PLC Based sorting system

1) Executive Summary -

About the system: In the industries, sorting of the finished products is a challenge since it requires manual labor and could be detrimental to the personnel's overall health and physical well-being if the product is heavy, extremely hot or cold, acidic, etc.
This task can also be monotonous and sometimes expensive (added labor cost). Hence, to overcome these shortcomings, we have designed a PLC based product sorting system.

For this system, we are implementing a color sorting mechanism where the system can sort the product as per the color and place them in the right place. The system will count the number of items and will notify the operator if the capacity of the stack is full and needs to be replaced with an empty one.

The system has discrete color sensors which will identify if the product goes into the stack in the front or let it pass through. If the sensor identify the right colour, the product is taken into the stack. The counters will count the number of products for each color. The conveyor belt will come to a halt if the stack is not being replaced with an empty one and one more of the same product has arrived at the place. The lights will tell the operator to change the stack.

Safety measures are taken into the account. Any operator comes near the robots, conveyor belt, motors etc, the system will be paused. And will resume when the operator is at a safe distance from the system. E-stop switch is being implemented inside the program to let the operator halt the operation until e-stop is released.

Required PLCs: For this system implementation, we have selected the ControlLogix system 1756 series PLC. This PLC is ideal for control application with EtherNet/IP™ for communication, has an expandable memory for fast program download and run.

Required input devices: Following input devices are used in the system

- Color sensors - used to read the color of the device
- Main Switch - Switch for the system to turn ON or completely turn OFF

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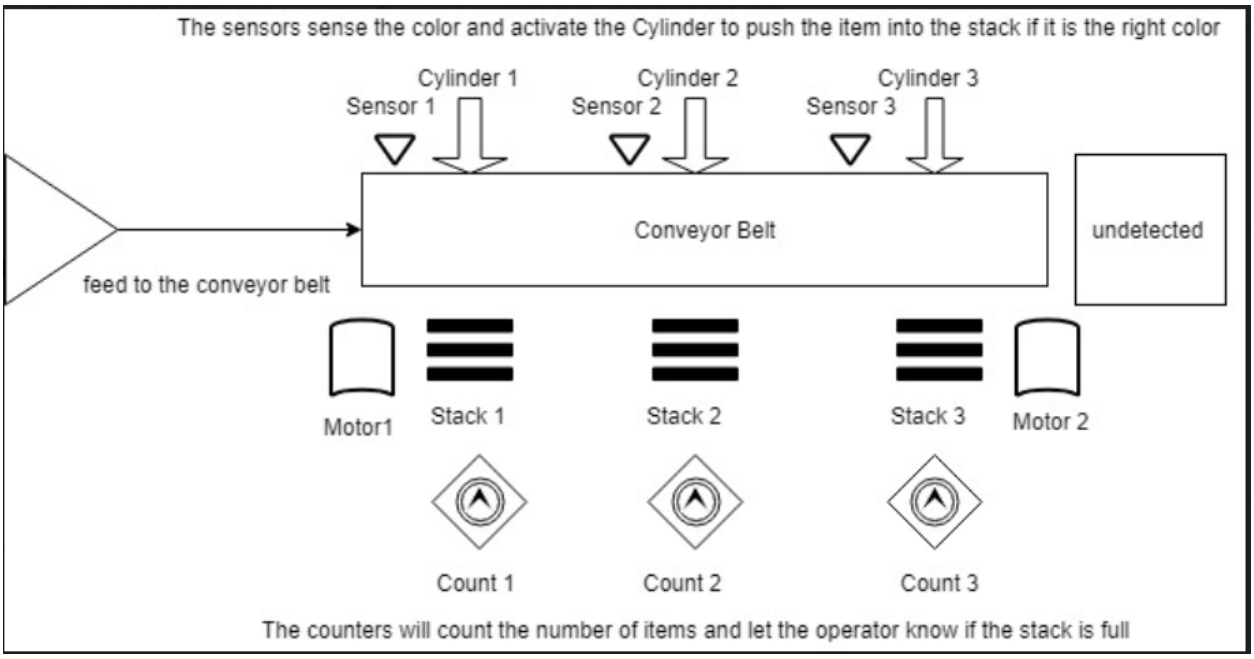
- E-Stop switch - A Normally Closed contact type switch in case of emergency.
- Start, stop switches - Push buttons for starting the system and stopping whenever is required
- Safety light curtains

Required output devices: Following output devices will be used:

- DC motors - Motors used to run the conveyor belt.
- Pneumatic cylinders - Used to PUSH the item into the stack
- Emergency Light - In case there is a system shutdown or hold because of any safety issues, this light will go on.
- Stack-full lights (turns ON when the stack is full) - one for each color. Whenever the stack is full, this light will turn on indicating which stack is full needs to be replaced.

General Graphic of the system: The graphic is made to understand the model in a simplistic manner. Here, Sensors are the color sensor, Cylinders are the Pneumatic Cylinders, Count are the attached counters.



Working environment of the system:

Temperature - This system is expected to work in normal conditions. The system can be kept inside the production facility with the Temperature (Ta) specified as 32 °F < Ta < 140 °F in the documentation of AB 1769 CompactLogix PLC.

Humidity - Humidity limits are specified as 5% to 95% non-condensing

Vibration - Though we will make sure that the PLC is attached to the place which is free from vibration still the specified limit as per the documentation is given as 2 g @ 10…500 Hz

Conditions - The system is designed as a part of the production facility. Hence it is assumed that the system will be inside the facility (indoor).

2) Full description of the system:

Working of the system:

- The process starts with the feeding of the part on the conveyor belt. As soon as the product is placed on the belt, the belt starts moving, the product is sensed with the help of the proximity sensor attached at the end of the belt.
- The product pass by the color sensors which are essentially discrete and are designed to identify a certain type of color. If the sensor identify it as a desired color, it will send a true signal to the PLC and the pneumatic cylinder will push the product into the stack which is placed right opposite to the sensor and the cylinder.
- Similarly, the product will pass through all the sensors and is checked for its particular type and is then pushed into the respective stack. In case, if due to a defect or some other reason the product was not able to qualify for any sensor, the defective stack is at the end of the conveyor where it will be counted using a laser sensor so to count the parts not being able to be read and to be checked for defects.
- The counter is attached with the cylinders which will help counting the number of parts being pushed into the stack. This will help the user to avoid overfilling the stack and could be replaced when the stack is full. Once the stack is full, the light will turn on indicating the user to change the stack and place an empty one. Once a stack is full the system stops.

- The operator has to place an empty stack on the place and hit the reset button if and the system will start again.

Environment:

Temperature - This system is expected to work in normal conditions. The system can be kept inside the production facility with the Temperature (Ta) specified as 32 °F < Ta < 140 °F in the documentation of AB 1769 CompactLogix PLC.

Humidity - Humidity limits are specified as 5% to 95% non-condensing

Vibration - Though we will make sure that the PLC is attached to the place which is free from vibration still the specified limit as per the documentation is given as 2 g @ 10…500 Hz

Conditions - The system is designed as a part of the production facility. Hence it is assumed that the system will be inside the facility (indoor).

Further environmental factors are given in the catalog for the AB PLC on the website as:

Environmental Specifications - 1756-IA8D

Attribute	1756-IA8D
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…+85 °C (-40…+185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	CISPR 11, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges

Safety considerations:

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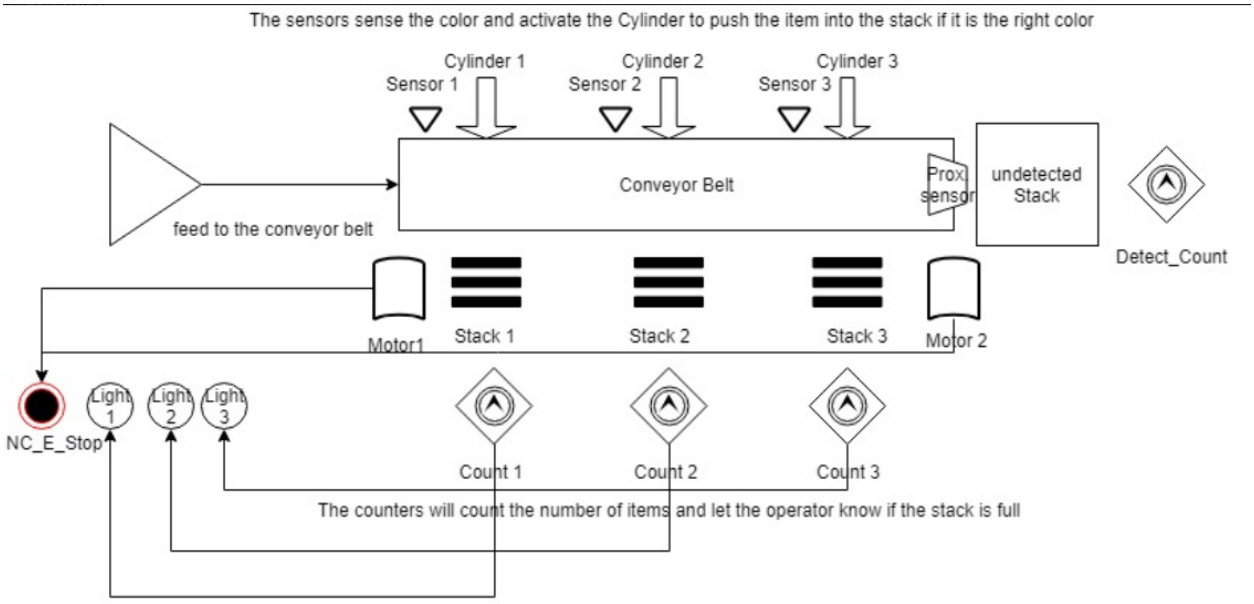
- For the safety, we are using the light curtains around the perimeter. The operator would want to keep a new stack or maybe check some equipment, or maybe accidently fall close to the machine. The light curtains will sense the presence of the operator and immediately halt the working of the system.
- E-Stop switch is given so as to stop the system manually in case is needed. Estop light will turn on in case e-stop switch is pressed. The e-stop switched is retentive and is to be reset before the operation is to proceed
- Main switch is to turn ON and OFF the system.

Graphic of the system:



In the above graphic, the input and output are given as the actual system. The Alias names for the inputs and outputs are used.

3) Logic Flow-Chart of the system:

Below is the given logic chart of the system. All the decision making and the flow is given using the blocks and YES-NO format.

All the Alias tags of the devices used in the system are given for clearer understanding of the system.

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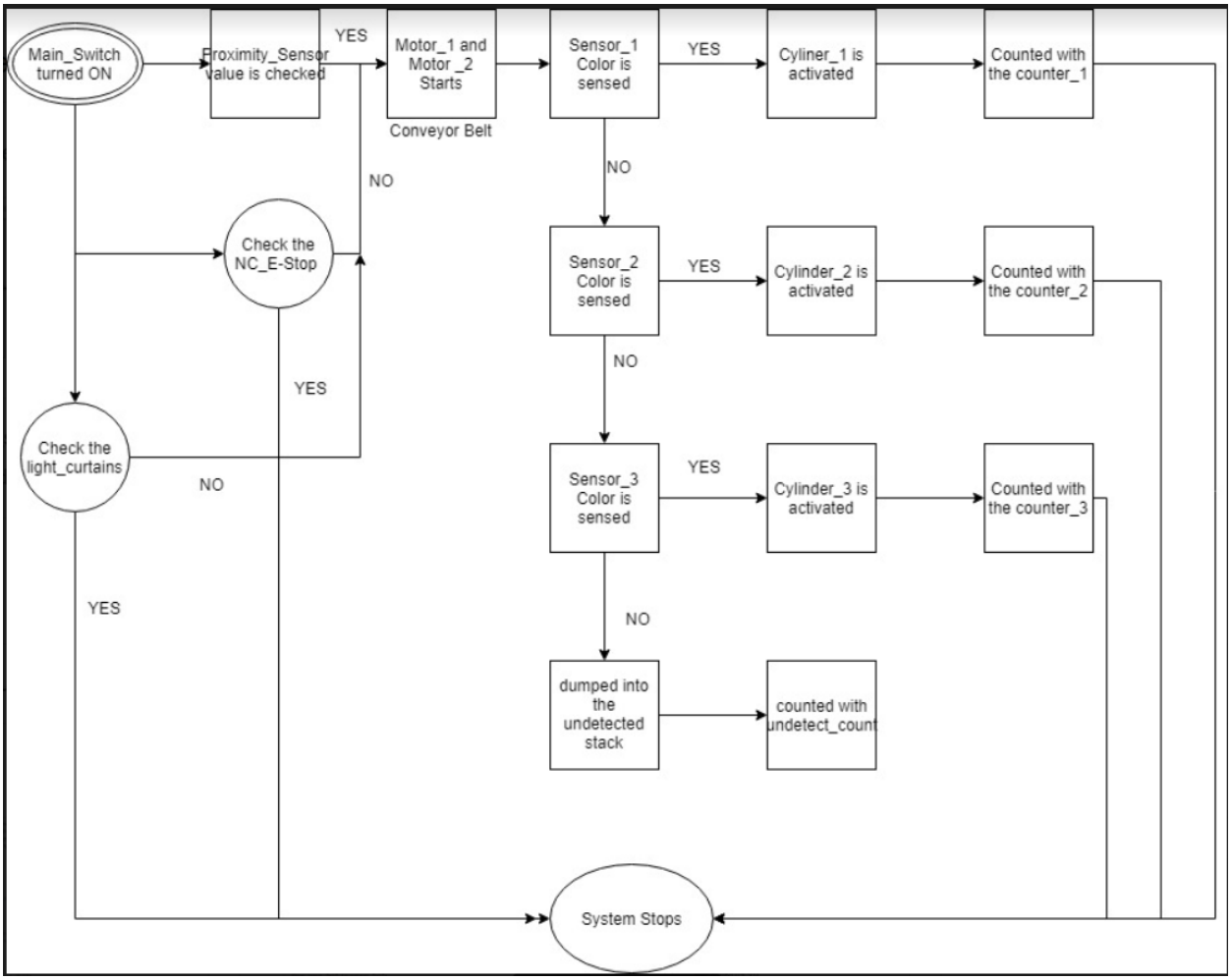

4) Table showing the definition of the devices:

The table is attached showing the details of the devices used in the project with appropriate information. (Excel file submitted as well)

	Logic Function (2)	Alias Tag (1)	Base Tag (10)	I/O (3)	Slot (9)	Device Type (4)	Manufacturer (5)	Device PN (6)	Contact(s) (7)	Notes (8)
1	LED LIGHTS FOR INDICATIONS	Light_1	Local:6:O.Data.11	OUTPUT	6	LED LIGHTS	BANNER AUTOMATION	75671		SELECT THE COLOR AS PER THE REQUIREMENT
2	AC MOTORS TO DRIVE THE CONVEYOR	Motor_1	Local:6:O.Data.3	OUTPUT	6	MOTOR 1	GRAINGERS	26101202		BOTH THE MOTOR SHOULD BE THE SAME FOR UNIFORM SPEED
3	AC MOTORS TO DRIVE THE CONVEYOR	Motor_2	Local:6:O.Data.4	OUTPUT	6	MOTOR 2	GRAINGERS	26101202		
4	TO IDENTIFY THE COLOR OF THE PRODUCTS	Sensor_1	Local:5:I.Data.3	INPUT	5	SENSOR 1	BANNER AUTOMATION	70826		AS PER THE PRODUCT REQUIREMENT
5	TO IDENTIFY THE COLOR OF THE PRODUCTS	Sensor_2	Local:5:I.Data.4	INPUT	5	SENSOR 2	BANNER AUTOMATION	70826		
6	TO IDENTIFY THE COLOR OF THE PRODUCTS	Sensor_3	Local:5:I.Data.5	INPUT	5	SENSOR 3	BANNER AUTOMATION	70826		
7	TO PUSH THE PRODUCTS INTO THE RESPECTIVE STACKS	Cylinder_1_ext	Local:6:O.Data.5	OUTPUT	6	CYLINDER	PARKER	27131701		
8	TO PUSH THE PRODUCTS INTO THE RESPECTIVE STACKS	Cylinder_2_ext	Local:6:O.Data.7	OUTPUT	6	CYLINDER	PARKER	27131701		
9	TO PUSH THE PRODUCTS INTO THE RESPECTIVE STACKS	Cylinder_3_ext	Local:6:O.Data.9	OUTPUT	6	CYLINDER	PARKER	27131701		
10	LIGHT CURTAINS TO ENSURE THE AREA OF SAFETY	LC	Local:5:I.Data.9	INPUT	5	SENSOR	BANNER AUTOMATION	89794		
11	EMERGENCY STOP BUTTON	E_Stop	Local:5:I.Data.15	INPUT	5	BUTTON	BANNER AUTOMATION	25067		SHOULD BE NORMALLY CLOSED AND RETENTIVE
12	START BUTTON	Start_PB_1	Local:5:I.Data.10	INPUT	5	BUTTON	BANNER AUTOMATION	804827		PUSH BUTTON
13	STOP BUTTON	Start_PB_2	Local:5:I.Data.11	INPUT	5	BUTTON	BANNER AUTOMATION	804827		PUSH BUTTON
14	MAIN SWITCH	Main_Switch	Local:5:I.Data.1	INPUT	5	BUTTON	BANNER AUTOMATION	804814		SELECTOR SWITCH
15	PROXIMITY SENSOR	Prox_Sensor	Local:5:I.Data.2	INPUT	5	SENSOR	BANNER AUTOMATION	801918		SHOULD BE OF THE SAME RANGE AS THE BELT LENGTH
16	Counter reset buttons	Res_Counter_1		OUTPUT						
17		Res_Counter_2		OUTPUT						
18		Res_Counter_3		OUTPUT						
19	CYLINDER RETRACTION	Cylinder_1_ret	Local:6:O.Data.6	OUTPUT	6		PARKER	27131701		
20		Cylinder_2_ret	Local:6:O.Data.8	OUTPUT	6		PARKER	27131701		
21		Cylinder_3_ret	Local:6:O.Data.10	OUTPUT	6		PARKER	27131701		
22	LED LIGHTS FOR INDICATIONS	Light_2	Local:6:O.Data.12	OUTPUT	6		BANNER AUTOMATION	75671		
23	LED LIGHTS FOR INDICATIONS	Light_3	Local:6:O.Data.13	OUTPUT	6		BANNER AUTOMATION	75671		
24										
25										
26										
27										
28										
29										
30										

PLC Based sorting system

5) Definition of a PLC:

- **Backplane -** The backplane in the chassis provides the communication between different modules within the PLC and provides the power to the modules as well. The **1756-A7** standard chassis is selected from the catalog which supports upto 7 slots in the PLC. The following section from the paperwork can be referred

Cat. No.	Description	Slots
1756-A4	Standard chassis	4
1756-A7		7
1756-A10		10
1756-A13		13
1756-A17		17

- **Power Supply -** Power supply provides the power to different modules of a PLC via backplane. The standard power supply 1756 - PA72 is taken.It is the standard AC supply. Refer to the AB manual below. Here 1756 refers to the part number which confirms the compatibility of this module with our PLC choice

Cat. No.	Description	Voltage Category	Operating Voltage Range	Chassis
1756-PA50	Slim AC power supply	120V/240V AC	85…265V AC	Standard, series A
1756-PA72	Standard AC power supply	120V/240V AC	85…265V AC	Standard, series A and series B
1756-PA75		120V/240V AC	85…265V AC	Standard, series B
1756-PB50	Slim DC power supply	24V DC	18…32V DC	Standard, series A
1756-PB72	Standard DC power supply	24V DC	18…32V DC	Standard, series A and series B
1756-PB75		24V DC	18…32V DC	Standard, series B
1756-PC75		48V DC	30…60V DC	Standard, series B
1756-PH75		125V DC	90…143V DC	Standard, series B

- **Input Module -** Input modules connect our inputs (sensors, buttons, switches,etc) to our PLC and take in the data from the sensor into the CPU where it is processes. We have a power supply of AC current. Hence, we can select an AC input module for our system. Lets select 1756 - IA16I for our

purpose since 16 bits input is adequate for our system.

AC Digital Input Modules

Cat. No.	Inputs/Outputs	Voltage Category	Operating Voltage Range	Removable Terminal Block
1756-IA8D	8 diagnostic inputs (4 points/group)	120V AC	79…132V AC	1756-TBNH 1756-TBSH
1756-IA16	16 inputs (8 points/group)	120V AC	74…132V AC	1756-TBNH 1756-TBSH
1756-IA16I	16 individually isolated inputs	120V AC	74…132V AC	1756-TBCH 1756-TBS6H
1756-IA32	32 inputs (16 points/group)	120V AC	74…132V AC	1756-TBCH 1756-TBS6H
1756-IM16I	16 individually isolated inputs	240V AC	159…265V AC	1756-TBCH 1756-TBS6H
1756-IN16	16 inputs (8 points/group)	24V AC	10…30V AC	1756-TBNH 1756-TBSH

- **Output Module -** We connect our outputs to the output modules. Output modules are the link from where we connect the PLC logic to the real world systems. Output modules provide the signals to the equipments required to run. We are selecting the 1756 - OA16I for this application which provides 16 outputs.

AC Digital Output Modules

Cat. No.	Inputs/Outputs	Voltage Category	Operating Voltage Range	Removable Terminal Block
1756-OA8	8 outputs (4 points/group)	120/240V AC	79…265V AC	1756-TBNH 1756-TBSH
1756-OA8D	8 diagnostic, electronically fused outputs (4 points/group)	120V AC	74…132V AC	1756-TBNH 1756-TBSH
1756-OA8E	8 electronically fused outputs (4 points/group)	120V AC	74…132V AC	1756-TBNH 1756-TBSH
1756-OA16	16 mechanically fused/group outputs (8 points/group)	120/240V AC	74…265V AC	1756-TBNH 1756-TBSH
1756-OA16I	16 individually isolated outputs	120/240V AC	74…265V AC	1756-TBCH 1756-TBS6H
1756-ON8	8 outputs (4 points/group)	24V AC	10…30V AC, current > 50 mA 16…30V AC, current < 50 mA	1756-TBNH 1756-TBSH

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- **CPU Module -** The computation module is required in a PLC to implement communications with other PLCs. we select 1756 - CMS1B1

Cat. Nos	Description
1756-CMS1B1	Compute module with: • Standard performance (dual-core CPU) • 32 GB SSD • Embedded Windows 10 IoT Enterprise LTSB 64-bit OS This module does not include a pre-loaded application.
1756-CMS1C1	Compute module with: • Standard performance (dual-core) • 32 GB SSD • Embedded Linux 32-bit (Debian 8.9) OS. This module does not include a pre-loaded application.

- **Communications Module - 1756 - EN2F** provides a reasonable communications speed so we will select this model for our system.

EtherNet/IP Communication Modules

EtherNet/IP (Ethernet Industrial Protocol) is an open industrial-networking standard that supports real time I/O messaging and message exchange. The EtherNet/IP network uses off-the-shelf Ethernet communication chips and physical media.

Cat. No.	Description	Media	Communication Rate	Integrated Motion on the EtherNet/IP Network Axes, max	TCP/IP Connections	Logix Connections
1756-EN2F	EtherNet/IP bridge, fiber	Fiber	100 Mbps	8	128	256
1756-EN2T	EtherNet/IP bridge, copper	Copper	10/100 Mbps	8	128	256
1756-EN2TR	EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps	8	128	256
1756-EN3TR	EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps	128	128	256
1756-EN2TXT	ControlLogix-XT, extended temperature EtherNet/IP bridge, copper for extreme environments	Copper	10/100 Mbps	8	128	256
1756-EN2TRXT	ControlLogix-XT, extended temperature EtherNet/IP bridge, embedded switch, copper	Dual copper	10/100 Mbps	8	128	256
1756-EN2TSC	EtherNet/IP secure communication module	Copper	10/100 Mbps	—	128	256
1756-ENBT	EtherNet/IP bridge, copper	Copper	10/100 Mbps	—	64	128
1756-EWEB	Ethernet web server module	Copper	10/100 Mbps	—	64	128

PLC Based sorting system

- **Controller - 1756 L8SE** is selected for our purpose

Cat. No.	Description	User Memory
1756-L81E	ControlLogix controller, 1 built-in USB port[1], single port EtherNet/IP	3 MB
1756-L82E		5 MB
1756-L83E		10 MB
1756-L84E		20 MB
1756-L85E		40 MB
1756-L81ES	GuardLogix safety controllers	3 MB standard 1.5 MB safety
1756-L82ES		5 MB standard 2.5 MB safety
1756-L83ES		10 MB standard 5 MB safety
1756-L84ES		20 MB standard 6 MB safety
1756-L8SP	GuardLogix safety partner (in SIL 3 applications, one safety partner is required for each GuardLogix 5580 controller)	Not applicable
1756-L71	ControlLogix controller, 1 built-in USB port[1]	2 MB
1756-L72		4 MB
1756-L73		8 MB
1756-L74		16 MB
1756-L75		32 MB
1756-L73XT	ControlLogix-XT controller, extreme environment	8 MB
1756-L71S	GuardLogix safety controllers	2 MB standard 1 MB safety
1756-L72S		4 MB standard 2 MB safety
1756-L73S		8 MB standard 4 MB safety
1756-L7SP	GuardLogix safety partner (one is required for each GuardLogix L7 controller)	Not applicable
1756-L72EROM	Armor ControlLogix controllers, EtherNet/IP dual-port	4 MB
1756-L73EROM		8 MB
1756-L72EROMS	Armor GuardLogix controllers, EtherNet/IP dual-port	4 MB standard

Following should be our configuration of our PLC:

SLOT 1 - CPU
SLOT 2 - CONTROLLER MODULE
SLOT 3 - COMM MODULE
SLOT 4- EMPTY
SLOT 5 - INPUT MODULE
SLOT 6- OUTPUT MODULE

6) Input and Output Devices:

- Light curtains:

BANNER

SLLCP40-1190P88

LS SERIES FULL FEATURE HEAVY-DUTY TYPE 4 SAFETY LIGHT CURTAINS

EZ-SCREEN LS Cascade, Pair

Resolution: 40 mm; Range: 12 m (40 ft)

Defined Area: 1190 mm (46.9 in.); Housing: Yellow

Connection: M12 8-pin 300 mm Pigtail QD; 2x OSSD, EDM, Fault Out & Fault Reset

Part Number: 89794

CERTIFICATIONS

c UL us CE

SPECIFICATIONS

Primary Housing Material	Aluminum
Safety Level	Type 4
Effective Aperture Angle	Type 4 Per IEC 61496-2
Connector Type	M12 Pigtail (Yellow)
Defined Area Height (mm)	1190
Dimensions WxD (mm)	36 x 45
Overall Length (mm)	1193
External Monitoring Device	1 Channel
Fixed Blanking	Yes
Housing Finish	Yellow Polyester

IP Rating	IP65; IP67
Number of Pins (Receiver/Emitter)	8
Operating Distance (m)	0.1 - 12
Operating Voltage	24 V dc +/- 15%
Operating Temperature	-20 to +55 deg. C; RH 95%
PL Rating	Ple
Recovery Time	49 / 168
Reduced Resolution	No
Resolution (mm)	40
Response Time	12
SIL Rating	SIL3; CL3
Electrical Safety Class	III
Scan Code	Selectable
Shock	10g at 16ms (6000 cycles)
Short Protection	Yes
System Type	Emitter/Receiver Pair
Vibration	10-55 Hz at 0.35 mm
Auxiliary Output	No
Fault Output	Yes
Housing Material	Aluminum; Zinc; Acrylic
OSSD Rating	24 V dc at 0.5 A each
Supply Current	151 mA Typical
Trip/Latch Output	Trip
Test Input	No
Feature: Cascade	Yes
Feature: End-to-End Sensing	Yes
Feature: ESD Safe	No

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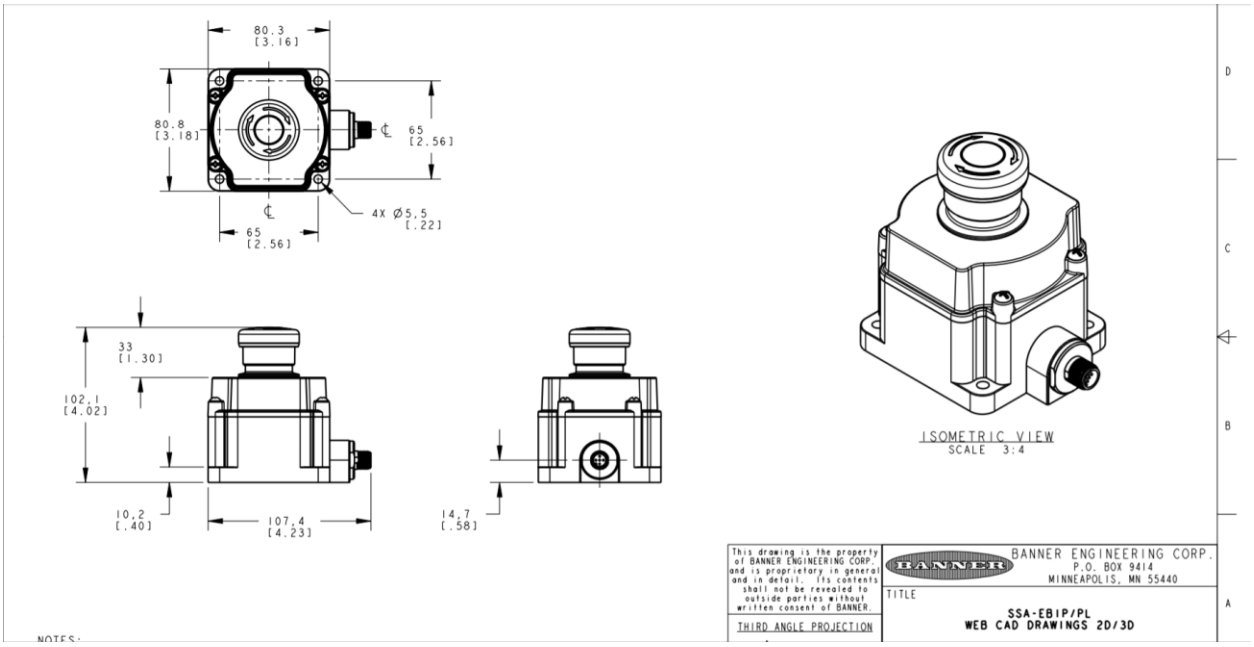
- **Emergency Stop switch -** The e-stop switch is a must have safety measure for any system. The operator can use this switch to manually stop the system immediately in order to ensure safety of the machine or man. We are using the e-stop switch from banner automation.

SSA-EB1 Flush-mount Emergency Stop Push Button:

40 mm Actuator

IP65; Contacts: 2NC; M12 4-pin QD

Part Number: 25067



- **Lights -** These general purpose light indicators can be used in our system for the status of the stacks in our system and a red light to indicate emergency halt of the system. K-50 Core Series lights. 85 to 130 V AC operation.

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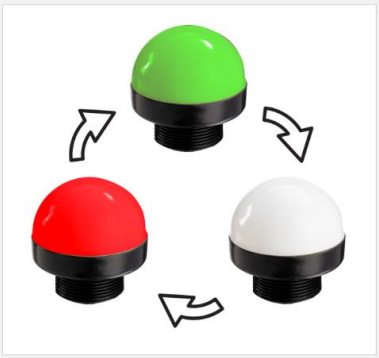
K50 Core Series

50 mm General Purpose LED Indicator



- Rugged, cost-effective and easy-to-install indicators
- Illuminated dome provides easy-to-see operator guidance and indication of equipment status
- Compact devices are completely self-contained — no controller needed
- 18 to 30V dc operation 85 to 130V ac operation
- Displays up to three colors
- Immune to EMI and RFI interference

BANNER

K50LGRYPQ

K50 CORE SERIES 50 MM GENERAL PURPOSE LED INDICATOR

K50 Series EZ-LIGHT: 3-Color General Purpose Indic

Voltage: 18-30V dc; Housing: Polycarbonate; IP67

Input: PNP; Colors: Green Red Yellow

Euro-style Quick-Disconnect Connector

Part Number: 75671

CERTIFICATIONS

SPECIFICATIONS

Housing Style	Base Mount - Dome Window
Primary Housing Material	Polycarbonate
Indication	Yes
Mounting Thread	M30 x 1.5
Color Input Control	Individual (One wire/color, same number of colors as input wires)
Number of Colors / Segments	3
Color Option 1	Green
Animation Option 1	Solid On
Color Option 2	Red

Color Option 3	Yellow
Max Current Color (mA)	40
Connection Type	Integral QD
QD Type/Cable Length	M12 (Euro) requires mating cordset
Number of Input Pins/Conductors	4
Supply Voltage	18-30 V dc
Input Type	PNP
Max Input Response Time (ms)	1
Physical Dimensions (LxWxH or DxH mm)	Ø50.0 x 69.0
Environmental Rating	IP67; IP69K
Max Op. Temperature (°C)	50
Min Op. Temperature (°C)	-40
Primary Housing Color	Black
Primary Window Material	Polycarbonate Diffused
Vibration and Mechanical Shock	Meets Mil. Std. 202F requirements method 201A. Also meets IEC 947-5-2; 30G 11 ms duration, half sine wave.
Mechanical Shock	Meets IEC 947-5-2; 30G 11 ms duration, half sine wave.
Vibration	Meets Mil. Std. 202F requirements method 201A.
Feature: Washdown Rated	Yes
Feature: Hazardous Area	No
Feature: Audible	No
Feature: Chemical Resistant	No
Multi-Color Device	Single Color On
Indicator Light	Yes
IO Link	No
Modbus RTU	No

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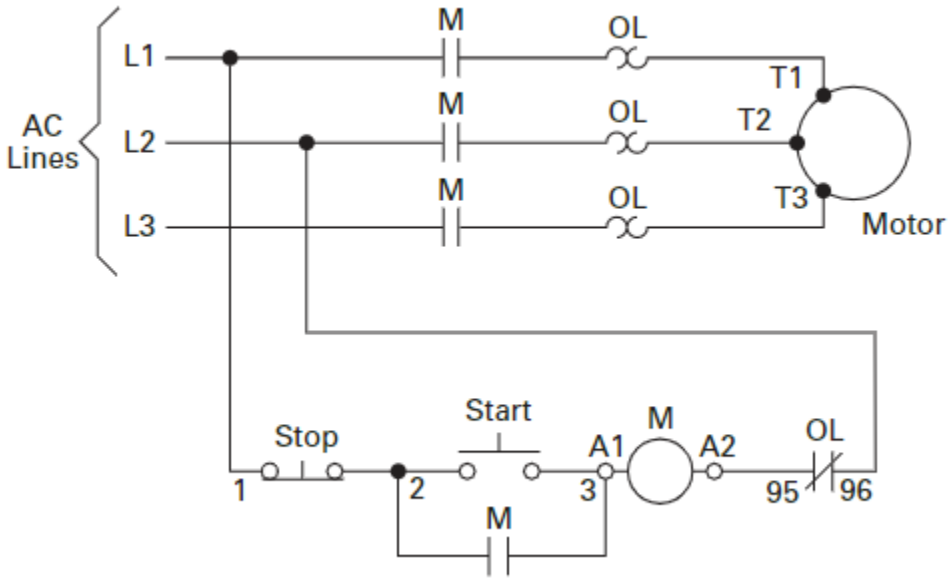
Wireless	No
Pro-Editor Compatible	No
Product Size (mm)	50
Color Technology	Standard LED
Product Size (mm)	50

- **DC Motors -**



The 3 phase AC motor is used for driving the conveyor belt in the system. We select the following AC Motor from graingers.

AC Gearmotor 115 Nameplate RPM 27 Max. Torque 500.0 in.-lb. Enclosure TEFC

Item # **6K352** Mfr. Model # **6K352** Catalog Page # **75** UNSPSC # **26101602**

Categories based on your search

Power Transmission

Gearmotors

AC Gearmotors

Item	AC Gearmotor
Gearmotor Type	AC Gearmotor
Gearmotor Voltage	115VAC
Gearmotor Phase	1
Max. Torque	500.0 in.-lb.
Gearmotor Shaft Type	Single
Gearmotor Shaft Orientation	Parallel
Gearmotor Rotation	CW/CCW
Nameplate RPM	27
Gearmotor Enclosure	Totally Enclosed Fan-Cooled
Gearmotor Mounting Position	All Angle
Gearmotor Brake Type	None
Length Less Shaft	12-5/16"
Hz	60
Overhung Load	325 lb.
Input HP	1/4
Gear Ratio	64:1
Full Load Amps	4
Thermal Protection	None
Max. Ambient Temp.	40 Degrees C
Motor Type	Split-Phase
Shaft Dia. (Dimension U)	3/4"
Shaft Length (Dimension V)	1.5"_x000D_
Bearings	Heavy Duty Ball, Needle Roller and Thrust Balls on Case, Ball on Motor
Lubrication	Permanent Heavy Duty Gear Oil
Housing	Die Cast Aluminum
Gear Case Material	Die Cast Aluminum
Gears	Hardened Steel, 1st Stage Helical, Subsequent Stages Spur, AGMA Class 9

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- **Color Sensors -** We use the QC50 series true color sensor from banner automation.

BANNER

QC50A3P6XDWQ

QC50 SERIES TRUE COLOR SENSOR

QC50 Series: True Color Sensor
Range: 20 mm; Input: 10-30V dc
Outputs: 3 PNP
Euro-Style Quick-Disconnect With Open Shield
Part Number: 70826

CERTIFICATIONS

SPECIFICATIONS

Primary Housing Material	Thermoplastic
Connection	Integral QD
Adjustments	Teach Button
Sensing Beam	Visible White LED
Outputs	PNP
Special Feature: Remote Teach	No
Sensing Beam Wavelength	400-700
Max Sensing Range (mm)	20
Power Supply/Supply Voltage	10-30 V dc
Quick Disconnect Type	M12 (Euro)

PLC Based sorting system

Number of Pins	8
Indicator	Digital Display
Operation	Light/Dark Operate
Output response time (ms)	0.335
Repeatability (µs)	N/A
Lens Material	Glass
IP Rating	IP67
NEMA Rating	N/A
Max Op. Temperature (°C)	55
Min Op. Temperature (°C)	-10
Max Op. Relative Humidity (%)	90% @ 50°C
Special Feature: Analog Output	No
Delay at Power-up (ms)	500
Feature: Timing (Hold/Delay)	Yes
Application: Color	Yes
Application: Luminescence	No
Application: Registration Mark	No

- **Pneumatic Cylinders -** Cylinders to push the item into the stacks. We are choosing the following given pneumatic cylinder for the purpose.

PLC Based sorting system

PARKER

7/16" Air Cylinder Bore Dia. with 2" Stroke Stainless Steel , Nose and Pivot Mounted Air Cylinder

Item # **49J544** Mfr. Model # **0.44DPSR02.00** Catalog Page # **N/A** UNSPSC # **27131701**

Web Price
$34.70 / each

One Time Delivery
Auto Reorder

1 Add to Cart

+ Add to List

Shipping Pickup

Ships from supplier to branch. Available for pickup on or before Thu. Nov 15.

ROCHESTER Branch #657
Branch Info | Change

Be the first to write a review

Shipping Weight **0.11 lbs.**

Country of Origin **USA** | *Country of Origin is subject to change.*

Technical Specs

Item	**Air Cylinder**	Mount	**Nose and Pivot**
Air Cylinder Product Group	**Air Cylinder**	Piston Material	**Aluminum**
Cylinder Action	**Double Acting**	Finish	**Silver**
Air Cylinder Bore Dia.	**7/16"**	End Cap Material	**Aluminum**
Stroke	**2"**	Piston Rod Material	**Stainless Steel**
Air Cylinder Type	**Round Body**	Magnetic Piston	**No**
Air Cylinder Mount	**Nose and Pivot**	Tube Material	**Stainless Steel**
Body Material	**Stainless Steel**	Nose Mount Thread	**7/16"-20**
Port Size	**#10-32 UNF**	Rod Dia.	**0.188"**
Single Acting/Double Acting	**Double Acting**	Rod Thread Size	**#10-32 UNF**
Cushion Type	**None**	Rod Thread Length	**0.50"**
Temp. Range	**-10 Degrees to 165 Degrees F**	Pivot Hole Dia.	**0.156"**
Cylinder Type	**Round Non-Repairable**	Features	**Non-Switch Ready**
Overall Length	**5.3"**	Max. Pressure	**250 psi**
Bore Dia.	**7/16"**		

- **Start/Stop push buttons -**

BANNER

OS80PMLY1GYQ

PRODUCTS FOR INDUSTRIAL AUTOMATION

OS80 Operator Station: Push Button, Yellow
Latching (Pull-to-Release); 2-Color
Voltage: 12-30 V dc; Housing: Polycarbonate; IP40
Output: PNP 1NO; Colors: Green Yellow
Euro 5-pin Integral Connector
Part Number: 804827

CERTIFICATIONS

CE

SPECIFICATIONS

Housing Style	Base
Primary Housing Material	Polycarbonate
Actuation	Yes
Activation Function	Push-Button
Mounting Thread	30 mm
Color Input Control	Individual (One wire/color, same number of colors as input wires)
Number of Colors / Segments	2
Color Option 1	Green
Animation Option 1	Solid On

Color Option 2	Yellow
Max Current Color (mA)	135
Connection Type	Integral QD
QD Type/Cable Length	M12 (Euro) requires mating cordset
Number of Input Pins/Conductors	5
Operation	Normally Open
Supply Voltage	12-30 V dc
Output Type	PNP
Input Type	PNP
I/O Block Compatible	Yes
Max Output Response Time (ms)	50
Physical Dimensions (LxWxH or DxH mm)	80.0 x 115.6
Environmental Rating	IP40
Max Op. Temperature (°C)	55
Min Op. Temperature (°C)	-25
Storage Temp (°C)	-40 to 70
Primary Housing Color	Black
Button Operation	Latching
Secondary Material	Polyamide
Feature: Hazardous Area	No
Feature: Audible	No
Feature: Chemical Resistant	No
Multi-Color Device	Single Color On
IO Link	No
Modbus RTU	No
Wireless	No
Pro-Editor Compatible	No

Product Size (mm)	80
Color Technology	Standard LED

- **Main Switch -** Selector switch as the main switch for the system.

BANNER

OS80K2MX1GYQ

PRODUCTS FOR INDUSTRIAL AUTOMATION

OS80 Operator Station: Key Switch; 2-Position Momentary-Off; 2-Color; Voltage: 12-30 V dc
Housing: Polycarbonate; IP40
Output: PNP 1NO; Colors: Green Yellow
Euro 5-pin Integral Connector
Part Number: 804814

CERTIFICATIONS

CE

SPECIFICATIONS

Housing Style	Base
Primary Housing Material	Polycarbonate
Actuation	Yes
Activation Function	Key Operated Selector Switch
Mounting Thread	30 mm
Color Input Control	Individual (One wire/color, same number of colors as input wires)
Number of Colors / Segments	2
Color Option 1	Green
Animation Option 1	Solid On

Color Option 2	Yellow
Max Current Color (mA)	135
Connection Type	Integral QD
QD Type/Cable Length	M12 (Euro) requires mating cordset
Number of Input Pins/Conductors	5
Operation	Normally Open
Supply Voltage	12-30 V dc
Output Type	PNP
Input Type	PNP
I/O Block Compatible	Yes
Max Output Response Time (ms)	50
Physical Dimensions (LxWxH or DxH mm)	80.0 x 106.6
Environmental Rating	IP40
Max Op. Temperature (°C)	55
Min Op. Temperature (°C)	-25
Storage Temp (°C)	-40 to 70
Primary Housing Color	Black
Button Operation	Momentary
Secondary Material	Polyamide
Feature: Hazardous Area	No
Feature: Audible	No
Feature: Chemical Resistant	No
Multi-Color Device	Single Color On
IO Link	No
Modbus RTU	No
Wireless	No
Pro-Editor Compatible	No

Product Size (mm)	80
Color Technology	Standard LED

- **Proximity Sensor:**

BANNER

Q4XTKLAF600-Q8

Q4X SERIES RUGGED LASER DISTANCE SENSOR





Q4X Series: Laser Adjustable Field

Range 600 mm; Input 10-30 V dc

Output: 1 PNP/NPN with IO-Link Communication; 1 PNP

Connection: Euro M12 4-pin Integral Connector

Threaded Barrel Housing

Part Number: 801918

CERTIFICATIONS

c UL us CE

SPECIFICATIONS

Sensing Mode (General)	Proximity
Sensing Mode (Detailed)	Background/Foreground Suppression
Housing Style	Rectangular w/M18 Mount
Primary Housing Material	Stainless Steel
Laser Classification	Class 1
Input/Output	Discrete
Indicator	Display; LED(s)

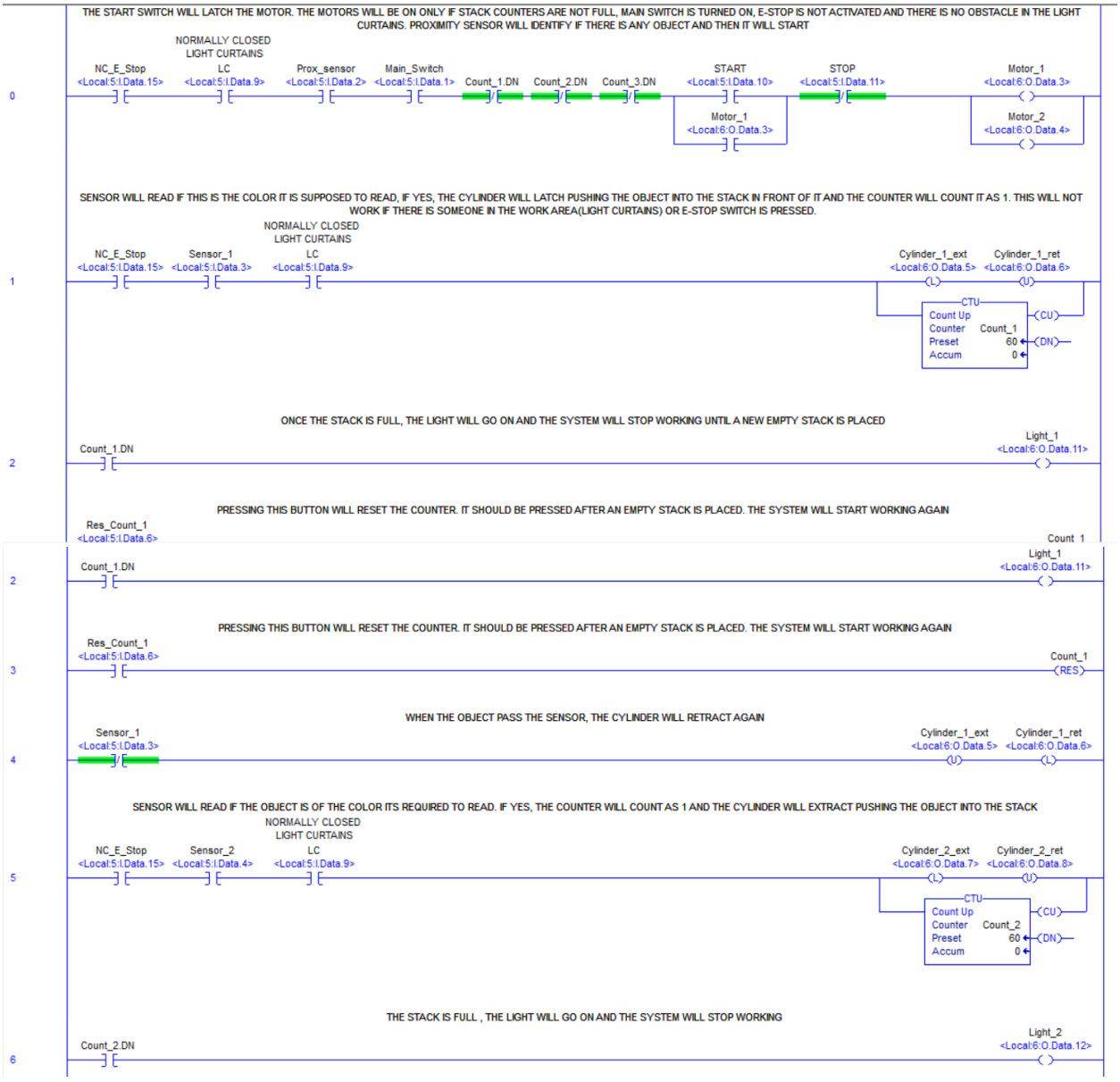
Analog Resolution/Discrete Repeatability	25 mm to 100 mm: +/-0.5 mm; 100 mm to 600 mm: +/- 0.5% of range
Max Sensing Distance (mm)	600
Minimum Sensing Distance (mm)	25
Sensing Beam	Visible Red Laser
Power Supply	10-30 V dc
Delay at Power-up (ms)	1500
Sensing Beam Wavelength (nm)	655
Adjustments	Push Button; Remote Teach
Temperature Effect (mm/°C)	+/- 0.05 mm/°C from 25 to 125 mm, +/- 0.35 mm/°C at 300 mm, +/- 0.85 mm/°C at 600 mm
Connection	Integral QD
QD Type/Cable Length	M12 (Euro) requires mating cordset
Number of Pins	4
Vibration	MIL-STD-202G req. Method 201A (vibration:10 to 60Hz max., double amplitude 0.06", max acc. 10G).
Mechanical Shock	MIL-STD-202G, Meth. 213B, Cond. I (100G 6x along X, Y & Z axes, 18 total shocks) w/ sensor operating
Output Saturation Voltage PNP Outputs	<2 V
Max Discrete (Switched) Output (mA)	100
Discrete (Switched) Outputs	1 NPN/PNP Configurable; 1 PNP
Output Protection	Protected against continuous overload and short circuit
IP Rating	IP67; IP68; IP69K
Storage Temperature (°C)	-25 to 75
Max Operating Temperature (°C)	50
Min Operating Temperature (°C)	-10
Max Op. Relative Humidity Non-Condensing (%)	95 at 55°C

PLC Based sorting system

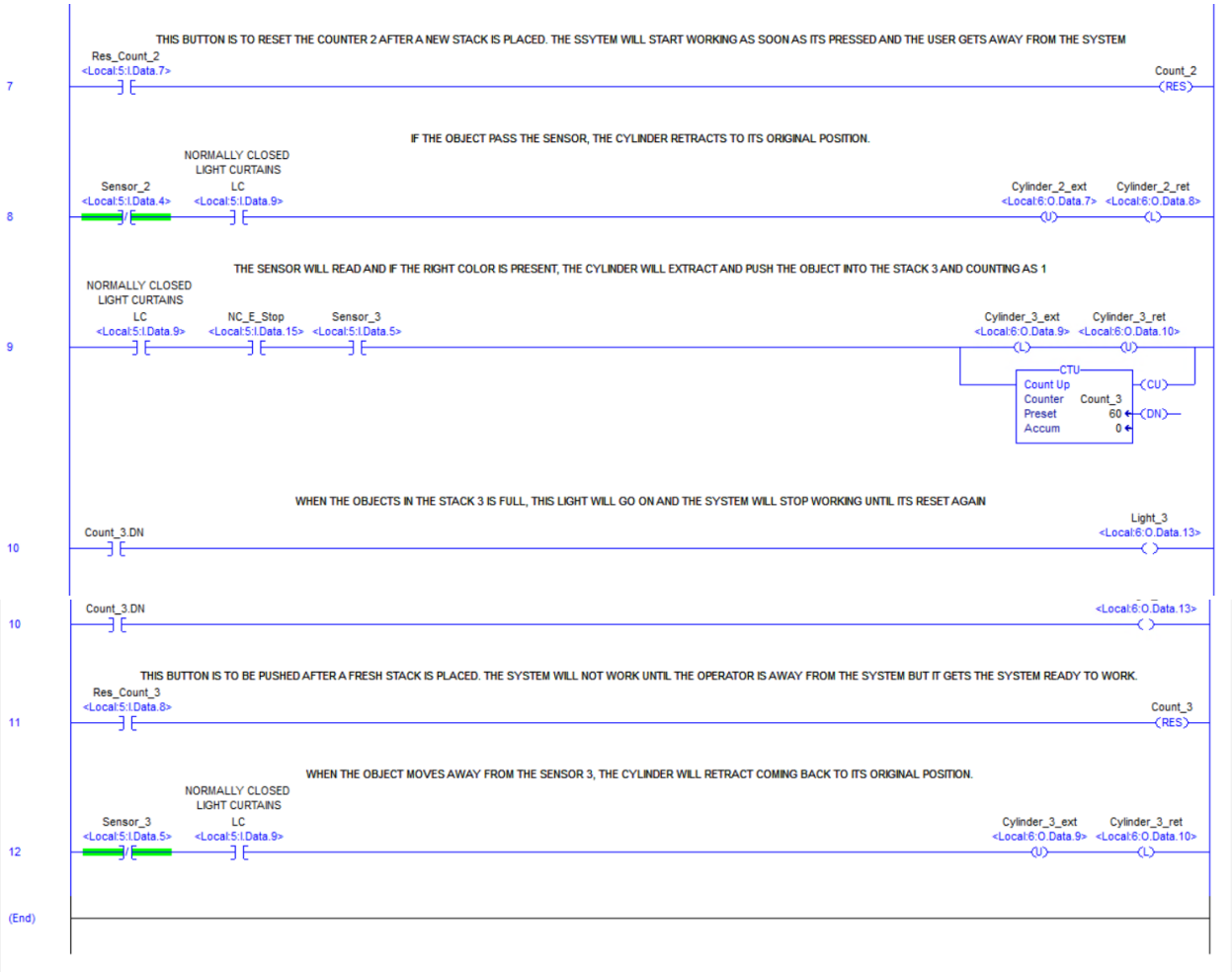
Window Material	Acrylic
Warm-up Time (minutes)	10
Minimum Response Time (ms)	2
Spot Size (@ Reference Distance)	1.9 mm x 1.0 mm @ 600 mm
Barrel Diameter (mm)	18
Minimum Window Size (mm)	0.4
Discrete Output Hysteresis (mm)	Automatically adjusted
Laser Control	Yes
Alarm Output (mA)	100
Max Ambient Light (Lux)	5000
Max Off-state Leakage Current (µA)	PNP: <50 @ 30 V dc; Push/Pull: N/A
Power/Current Consumption (exclusive of load)	< 700 mW
Supply Protection Circuitry	Protected against reverse polarity and transient overvoltages
Feature: Remote Teach	Yes
Feature: Washdown Rated	Yes
Feature: Clear Object Detection	Yes
Feature: Timing (Hold/Delay)	Yes
Feature: Ecolab Certified	Yes
Feature: Chemical Resistant	Yes
IO Link	Yes
RS-232	No
RS-422	No
RS-485	No
SSI	No
Wireless	No
1-wire Serial Interface	No

7) RS Logix ladder logic:

The ladder logic is created in the RS Logix 5000 software and is attached with this file as:



PLC Based sorting system



8) OPERATING CONDITIONS:

- There should be no operator inside the perimeter of the light curtain. This is to ensure that the operator doesn't get in the way and get injured
- The stacks should be empty. The capacity is set at 60
- E-stop switch should be in default state (shouldn't be in pressed state)
- The main switch should be ON
- The proximity sensor should read an object to move the conveyor belt.
- Counters will be at zero.
- Start switch will start the operation.
- The conveyor belt should be loaded

9) SAFETY CONSIDERATIONS:

Personnel safety:

- In the case if an operator is inside the work space, the light curtains will detect and immediately shuts down everything. When the operator leaves the space, the system resumes where it was left.

Emergency Shutdown:

- In case there is an emergency, E- stop button could be used and everything halts altogether. When the switch is released, the system will resume from where it was left.

Loss of power:

- The system will stop working until start switch is pressed again. Rest everything will resume as to how it should be

Faulty Inputs and Outputs:

- If the sensors malfunction, one specific type of color object will be dropped inside the undetected stack. This will easily indicate which sensor is malfunctioning
- In case any cylinder is malfunctioning, again it can easily be noticed by additional undetected (unsorted) objects of the same type in the undetected stack.
- If the proximity sensor malfunctions, the belt will stop working even if there is any object and this can be troubleshooted right away.
- We would want to monitor all the input and outputs of the system with the help of the lights. Any system malfunctions, the light should turn off. This can be done by hard wiring lights to the input and output devices which shows the status of the equipment constantly.
- If one of the motor is malfunctioning, the system should shut down since we are latching using the motor bit.

PLC Faults:

- Fault in the PLC can be detected by observing the system and if there is any component not working, the status LED on the PLC module can be checked if there is any error in wiring.
- Programming should be thoroughly checked and then the Communication cable or connection can be troubleshooted.

PLC Based sorting system

Additional Hardware used:

- The operator should use helmets and protection gloves, glasses all the time during the operation.
- Proper warning boards should be used
- Fencing and isolating the work envelope is a good practice at such a place with moving parts.
- Motors in the conveyor belt will be provided with proper casing to avoid any accidental injury.