Motion Control

Do-more H2 Series PLC to *Sure*Step Stepping System with *C-more* Touch Panel (HMI)

Rotary Index Table Station
Part 1 of 5
Control System Overview

VID: L-PC-DM-STP-CM-001-1

Motion Control Video Rundown and References

This LEARN video covers the Rotary Index Table Station that uses the **Do-more** H2 Series PLC. A ***C-more*** Touch Panel is used as the operator interface. Various sensors are also used with the Rotary Index Table to control operational functions.

The Rotary Index Table is the second stage of an overall application based on various Motion Control systems. The first and second stage are controlled with ***Sure*Step** Stepper Systems using ADC products, with the final stage based on ***AutomationDirect's Sure*Servo** Servo System. To the right is a list of topics covered in this video series.

"Links" pointing to available technical information from ***AutomationDirect*** have been included, such as the example on the ***Sure*Step** User Manual shown below.

Link to *Sure*Step Stepping Systems User Manual:
http://bit.ly/r5dgUO

a. Control System Overview

b. Schematic Diagrams

c. **Do-more** Ladder Logic Programming

d. ***C-more*** Touch Panel Programming

e. Operational Demonstration

It may be helpful to review the Part Feeder Station video. The link is shown below.

Link to Motion Control – Part Feeder Station:
http://bit.ly/28MmIYF

Motion Control Video Rundown and References (cont'd)

This handout can be used to follow along with the video, and can also be useful as a refresher to the steps required to create a working Motion Control System using a **Do-more** H2 Series PLC to control an ***AutomationDirect SureStep*** Advanced Stepper System, interfaced with a ***C-more*** Touch Panel, monitored with ADC sensors, and constructed using ADC wiring components.

For additional information on ***AutomationDirect's*** products that are a good choice for a Motion Control application, please refer to the Automation Notebook article titled 'Starting with Steppers' under the Tech Thread, Part 1 of 2 published in Issue 21 (Fall 2011), and Part 2 of 2 published in Issue 22 (Spring 2012). Various stepper motor control methods are discussed in this article. Links to Part 1 & 2 are shown below to the left.

The eight part video series titled 'Motion Control – ***Direct*LOGIC** Micro PLC/CTRIO Module to ***SureStep*** Stepping System with ***C-more*** Micro-Graphic Panel (HMI)' is another excellent resource detailing Motion Control System information.

8 Part Video Series: http://bit.ly/28OWORY

Link to "Starting with Steppers" Part 1: http:/bit.ly/J5U0tN

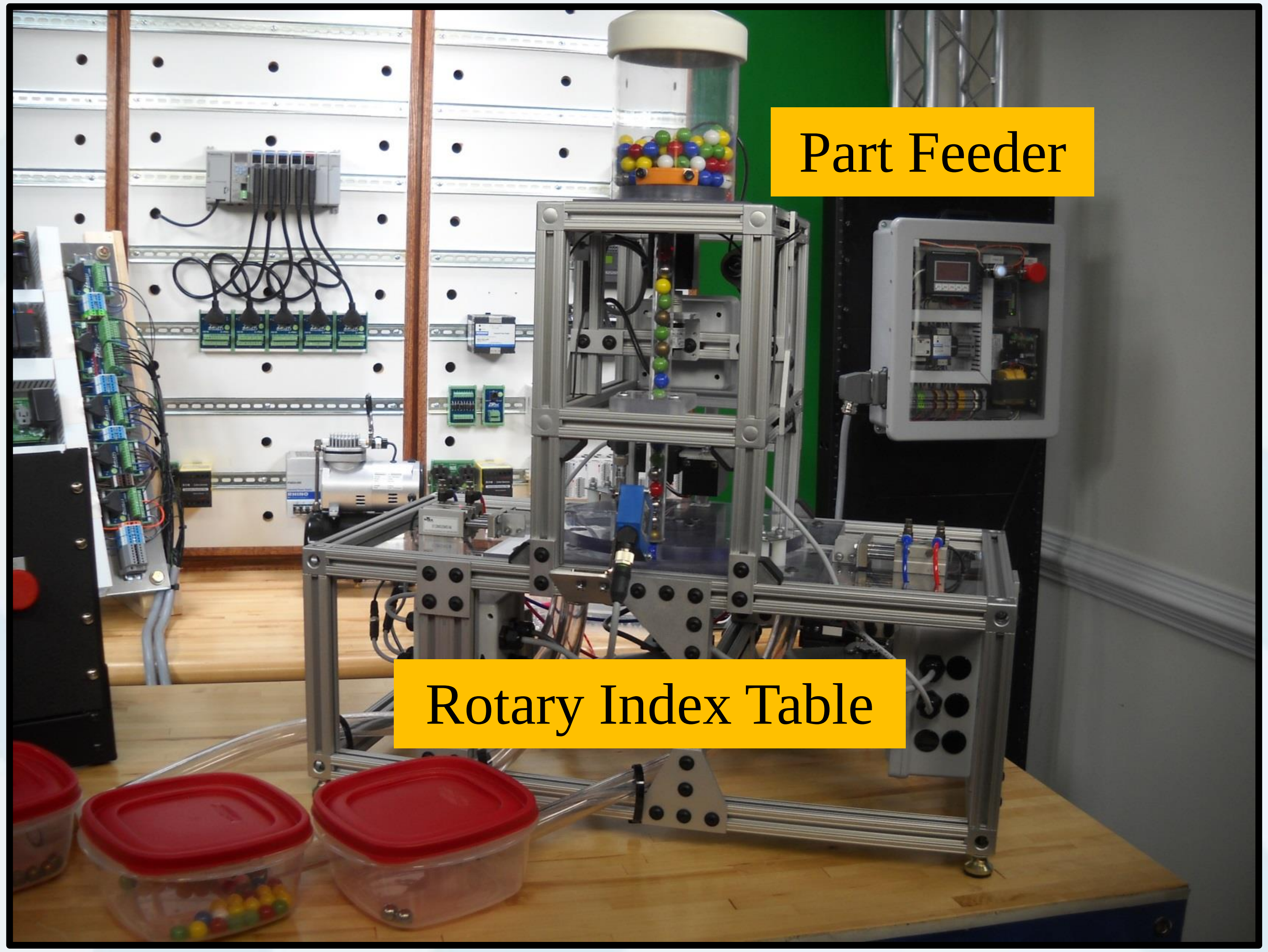
Link to "Starting with Steppers" Part 2: http:/bit.ly/IQSjUb

Application – Rotary Index Table Station

The Rotary Index Table Station was designed to accept the marbles being dispensed by the Part Feeder Station, loading them one at a time into one of eight pockets on a circular disk. The disk is indexed 45 degrees of rotation for each marble that is loaded. Various operations can then be preformed at each of the eight positions.

The Index Table disk is rotated using a ***Sure*Step** stepping motor that is controlled with a ***Sure*Step** Advanced Microstepping Drive, part number STP-DRV-80100. The ***Sure*Step** Serial Command Language (SCL) is used to control the motion moves. The commands are formed in the **Do-more** PLC and sent via the CPU's serial port to the ***Sure*Step** drive.

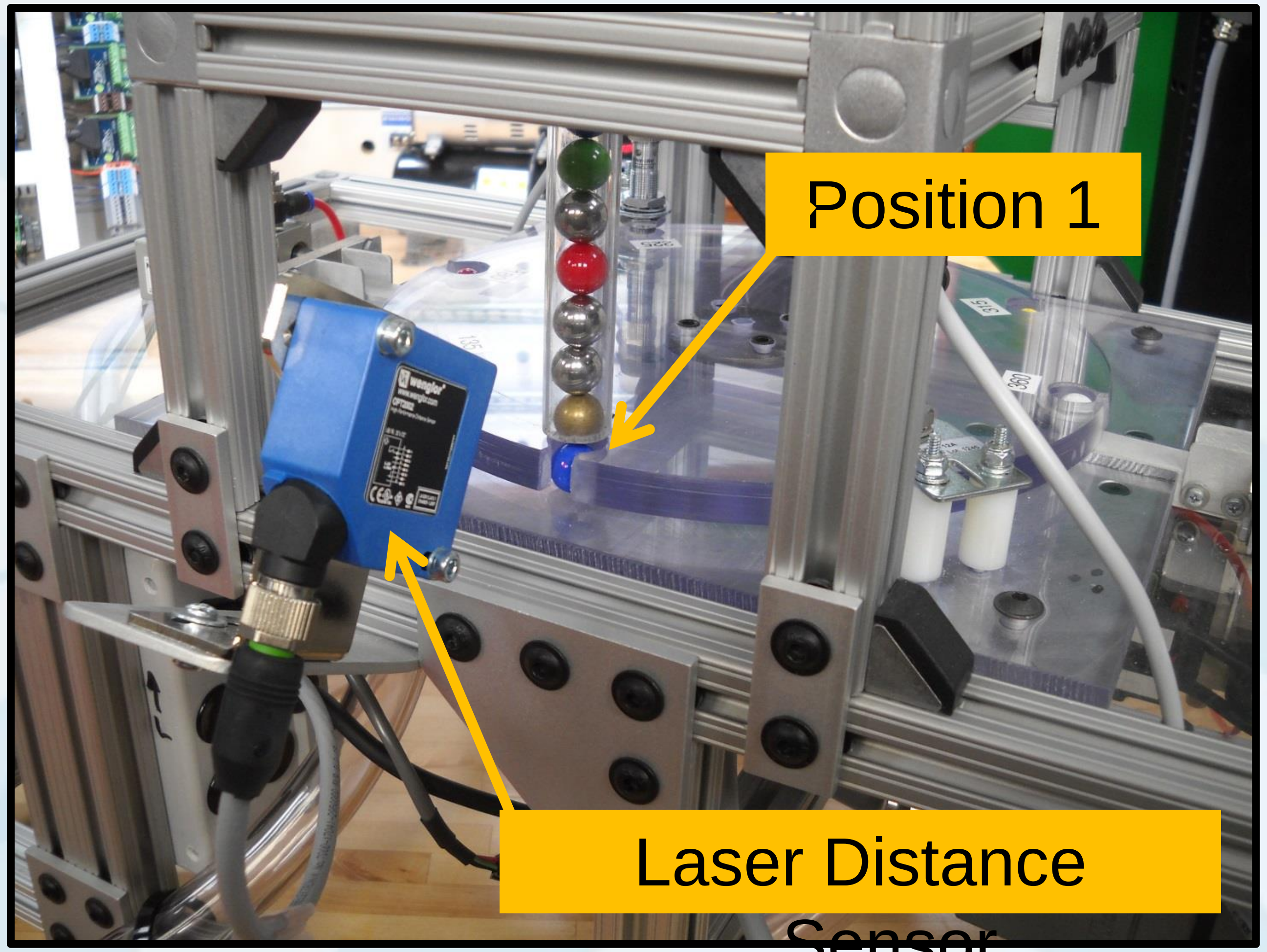
The Rotary Index Table mechanism was designed and built using 80/20 structural components, as was seen with the Part Feeder Station. The two stations are joined together so that the part exit from the Part Feeder Station lines up with the load position on the Rotary Index Table.



Application – Rotary Index Table Station (cont'd)

The eight positions on the rotary disk are designated as follows:

Position 1 – Entrance for the part is due South when facing the unit. A laser distance sensor with analog output is used to detect when the part is present.
Position 2 – Proximity used to detect the steel parts.
Position 3 – (due East) Pneumatic slide cylinder used to reject the steel parts.
Position 4 – Idle at this time.
Position 5 – (due North) Homemade sensor is used to detect color of the marbles. (Not supported by ADC.)
Position 6 – Proximity used to detect the brass parts.
Position 7 – (due West) Pneumatic slide cylinder used to reject the brass parts.
Position 8 – Exit from the Rotary Index Table.



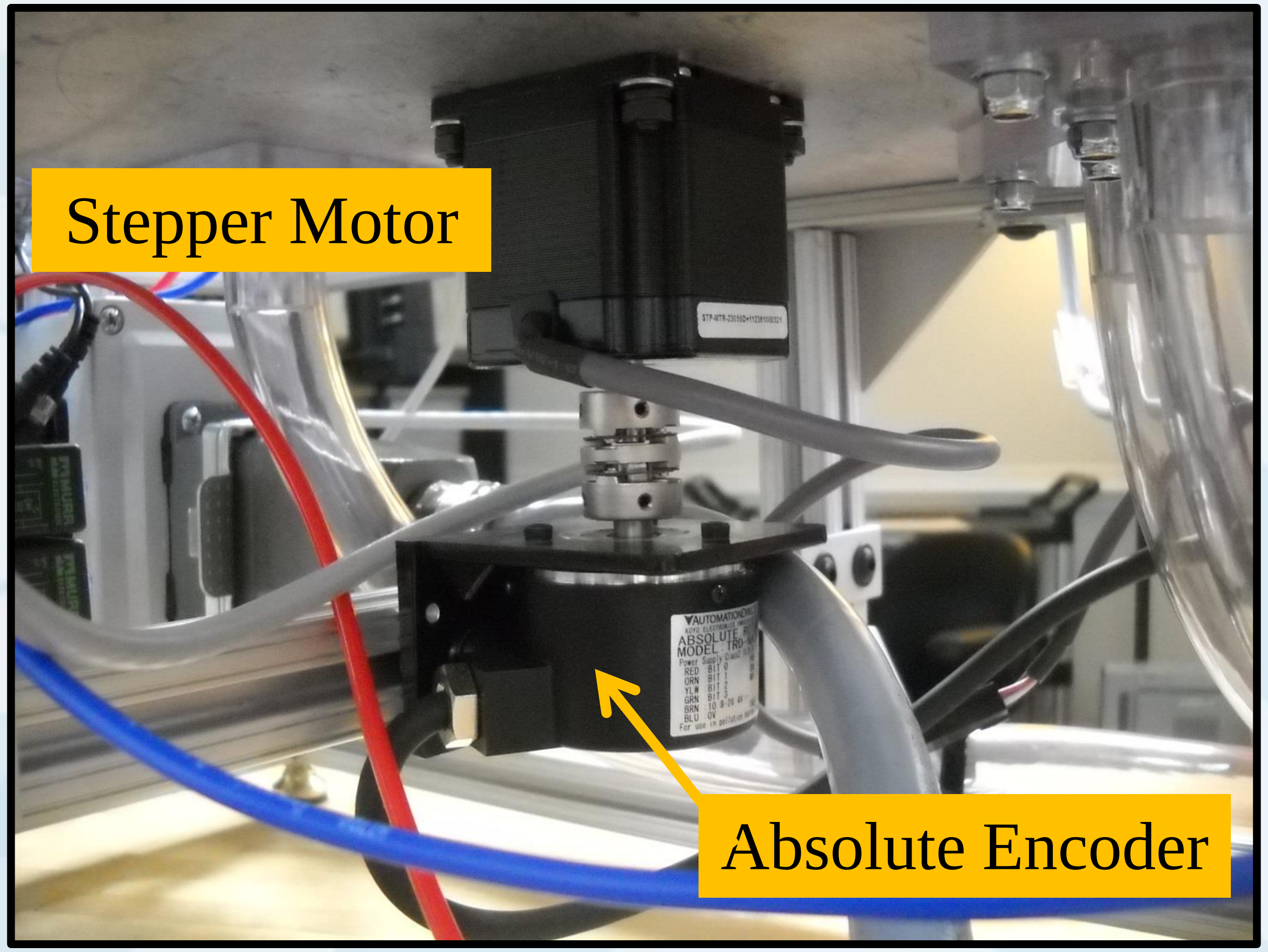
Direction of rotation for the rotary disk is counter clockwise. The Rotary Index Table can be thought of as a rotary

Sensors – Absolute Encoder

Various sensors are used to provide information to the PLC during the operation of the Rotary Index Table.

An absolute encoder is coupled to the backside of the stepper motor's dual shaft. The output from the absolute encoder is Gray Code, 9-bit 360 pulses/revolution. The encoder is wired into a DC Input module, and within the Do-more ladder logic, a value of 1 to 360 degrees of rotation is converted/produced. The value is used to verify the position of the eight different pockets that are around the outer edge of the rotary disk.

The absolute encoder is not used to automatically correct for positioning. It is used to initially set the starting position of the rotary disk to make sure the exit tube from the Part Feeder Station is aligned with one of the eight pockets. This is done by having a one degree jog push button function on the C-more Touch Panel for either a clockwise or a counter clockwise direction. A readout of the rotary disk position in degrees is also displayed on the C-more Touch Panel for monitoring the position.



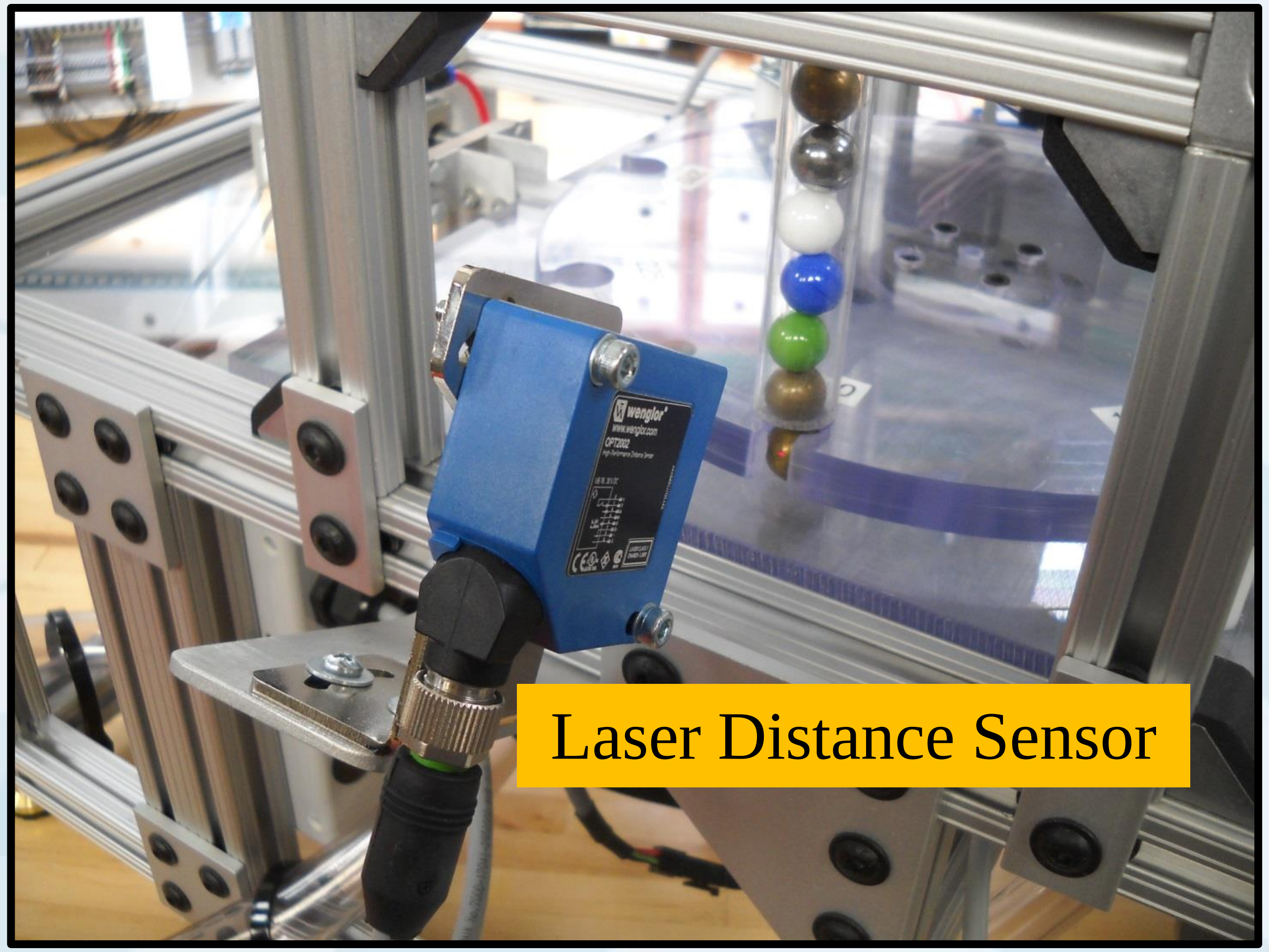
TRD-NA360NWD

Sensors – Laser Distance Sensor

A Laser Distance Sensor is used to detect that a part is loaded into the rotary disk's position 1 pocket. The laser distance sensor used has a range of 30 to 80mm, which is equivalent to 1.18 to 3.15 inches.

The output of the laser distance sensor is a 4-20 mA analog signal. This signal is wired into an analog input module. The analog input module produces a value of 0 to 4095 that is scaled to read as 1.18 to 3.15 inches within the Do-more ladder logic.

Within the ladder logic, compare contacts are used to determine if the distance sensor is measuring all the way to the bottom of the pocket, or if it is seeing a part. Seeing a part in the pocket would be represented by any distance less than 2.85 inches. And to prevent indicating a part from an object blocking the pocket, or seeing the edge of the rotary disk, a compare contact is also used to make sure the distance seen is greater than 2.45 inches.



OPT2002

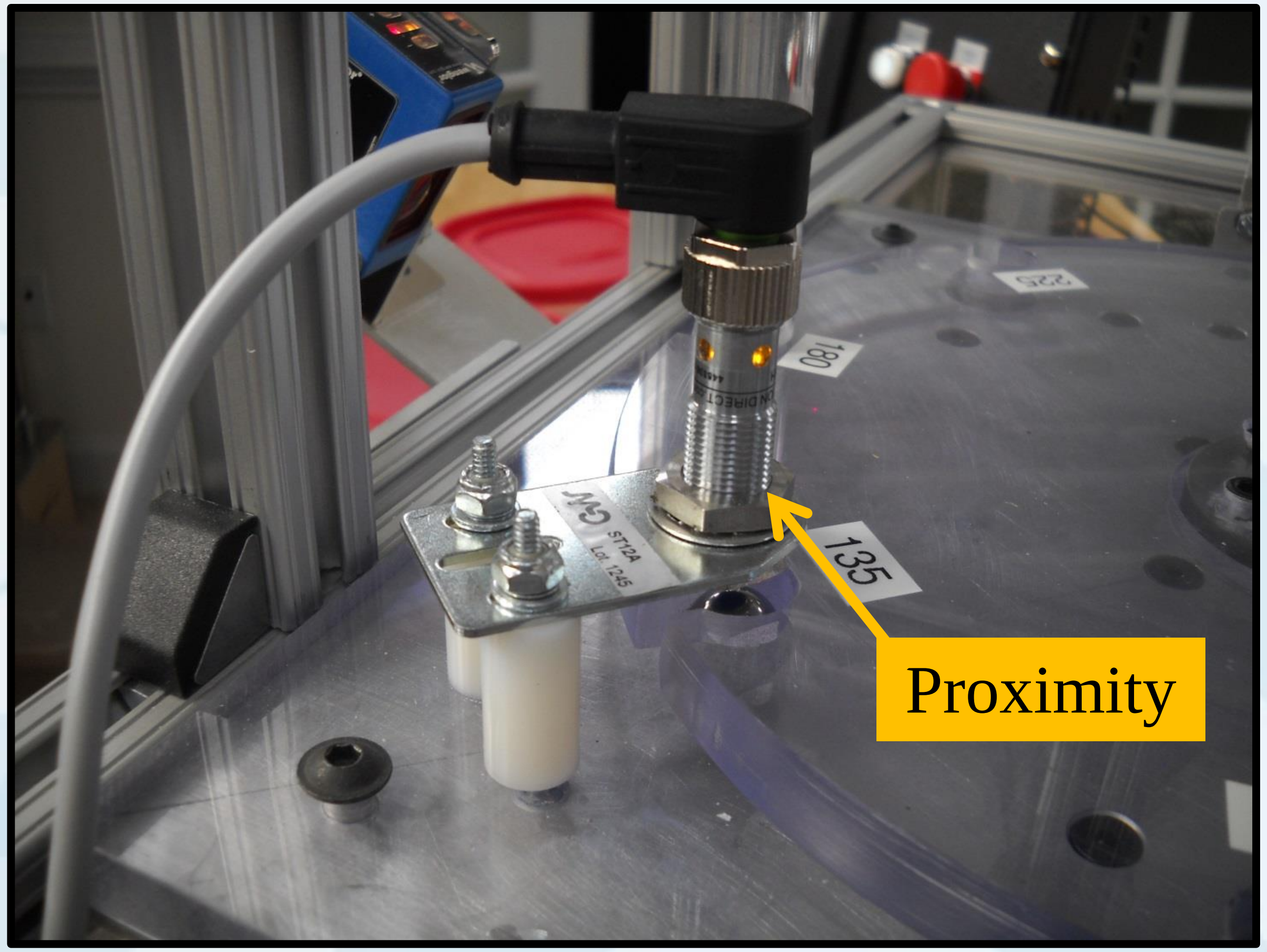
Sensors – Proximities

To sort out the steel and brass balls from the marbles, two inductive proximities are used to detect the metallic marbles. The proximities that are being used normally sense ferrous metals, but although not as sensitive, can also detect non-ferrous metals, such as brass.

At position 2 on the rotary disk, one of the proximities is adjusted so that it will detect the steel balls, but not the brass. At position 3, a pneumatic slide cylinder is used to operate a reject gate that will allow the steel ball to be dumped to the steel ball reject bin.

Likewise at position 6 on the rotary disk, the second proximity is adjusted so that it will detect the brass balls. Physically it is adjusted so that it is closer to brass balls then the distance that is seen to detect the steel balls.

As with the steel ball detection, at position 7, a second pneumatic slide cylinder is used to operate a reject gate that will allow the brass ball to be dumped to the brass ball reject bin.



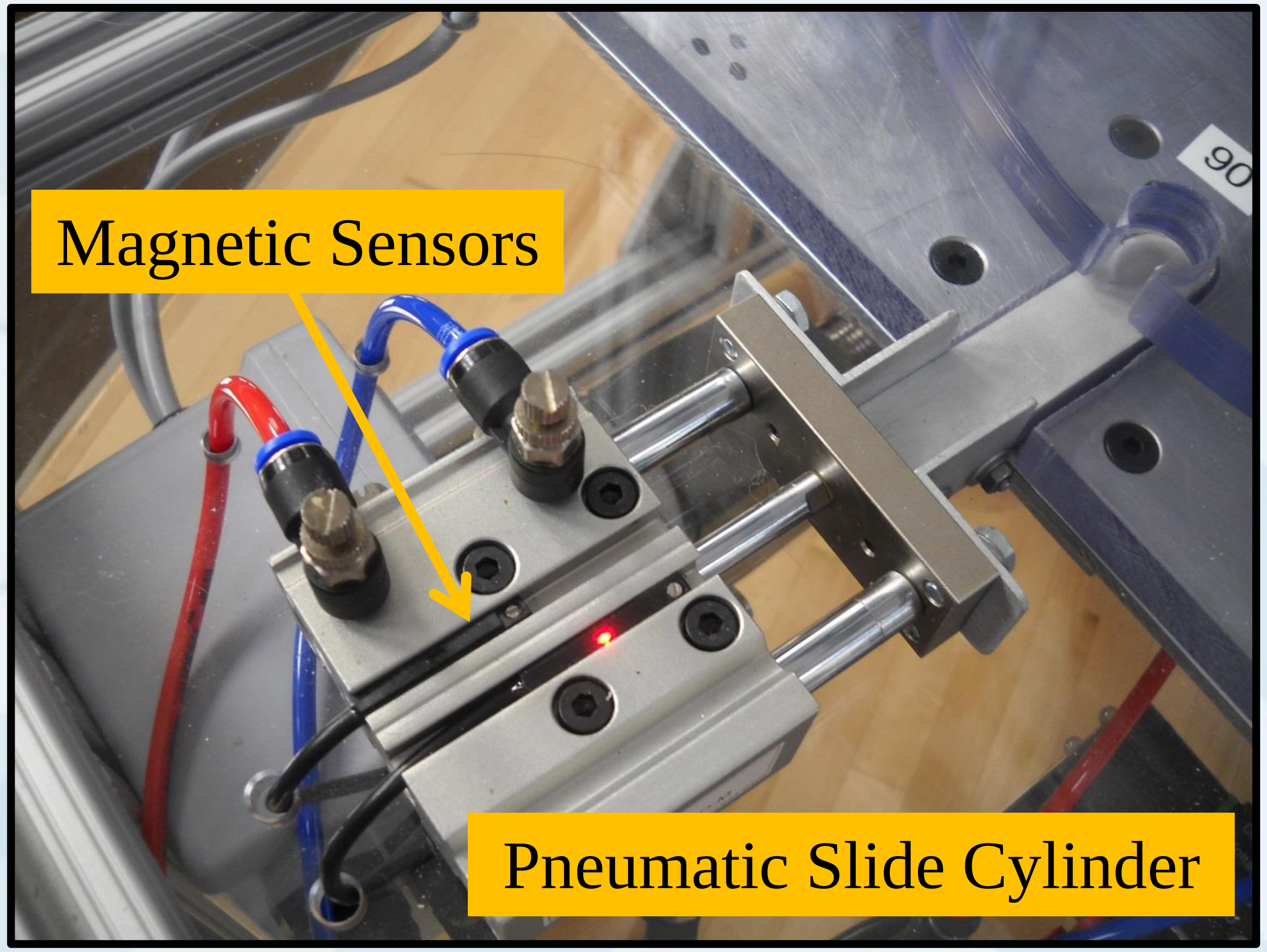
AM1-AN-5H

Sensors – Pneumatic Cylinder Magnetic Sensors

The two pneumatic slide cylinders that are used to reject the steel and brass balls incorporate magnetic sensors. The sensors are used to determine when the cylinder is fully extended and fully retracted.

The slide cylinder incorporates a magnetic piston that will actuate the magnetic sensors when the sensors are adjusted accordingly to the correct positions.

The fully extended signal is used to make sure the reject gates are fully closed before an index can be executed, and the fully retracted signal is used to sequence the reject gate during operation to make sure the cylinder has made a full stroke.



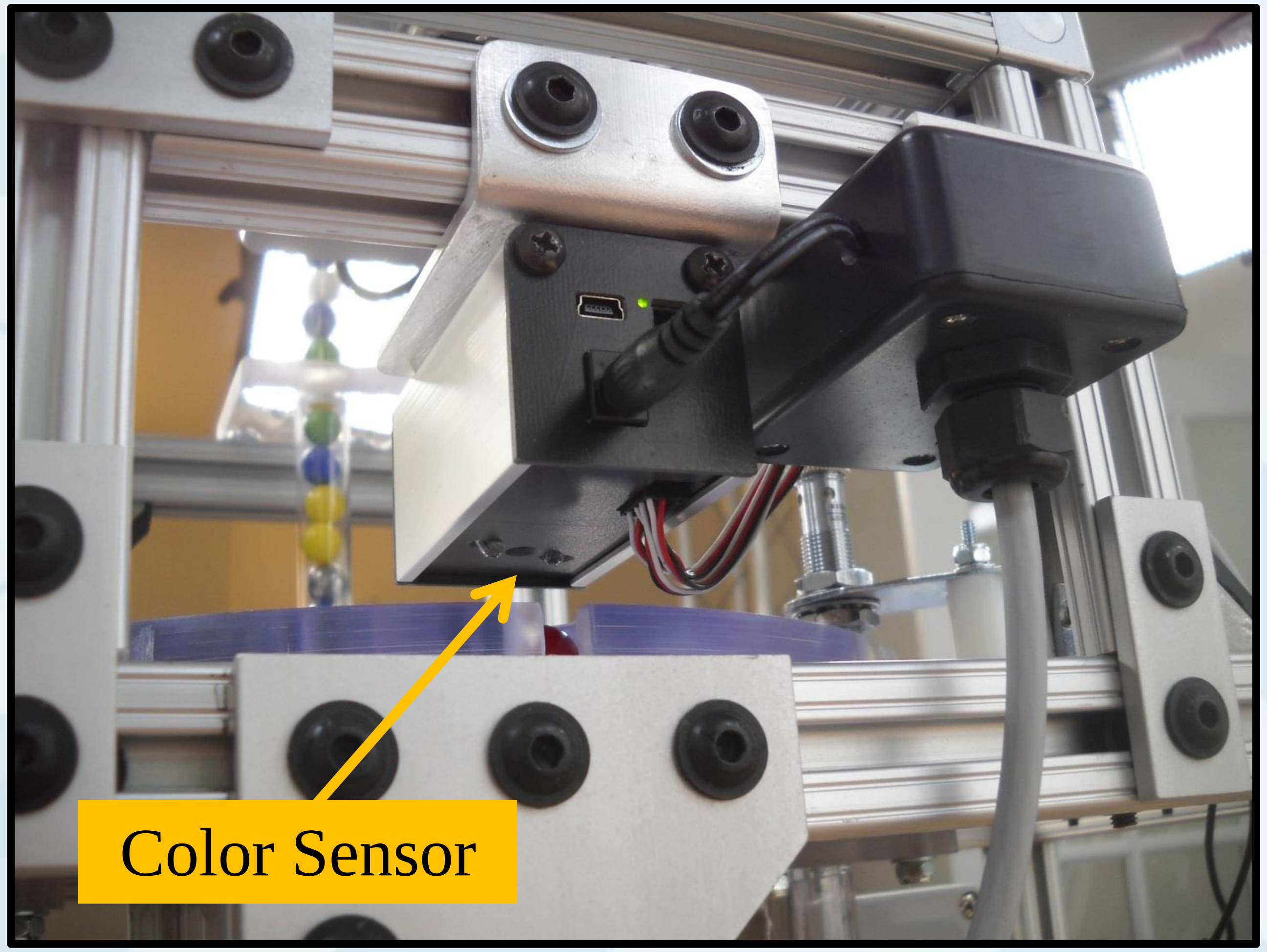
CPS9H-AN-F

Color Sensor

A homemade color sensor, not sold or supported by ***AutomationDirect.com***, is used on the Rotary Index Table to detect the color of the six different colored marbles that are being dispensed into the rotary disk.

The use of the color sensor allows us to show how to interface a device that operates on 5 Volt TTL logic level signals into PLC 24 VDC input modules. An ***AutomationDirect*** Signal Conditioner and Optical Isolator, p/n FC-ISO-C, was chosen for this purpose.

Three digital signals programmed from the color sensor produce a three bit code that represents the marble's color plus additional information.



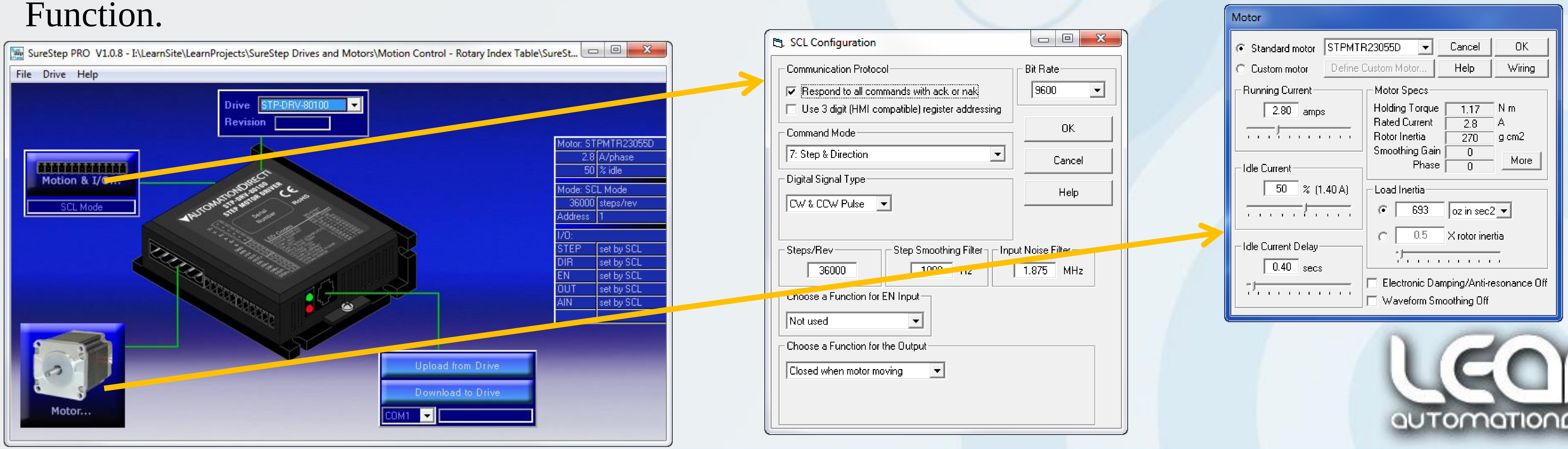
Color	Bit 2	Bit 1	Bit 0
None	0	0	0
Red	0	0	1
Green	0	1	0
Blue	0	1	1
Yellow	1	0	0
White	1	0	1
Black	1	1	0
Brass	1	1	1

FC-ISO-C

Using the *Sure*Step Pro Configuration Software

The ***Sure*Step** advanced drive is configured using the ***Sure*Step** Pro Configuration Software. In our application, we our using the STP-MTR-23055D dual shaft stepper motor, so in the software we select the Motor icon which brings up the Motor dialog window. Within the window, we select the STP-MTR-23055D stepper motor, which fills in the Motor Specs, etc. The Load Inertia for the rotary disk in our application was calculated to be 693 oz-in-sec^2, so this value is entered.

The Motion & I/O icon when clicked will allow us to select the Motion Control Mode dialog box. From this dialog box we select SCL (Serial Command Language) Configuration. Step & Direction is selected for the Command Mode, 36,000 is entered for the Steps/Rev, and ‘Closed when motor moving is selected for the Output Function.

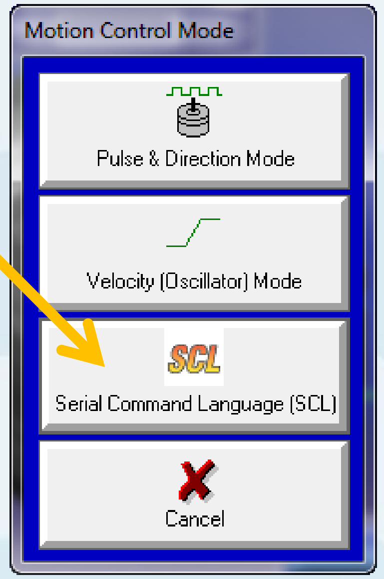


SCL – Serial Command Language

As mentioned earlier, the stepper motor is driven with a ***Sure*Step** advanced microstepping drive, which is controlled by commands communicated by a serial connection between the **Do-more** PLC and a serial port on the drive. The commands are a combination of ASCII abbreviations that are part of the Serial Command Language. An example of the commands is shown here:

AC25<ENTER> Set accel rate to 25 rev/sec/sec
DE25<ENTER> Set decel rate to 25 rev/sec/sec
VE5<ENTER> Set velocity to 5 rev/sec/sec
FL20000<ENTER> Move the motor 20000 steps in the CW direction.

The ability to use SCL commands is enabled within the ***Sure*Step** Pro Configuration Software by selecting Serial Command Language (SCL) under the Motion Control Mode.



All of the SCL commands are described in the SCL User Manual. Information on how the serial communications is setup is also explained in the User Manual. The SCL User Manual can be found at the link shown below.

Link to SCL User Manual: http:/bit.ly/28XJhdp

SCL – Serial Command Language (cont'd)

Also available is a document that covers the various motion concepts that are associated with the ***Sure*Step** Serial Command Language. Here is the link to that document.

Link to Intro to Stepper and Motion Concepts: http:/bit.ly/28Vu51F

An example of ladder logic used to send SCL commands to a ***Sure*Step** advanced drive from a **Do-more** PLC's serial port can be found at this link. Look for application note EP-COM-014.

Link to Example Programs – EP-COM-014: http:/bit.ly/28RMxHN

And for reference, the following is a link to the data sheet covering the ***Sure*Step** advanced drives, **AutomationDirect** part numbers STP-DRV-4850 and STP-DRV-80100.

STP-DRV-80100

Link to Advanced Microstepping Drives Data Sheet: http://bit.ly/28XJAEW

Other available videos in this series on Motion Control.

Title	VID Number
Part 2 of 5 – Schematic Diagrams.	L-PC-DM-STP-CM-001-2
Part 3 of 5 – **Do-more** Ladder Logic Programming.	L-PC-DM-STP-CM-001-3
Part 4 of 5 – ***C-more*** Touch Panel Programming.	L-PC-DM-STP-CM-001-4
Part 5 of 5 – Operational Demonstration.	L-PC-DM-STP-CM-001-5

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