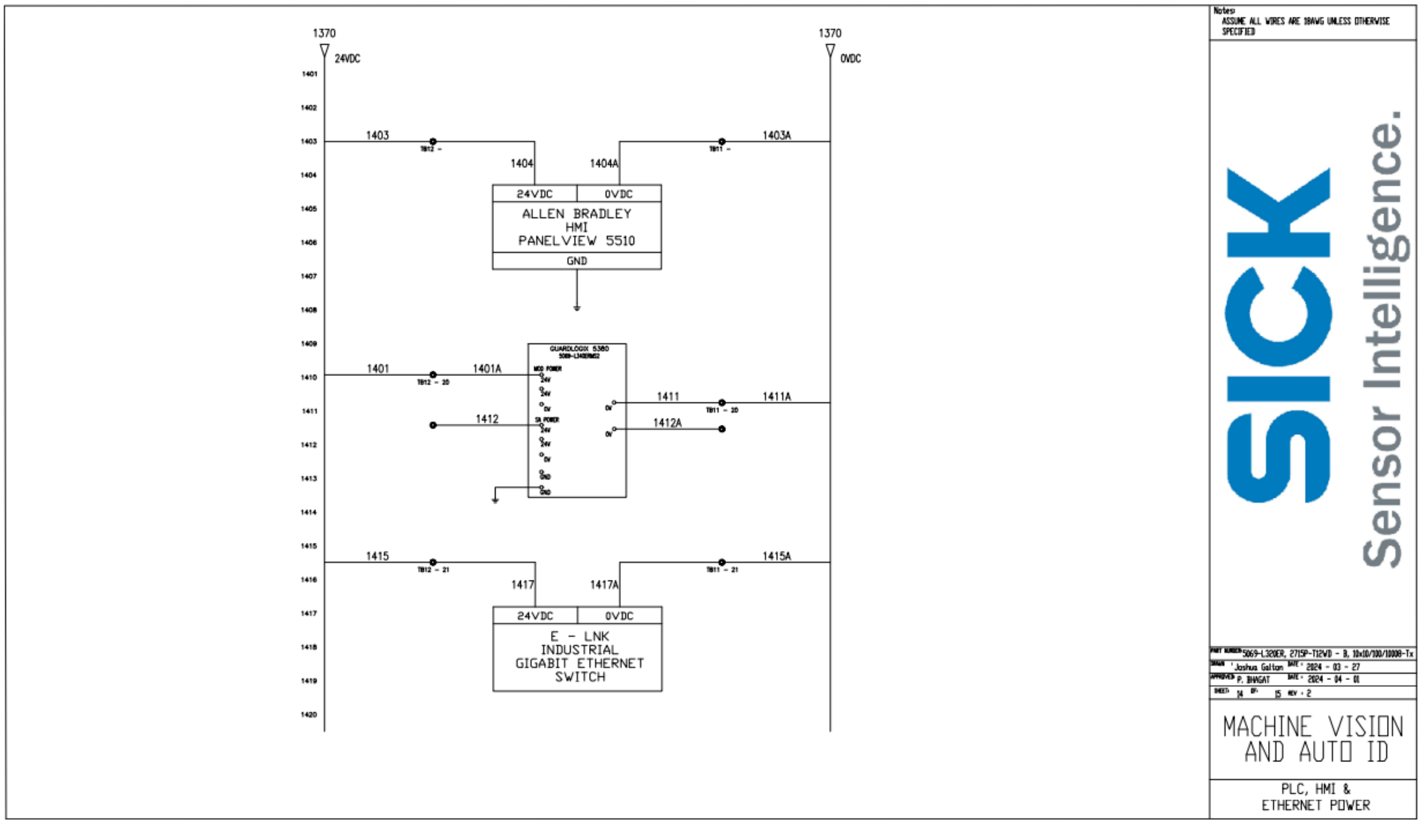

Notes: ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
920
24VDC
1020
0VDC
1104
1103
1004
1004A
1007 1007A 1007B
1007C 1007D 1007E
GND DIGITAL INPUT DIGITAL OUTPUT
KTS - WB9224115AZZZZ
WTT12L-A2563
24VDC N/A I/O LINK
1010 1010A
1010B 1010C
1012
1012A
M12 - 5 PIN FEMALE CONNECTOR TO FLYING LEADS CONTRAST & DISTANCE SENSOR
24VDC RED
GND BLUE
DIGITAL INPUT WHITE
DIGITAL OUTPUT GREEN
I/O LINK PINK
455
449A
1053
1053A
1055 1055A 1055B 1055C
Z A B GND
DBS36E-S3CL02000
24VDC A- B- Z-
1058 1058A 1058B 1058C
1061
1061A
449
455A
FLYING LEADS CABLE ENCODER
24VDC RED
GND BLUE
A WHITE
A- BROWN
B PINK
B- GRAY-PINK
Z YELLOW
Z- RED-BLUE
1051
1101
SICK
Sensor Intelligence.
PART NUMBER: KTS-WB9224115AZZZZ, WTT12L-A2563
DRAWN: Joshua Galton DATE: 2024 - 03 - 27
APPROVED: P. BHAGAT DATE: 2024 - 04 - 01
SHEET: 10 OF: 15 REV: 2
MACHINE VISION AND AUTO ID
SENSORS


Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
AB
5069–IB16F
INPUT MODULE
COMPACT 5000
10–32VDC 16–PT SINKING FAST INPUT MODULE
1070
24VDC
0VDC
262
1102
1004B
1103
SAFETY CONTROLLER DIGITAL OUTPUT
DISTANCE SENSOR DIGITAL OUTPUT
SPARE
DC COM 1
DC COM 2
1201
SICK
Sensor Intelligence.
MACHINE VISION AND AUTO ID
INPUT CARD

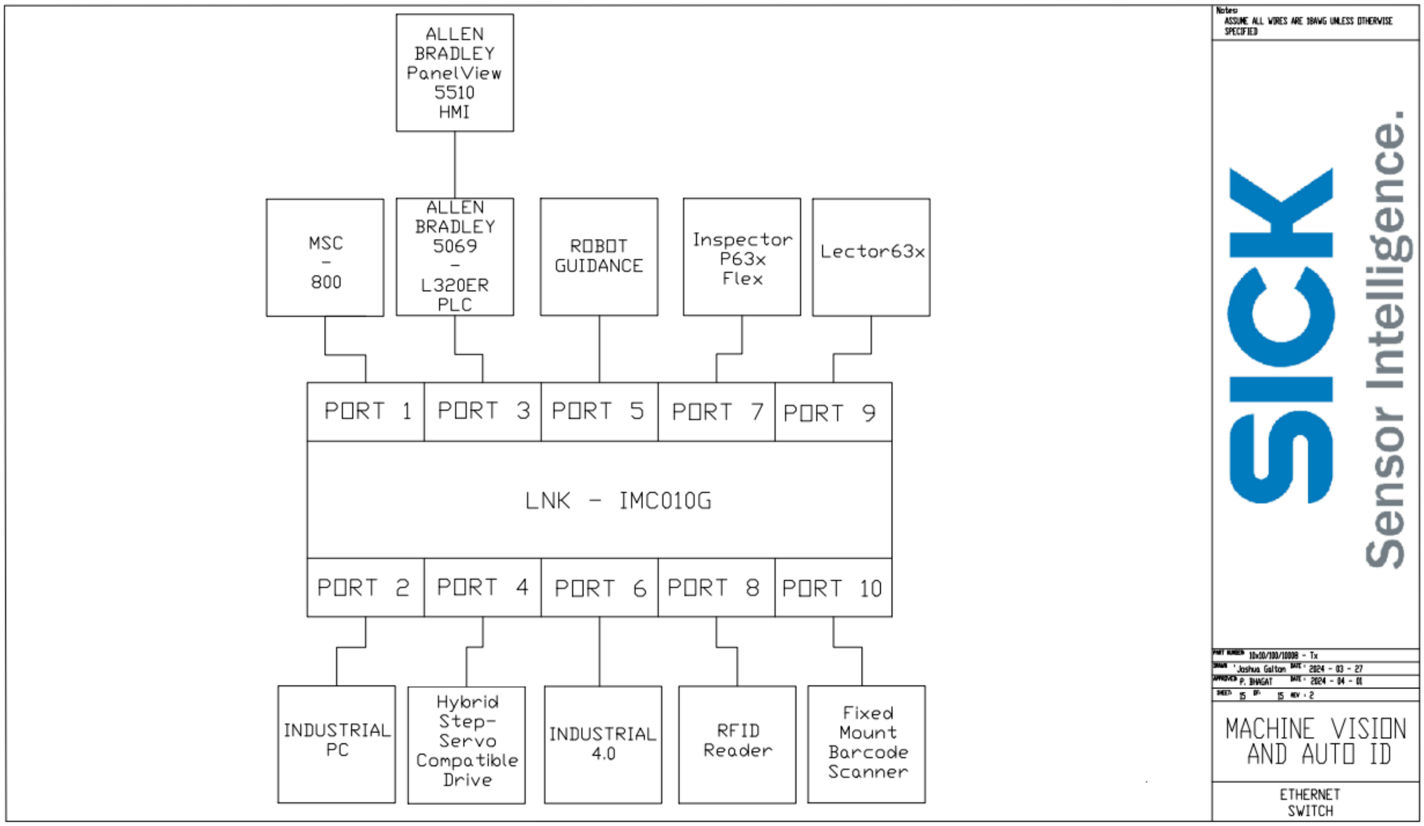

Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
AB
5069–OB16F
COMPACT LOGIX
24VDC 16–PT SOURCING OUTPUT
1120
24VDC
0VDC
1202
DORNER CONVEYOR START/STOP
1203
1203A
1203B
DORNER CONVEYOR CW/CCW
1204
1204A
1204B
1004
CONTRAST SENSOR DIGITAL INPUT
1205
INSPECTOR SWITCHING INPUT
1206
611
SPARE
COM
1219
1251
AB
1769–OF8V
COMPACT LOGIX
8 CHANNEL ANALOG OUTPUT
1220
DORNER CONVEYOR
1252
1252A
1307
1253
1253A
1307D
SPARE
1351
SICK
Sensor Intelligence.
MACHINE VISION AND AUTO ID
OUTPUT CARDS



Notes: ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
1100 SERIES REMOTE SIGNAL BRUSHLESS DC MOTOR CONTROLLER
Brushless DC Motor ORIANTAL MOTOR BLHM230KC-GFS13
Hybrid Step-Servo CompatibleDrive
SLOW TRIP BREAKER
SICK Sensor Intelligence.
1100 Series Variable Speed Drive,
Joshua Galton 2024 - 03 - 27
P. BHAGAT 2024 - 04 - 01
MACHINE VISION AND AUTO ID
BRUSHLESS DC MOTORS

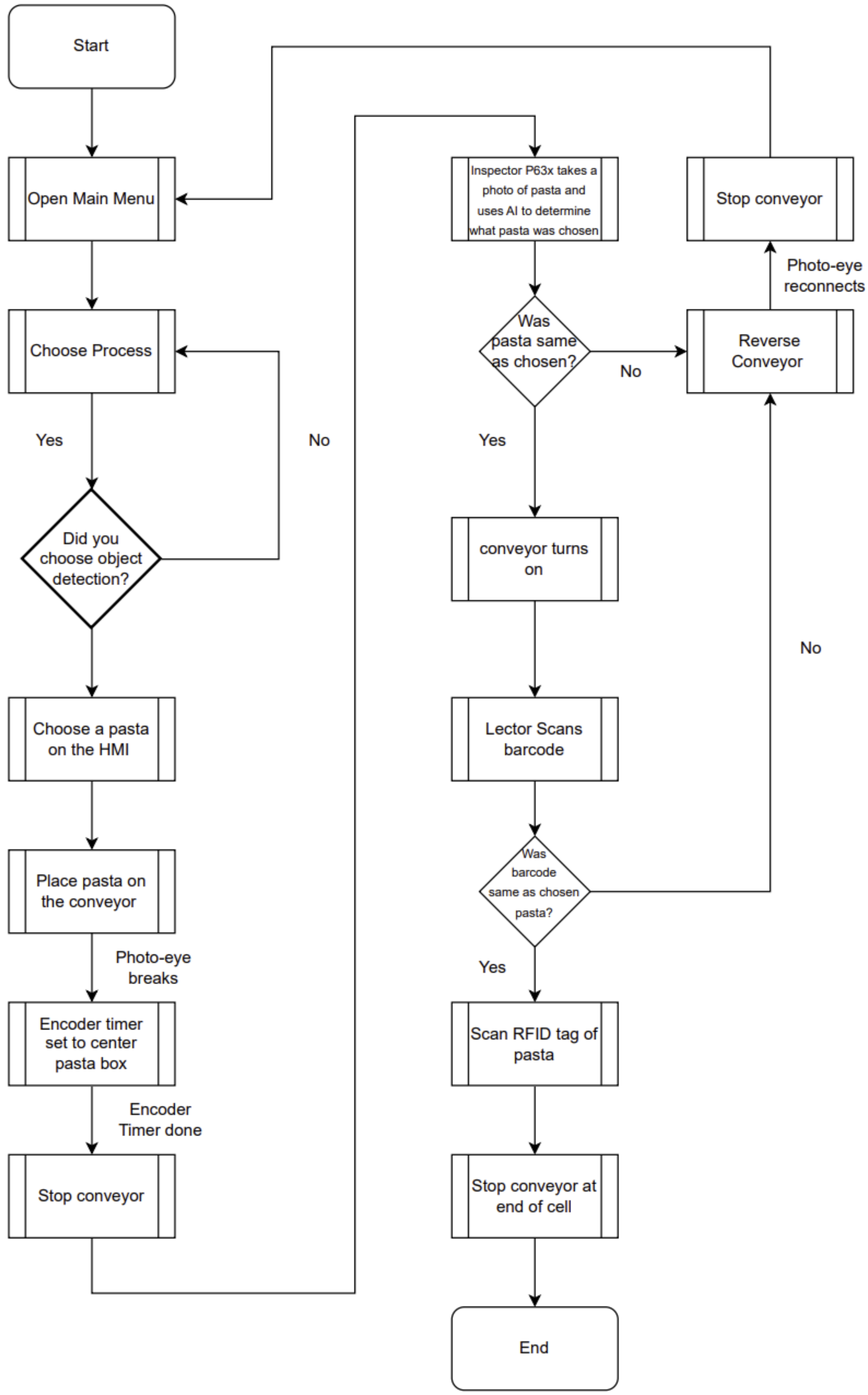


Notes: ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
ALLEN BRADLEY HMI PANELVIEW 5510
GUARDLOGIX 5380
E - LNK INDUSTRIAL GIGABIT ETHERNET SWITCH
SICK Sensor Intelligence.
Joshua Galton 2024 - 03 - 27
P. BHAGAT 2024 - 04 - 01
MACHINE VISION AND AUTO ID
PLC, HMI & ETHERNET POWER

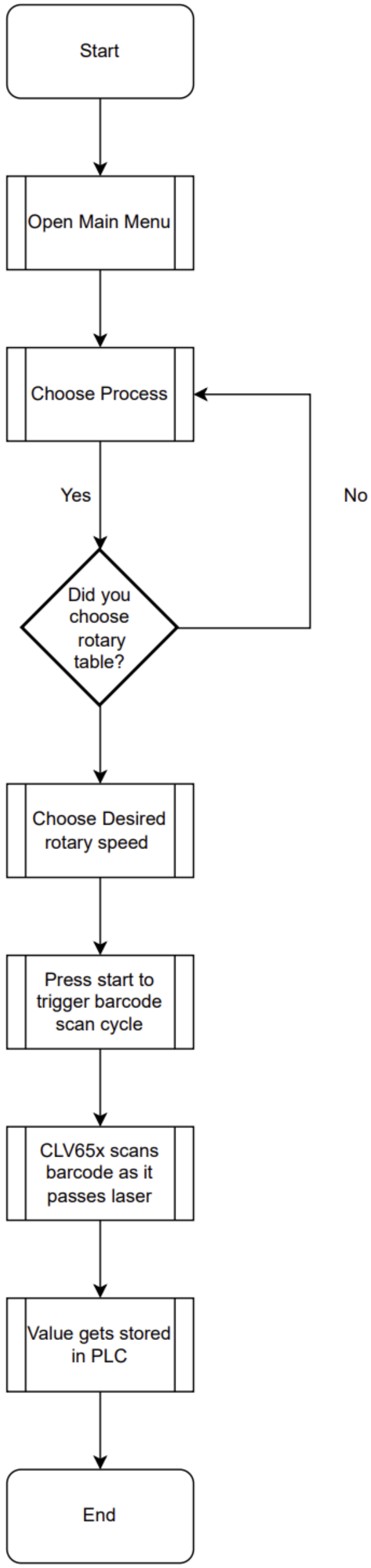


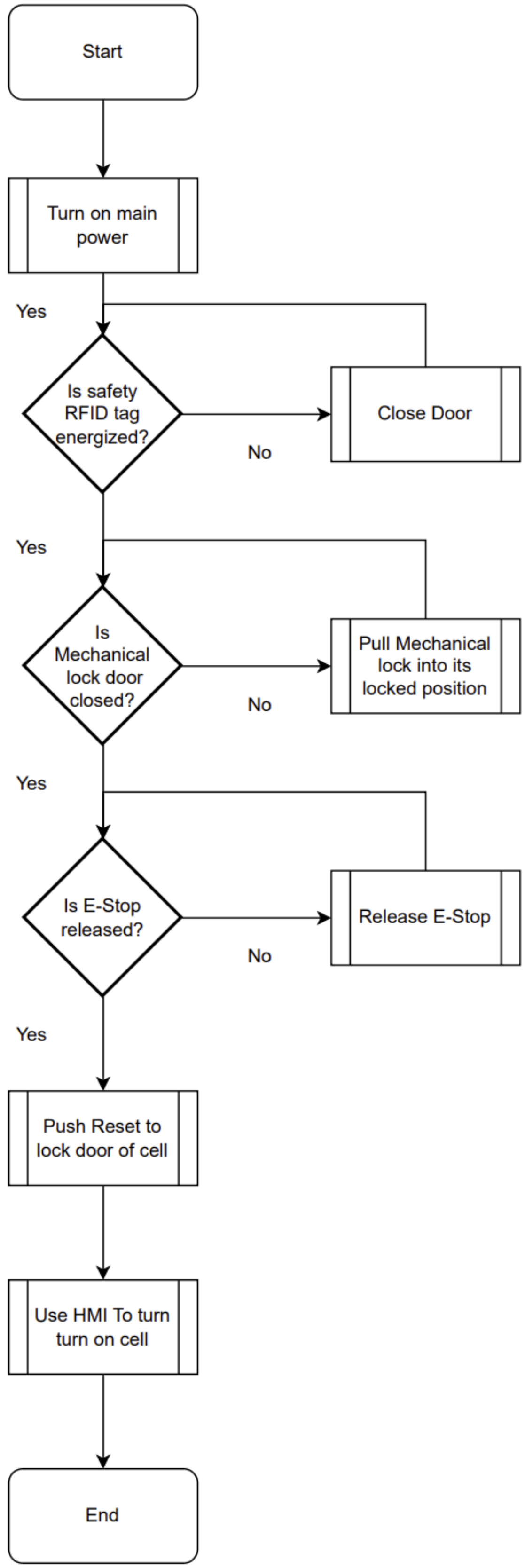
ALLEN BRADLEY PanelView 5510 HMI
MSC - 800
ALLEN BRADLEY 5069 - L320ER PLC
ROBOT GUIDANCE
Inspector P63x Flex
Lector63x
PORT 1
PORT 3
PORT 5
PORT 7
PORT 9
LNK - IMC010G
PORT 2
PORT 4
PORT 6
PORT 8
PORT 10
INDUSTRIAL PC
Hybrid Step-Servo Compatible Drive
INDUSTRIAL 4.0
RFID Reader
Fixed Mount Barcode Scanner
Notes:
ASSUME ALL WIRES ARE 18AWG UNLESS OTHERWISE SPECIFIED
SICK
Sensor Intelligence.
PART NUMBER: 10x10/100/1000B - Tx
DRAWN: Joshua Galton DATE: 2024 - 03 - 27
APPROVED: P. BHAGAT DATE: 2024 - 04 - 01
SHEET: 15 OF: 15 REV: 2
MACHINE VISION AND AUTO ID
ETHERNET SWITCH

Process Flow Diagram – Object Detection



Process Flow Diagram – Rotary Operation




Start
Turn on main power
Yes
Is safety RFID tag energized?
No
Close Door
Yes
Is Mechanical lock door closed?
No
Pull Mechanical lock into its locked position
Yes
Is E-Stop released?
No
Release E-Stop
Yes
Push Reset to lock door of cell
Use HMI To turn turn on cell
End