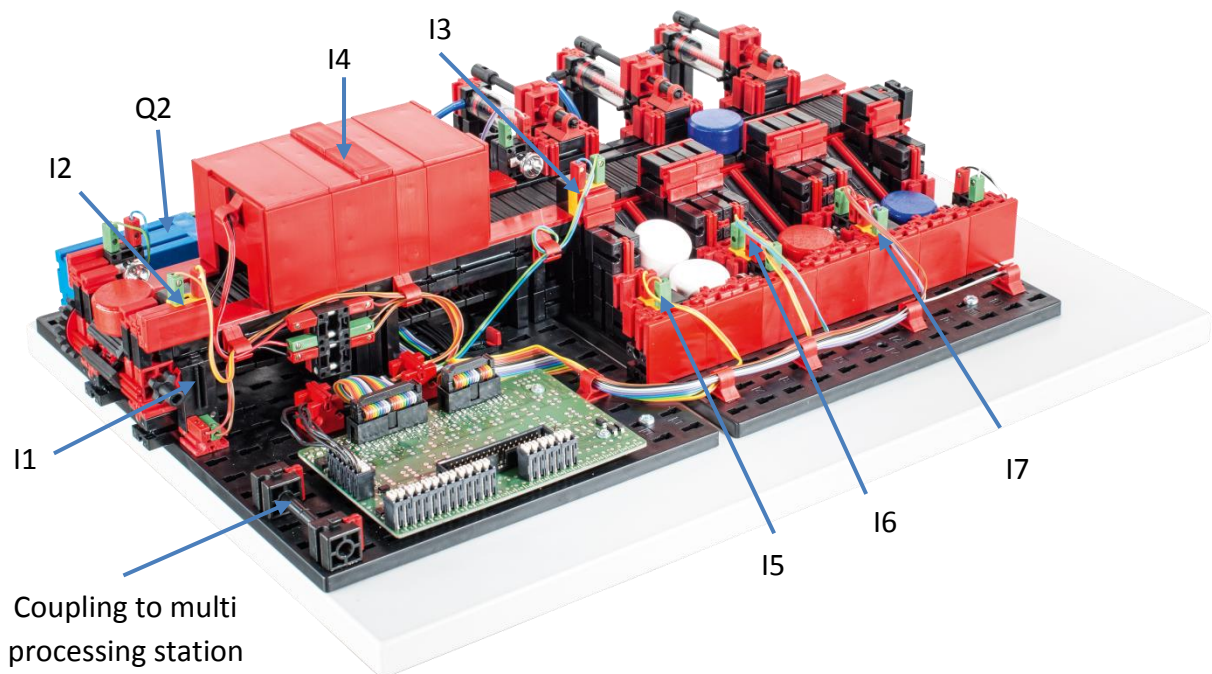


**536633**

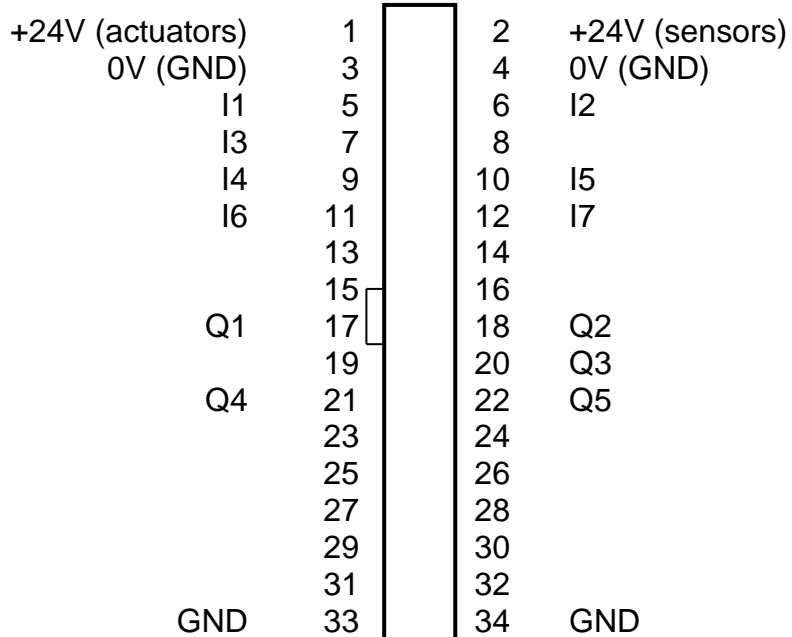
**Sorting Line with Detection 24V**



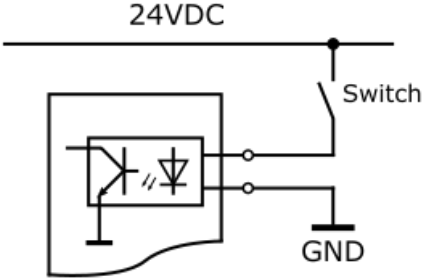
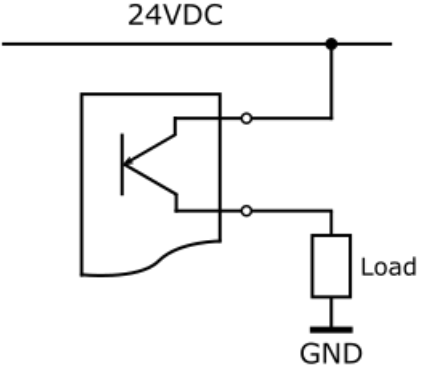
Not in the picture: Q1, Q3, Q4, Q5

**Circuit layout for Sorting Line with Detection**

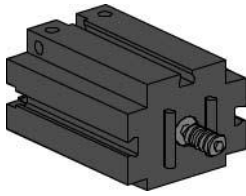
Terminal no.	Function	Input/Output
1	power supply (+) actuators	24V DC
2	power supply (+) sensors	24V DC
3	power supply (-)	0V
4	power supply (-)	0V
5	pulse counter	I1
6	light-barrier inlet	I2
7	light-barrier behind color sensor	I3
8	not used	
9	color sensor	I4
10	light-barrier white	I5
11	light-barrier red	I6
12	light-barrier blue	I7
17	motor conveyor belt	Q1
18	compressor	Q2
19	not used	
20	valve first ejector (white)	Q3
21	valve second ejector (red)	Q4
22	valve third ejector (blue)	Q5



**PLC input and output configuration**

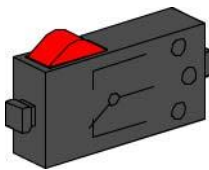
	Inputs	Outputs
Type	Sinking input	Sourcing output
Switching		

## Technical data:



### **S motor:**

The high-bay rack feeder boom is powered by an S motor. This compact motor is a permanent magnet DC motor that can be used together with an attachable motor reducing gearbox. The motor is operated at a rated voltage of 24V DC and the maximum current input is 300 mA. The result is a maximum torque of 5 mNm and an idling speed of 10,700 rpm. The motor reducing gearbox has a gear ratio of 64.8:1 and a lateral output.



### **Mini-switch:**

For the sorting line with detection, the mini-switch is used as a pulse counter. Combined with a pulse wheel, the push-button switches are used as incremental rotary encoders to determine the position of the conveyor belt. The mini-switch used for this purpose includes a changeover switch and can be used both as a normally closed contact and as a normally open contact. When the switch is actuated, equipotential bonding occurs between contact 1 and contact 3, while the connection between contact 1 and contact 2 is separated. Figure 1 shows the schematic circuit diagram of the mini-switch.

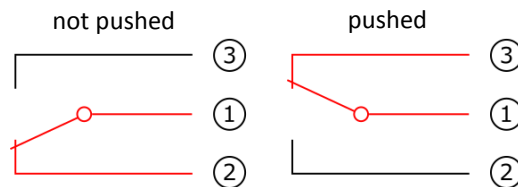
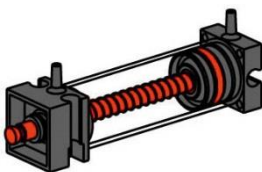


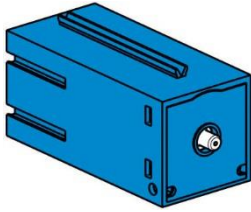
Fig. 1: Mini-switch circuit diagram

### **Pneumatic cylinders:**



The ejection of workpieces in the sorting line with detection is managed by three pneumatic cylinders which are controlled with the help of 3/2 way solenoid valves. In the case of the pneumatic cylinders, a piston divides the volume of the cylinder into two chambers. Differing pressure between these two chambers results in force placed on the piston, causing the piston to move. This movement corresponds to a change in volume in both chambers.

### Compressor:



A diaphragm pump supplies compressed air to the vacuum gripper robot. This type of diaphragm pump consists of two chambers separated by a diaphragm; see Figure 2. A cam moves a piston in one of the two chambers up and down, causing the air in the other chamber to be drawn in or pressed out. During the downward stroke the diaphragm is pulled back, causing air to be pulled into the second chamber through the inlet valve. When the piston moves up, the diaphragm presses the air out of the pump head through the outlet valve. The compressor used in this case operates at a rated voltage of 24V DC and produces an overpressure of approximately 0.7 bar. The maximum current input of the compressor is 70 mA.

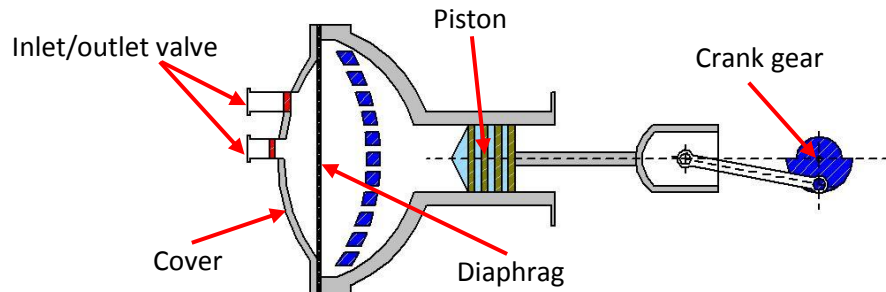


Fig 2: Schematic drawing of the diaphragm pump

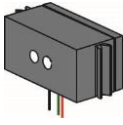
### Phototransistor:



Phototransistors are used as light barriers in the sorting line with detection. In the process, the phototransistor conducts electricity from a certain level of brightness. However, if this luminescence threshold is exceeded, the phototransistor loses its conductivity. Together with a lens tip lamp, which faces the phototransistor, the phototransistor usually conducts electricity and can thus be used as a light barrier. A stray light hood can be used to reduce the effects of ambient light.

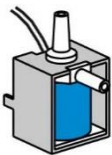
Caution: When connecting the phototransistor to the power supply, make sure the polarity is correct. Connect the positive pole at the red marking on the phototransistor.

### Color sensor



Color sensors are mostly used in automation technology, for instance. During this process, for example, the color or a color imprint is to be examined to ensure that the correct components are installed. The fischertechnik color sensor transmits red light, which is reflected with a different intensity from different colored surfaces. The intensity of the reflected light is measured by the phototransistor and output as a voltage value between 0 V and 9 V. The measured value is dependent on the ambient brightness and the distance of the sensor from the colored surface. The connection is made using three cables. The red cable is connected to the 9V DC, the green cable is connected to ground and the black cable is connected to a universal input. The adapter board converts the voltage from 24V DC to 9V DC.

### 3/2 way solenoid valve:



3/2 way solenoid valves are used to control the pneumatic cylinders. These control valves have three connection points and two control states. The switching operations are carried out by a solenoid coil (a), which operates against a spring (c). When voltage is applied to the solenoid, the movable core (b) of the coil moves against the spring as a result of Lorentz force, causing the valve to open. Open in this case means that the compressed air connection (current description: 1, previous description: P) is connected with the cylinder connection (1, previously A). If this voltage drops, the spring pushes the core back again, causing the valve to close again. In this position, the cylinder connection (2, previously A) is connected with the air vent (3, previously R). Figure 3 shows a schematic drawing of the 3/2 way solenoid valve. The solenoid valve connection is made using two cables: one connected to the PLC output and the other connected to ground.

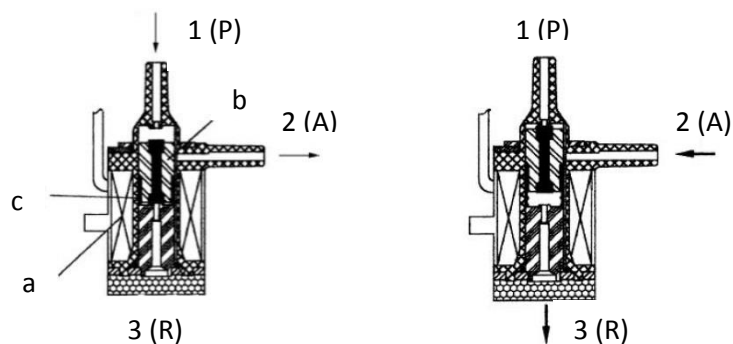


Fig. 3: 3/2 way solenoid valve

## Sorting line with detection

The sorting line with detection is used for the automated separation of different colored building blocks. In this process, a conveyor belt conveys geometrically identical, yet different colored components to a color sensor, where they are separated according to their color. The conveyor belt is powered by an S motor and the transport route is measured with the help of a pulse switch. The ejection of workpieces is handled by pneumatic cylinders, which are assigned to the appropriate storage locations and are actuated by solenoid valves. Several light barriers monitor the flow of workpieces and the fill level of the storage locations.

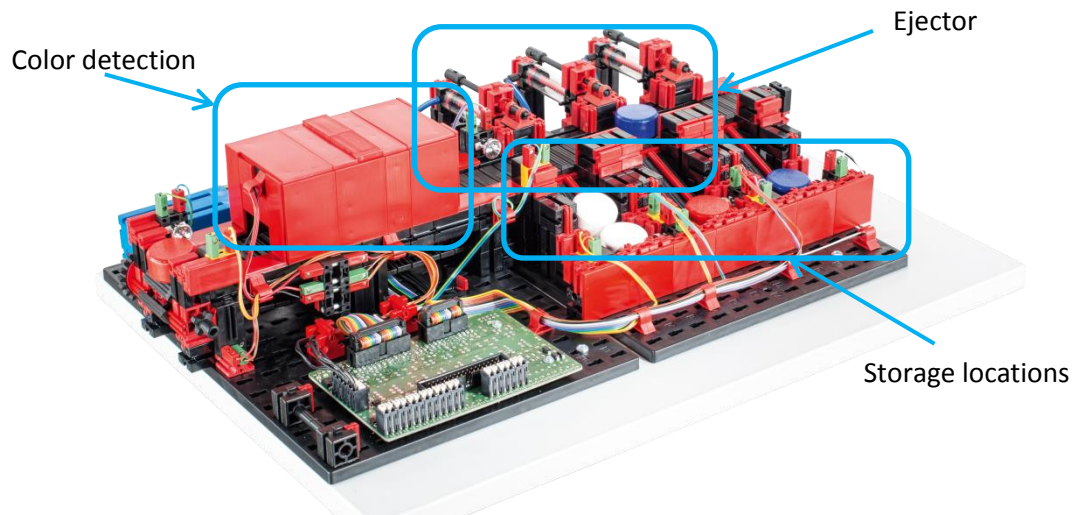


Fig. 1: Areas of the sorting line with detection

Color detection is handled by an optical color sensor, which can detect their color based on a surface reflection. Technically speaking the color sensor is therefore a reflective sensor which indicates how well a surface reflects light. The sensor's measured value is therefore not proportional to the wavelength of the measured color and even the assignment of color coordinates or color spaces (e.g. RGB or CMYK) is not possible. In addition to the object's color, ambient light, the surface of the object and the distance of the object from the sensor influence the quality of the reflection. For this reason, it is imperative that the color sensor is protected from ambient light and the surface of the objects are similar. In addition, it is important that the sensor is installed perpendicularly to the object's surface. Threshold values that limit the measured values of individual colors make a distinction between the colored workpieces. Since the value ranges of different color sensors differ, the limit values absolutely must be adjusted.

Ejection is controlled with the help of the light barrier located before the first ejector. Depending on the color value detected, the corresponding pneumatic cylinder is triggered with a delay after the light barrier is halted by the workpiece. This is where the pulse switch comes in, which senses the rotation of the gear wheel driving the conveyor belt. Unlike a time-dependent delay, this approach can withstand disruptions in the conveyor belt speed. The ejected workpieces are fed through three chutes to the particular storage locations. The storage locations are equipped with light barriers that detect whether the storage location is filled or not. However, the light barriers cannot tell how many workpieces are in the storage location.

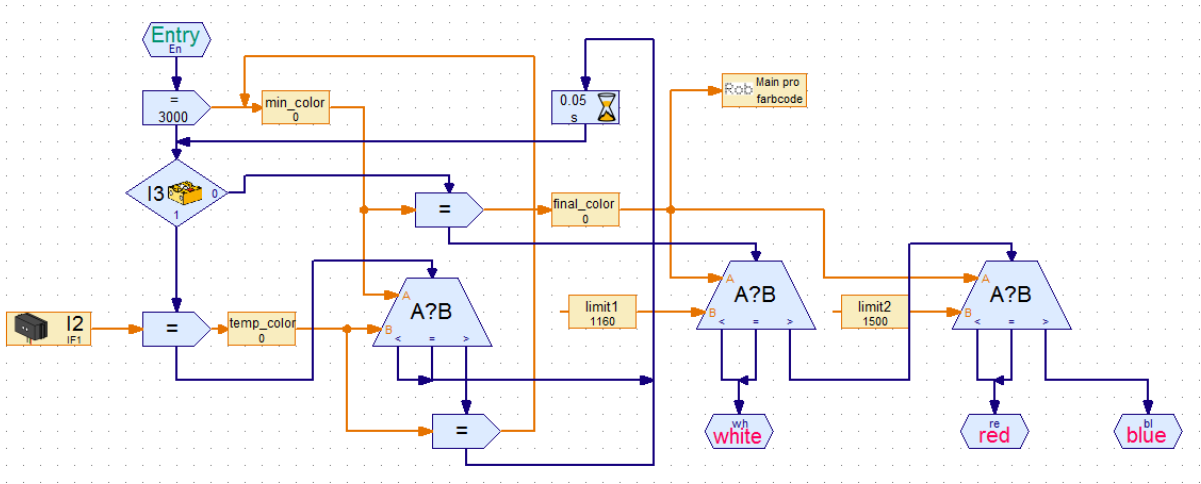


Fig. 2: ROBO Pro color detection implementation

To detect color, the workpiece passes under the color sensor. During this time interval, the minimum value of the measured color value is determined and the workpiece is assigned a color. At the time when the workpiece is needed, in order to pass by the color sensor, the minimum value is compared to the current measured value and is replaced by this value if necessary. A value is selected as the initial value of the minimum value; this value is higher than the maximum value of the color sensor. This ensures that the minimum value is actually equal to the lowest measured value and not the initial value. The determined minimum value is then compared to the two limit values in order to obtain the assignment to the colors white, red and blue. In some cases the limit values have to be adjusted to other operating conditions.

### Calibration

Due to different environmental influences and variations in the color sensor, the sorting line with detection needs to be calibrated. To do this, the limit values used to distinguish the different colors need to be set in the "Calibration" subroutine. While the first limit value "limit1" is used to distinguish between white and red, the second limit value "limit2" is used to distinguish between red and blue.

Table 1: Predefined and modified limit values of the color sensor

Limit value	Predefined value	Adjusted value
limit1	1320	
limit2	1550	



## Color detection

Briefly describe how the color sensor, which is used in the sorting line, works.

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Which interference factors can affect the measured value of the color sensor?

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What are the physical requirements to ensure fault-free operation of the color sensor?

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Name two common color spaces.

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What might a color sensor look like that consists of reflective sensors and outputs an actual color value?

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## Color detection

## ANSWER

Briefly describe how the color sensor, which is used in the sorting line, works.

*The color sensor used is a reflective sensor. It measures the reflection of red light, which is reflected by the object to be measured.*

Which interference factors can affect the measured value of the color sensor?

*Ambient light*

*Surface of the detected object*

*Reflection angle*

What are the physical requirements to ensure fault-free operation of the color sensor?

*The color sensor must be protected from ambient light (e.g. housing)*

*The surface of the objects to be measured must be similar.*

Name two common color spaces and name their basic colors.

*RGB (red - green - blue)*

*CMYK (cyan - magenta - yellow - key (black))*

What might a color sensor look like that consists of reflective sensors and outputs an actual color value?

*A color sensor that outputs an actual color value must consist of three reflective sensors. In the RGB color space, these sensors must emit red, green and blue light sequentially and then measure each reflection.*

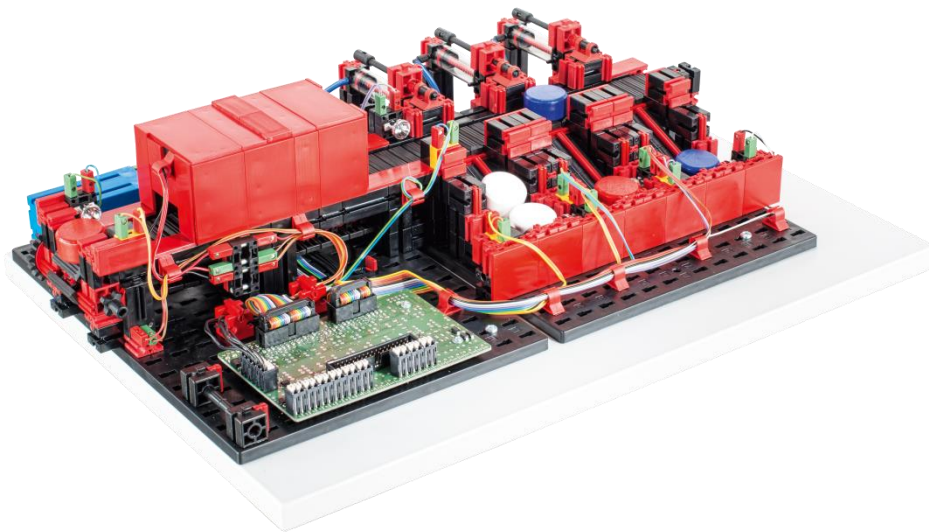
## Sorting line with detection

Identify the “color detection”, “ejector” and “storage location” areas.

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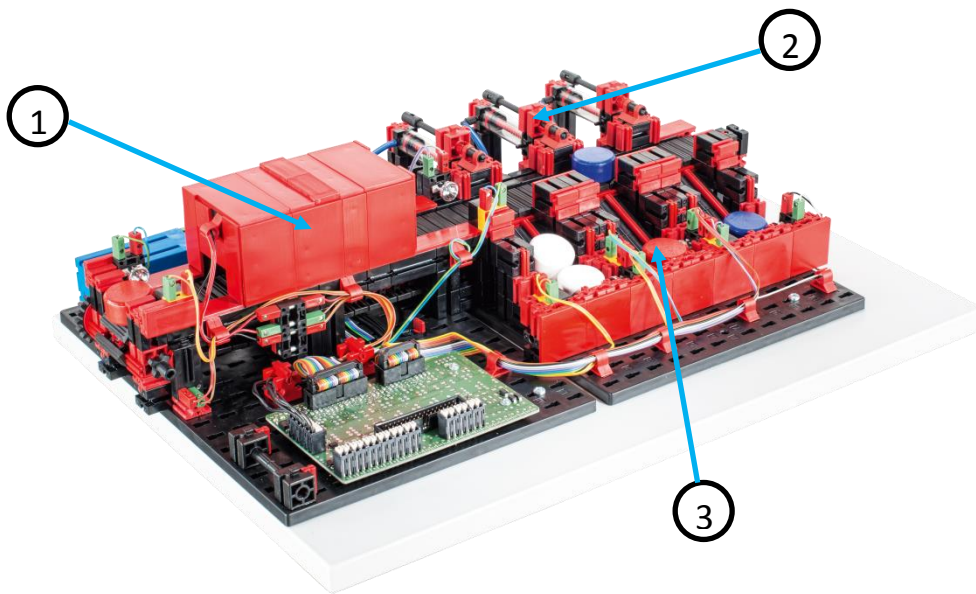


## Sorting line with detection

**ANSWER**

Identify the “color detection”, “ejector” and “storage location” areas.

1. *Color detection*
2. *Ejector*
3. *Storage locations*



## Maintenance and troubleshooting

The sorting line is generally maintenance free.

**Problem:**      **The sorting line is not sorting the colored workpieces correctly.**

Solution:        Adjust the limit values in the "Configuration" subroutine. Also make sure that ambient light is not interfering with the color sensor.

**Problem:**      **The workpieces are not being pushed off, but the conveyor is still in the correct location.**

Solution:        Make sure that the pneumatic hoses are connected correctly and that the compressor is running correctly.

**Problem:**      **The conveyor belt is not starting or is stopping too soon.**

Solution:        Verify that the light barriers in front of the color detector and in front of the ejector are working correctly and that they are connected properly. When doing so, make sure the polarity of the phototransistor is correct.