



Greetings ...

This edition of our **Email PLC Quiz** contains questions which are somewhat **Beyond Beginner** and could prove challenging even for some technicians who have considerable PLC experience. As always, the primary objective of the quiz is to cover useful skills for technicians who troubleshoot systems controlled by Allen-Bradley PLCs.

PLEASE NOTE: If you would rather not receive more Email PLC Quizzes like this one, just reply to this email with the word "remove" in the subject line. On the other hand, if you know someone who might find this type of information useful, please feel free to forward this email to them.

IMPORTANT: Due to size and bandwidth considerations, this edition of the PLC Quiz is being sent as an email attachment. If you have trouble opening the attachment, you may download the entire file (in an easy to print PDF format) from our website at www.ronbeaufort.com - look in the "Sample Lessons" section. Answers to the quiz are also available in the same section as a separate file. Absolutely no registration or visitor information is ever required for access to our website.

Also, if you'd like to discuss the information contained in any of our quizzes, please feel free to contact us. We'll be glad to answer any questions that you might have.

Please keep in mind that this material is intended only for use with the PLC-5, the SLC-500, and the ControlLogix families of Allen-Bradley PLC processors. You should also keep in mind that there may be certain important differences in operation between these three processor families. For example, information pertaining to a PLC-5 system might not be directly applicable to the SLC-500 or to the ControlLogix platforms. In simple terms, all Allen-Bradley processors do NOT function in exactly the same way.

LEGAL DISCLAIMER: This material is provided "as is" with no warranty of any kind. Specifically, we do not assume responsibility or liability for any actual use of this material in an industrial setting and shall be held harmless with respect to any information presented herein. In all cases, consult all applicable codes, regulations, and standards - and your local plant engineering staff - before applying any control strategy.

We'd also like to say "thank you" to all of you who have contacted us and asked for future editions of our PLC Quizzes - and who have recommended your friends and associates to be added to our email list. Based on all of the comments we've received so far, it seems that we're meeting our goal of making our quizzes: (1) entertaining, (2) thought provoking, and (3) educational. We've also been pleased to hear about the "spirited" debates over our previous editions that have taken place around the maintenance shops. We'd like to say a special "thank you" for all of your excellent suggestions for topics to be covered in our future editions. We'll definitely try to get around to those in the months ahead.

Good luck on the quiz ...

Beyond Beginner Quiz #215 - Part 1 - "Toggling" Bits

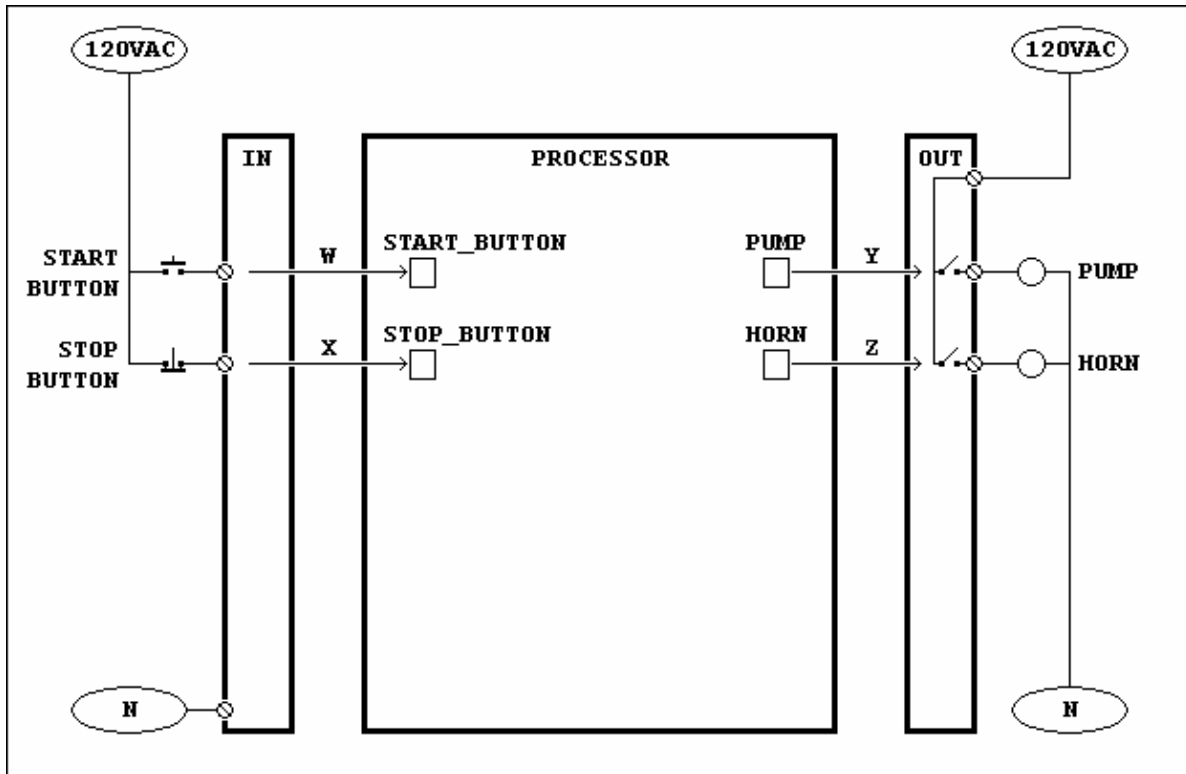


Figure 1 - Wiring for Beyond Beginner Quiz #215

Figure 1 shows the wiring for a simple control system with two field output devices: a PUMP and a HORN. There are also two field input devices. The momentary START_BUTTON is wired for normally-open operation. The momentary STOP_BUTTON is wired for normally-closed operation. All of the wiring and field devices are in good condition. Specifically, there are no burned-out coils, broken wires, bad switches, etc.

The intended operation of the system is that an operator can start the PUMP by momentarily pressing the START_BUTTON. The operator can stop the PUMP by momentarily pressing the STOP_BUTTON. Whenever the PUMP is running, the HORN should sound. The system has been working as intended for a very long time.

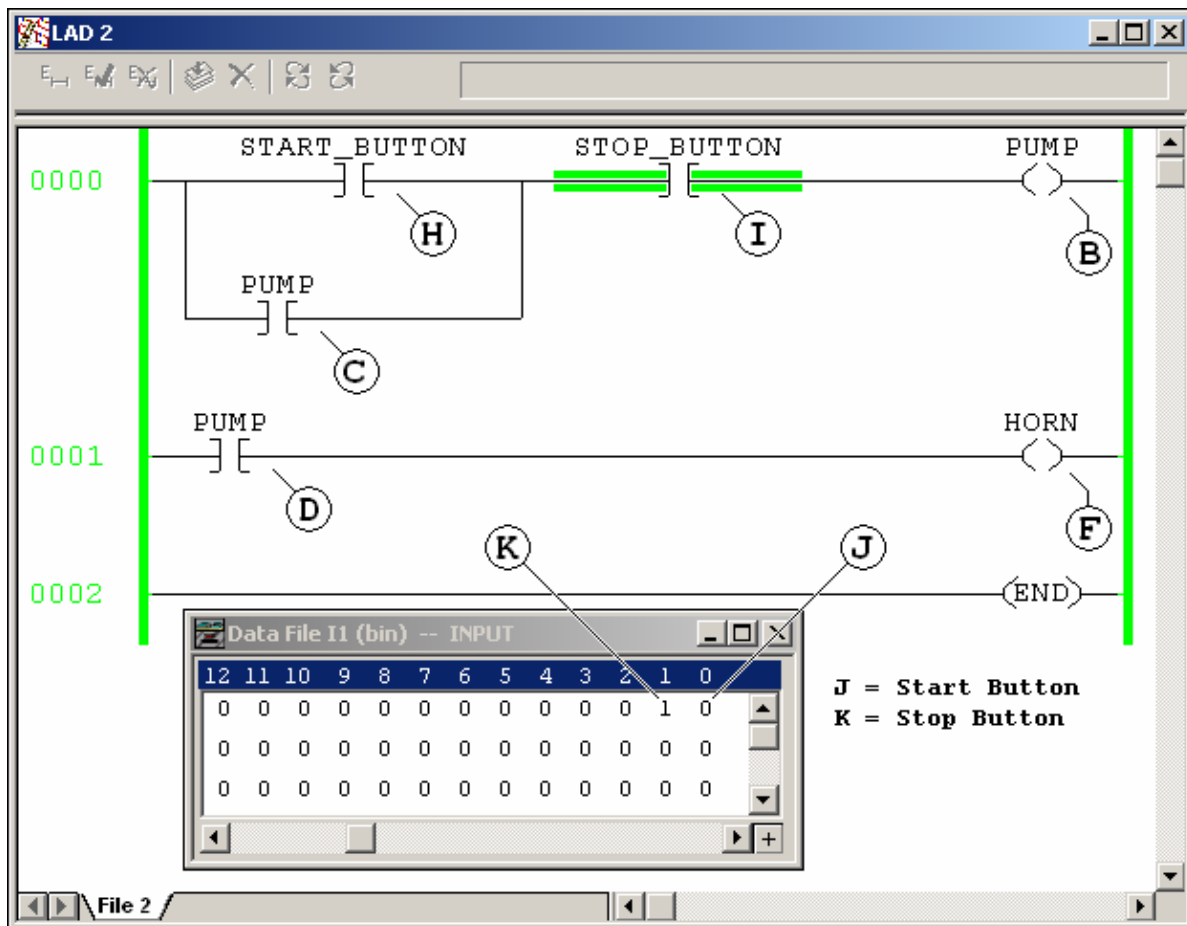


Figure 2 – Ladder Logic and the Input Data Table

Note that Figure 2 shows the entire ladder logic program and also part of the processor's Input Data Table. The rungs in this file are being properly scanned as in a normal simple program.

While taking the quiz, be sure to read each question and answer carefully – and then pick the **BEST** answer which **MOST LIKELY** answers the question. And be sure to pay particular attention to the specific Allen-Bradley platform (PLC-5, SLC-500, or ControlLogix) involved.

Actually the sometimes “surprising” differences in operation between the three major platforms are the main reason that we’ve classified this particular quiz at the “beyond beginner” level. Even “Top Gun” students with several years of experience often arrive at our PLC Boot Camp classes with serious misconceptions about how these different platforms handle the same basic functions such as “Toggling Bits” and “Forcing” inputs and outputs. These inconsistencies in operation can make it quite challenging whenever a technician has to switch from one platform to another while troubleshooting.

Some of the “screen shot” figures used in the quiz will be taken from various RSLogix software packages. Naturally there may be some minor differences in how the rungs and the data tables are displayed from one package to another. In spite of that, the actual structure of the rungs will always be identical whether we’re discussing the PLC-5, the SLC-500, or the ControlLogix platform. You should have no trouble interpreting the pictures regardless of which software package was used in producing them.

One more note about the ControlLogix system is in order. The hardware configuration for our test uses the default setting of 10.0 milliseconds for the RPI (Requested Packet Interval) for both the input and the output modules.

Since this quiz focuses on the “Toggle Bit” operation, let’s define what the term “Toggle Bit” actually means before we get started.

First of all, a “bit” is a “box” in the PLC processor’s memory – and this “bit/box” can hold either a ONE or a ZERO.

Second, when we toggle a bit, we simply change its status. Specifically, suppose that we toggle a bit which contains a ONE. After the toggle, the bit will contain a ZERO. And vice versa. Suppose that we toggle a bit which contains a ZERO. After the toggle, the bit will contain a ONE.

That seems simple enough, now let’s see how you do on the quiz. Take your time – and stay alert. Notice that most of the toggle and force operations are associated with the **PUMP** – but most of the questions pertain to the operation of the **HORN**. This is not an attempt to trick you – but you’ll definitely need to pay close attention to make sure that you’re answering the specific question that is being asked.

Begin with the conditions shown in Figures 1 and 2. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a "Toggle Bit" operation at **Position B**. Notice that Position B is an OTE to control the **Pump**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 1 – for a PLC-5 system

Answer 1A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 1B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 1C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 1D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 2 – for an SLC-500 system

Answer 2A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 2B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 2C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 2D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 3 – for a ControlLogix system

Answer 3A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 3B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 3C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 3D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Begin with the conditions shown in Figures 1 and 2. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a "Toggle Bit" operation at **Position J**. Notice that Position J is the bit on the Input Data Table for the **Pump's Start_Button**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 4 – for a PLC-5 system

Answer 4A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 4B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 4C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 4D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 5 – for an SLC-500 system

Answer 5A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 5B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 5C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 5D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 6 – for a ControlLogix system

Answer 6A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 6B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 6C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 6D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Begin with the conditions shown in Figures 1 and 2. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a "Toggle Bit" operation at **Position H**. Notice that Position H is an XIC for the **Pump's Start_Button**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 7 – for a PLC-5 system

Answer 7A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 7B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 7C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 7D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 8 – for an SLC-500 system

Answer 8A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 8B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 8C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 8D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 9 – for a ControlLogix system

Answer 9A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 9B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 9C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 9D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Beyond Beginner Quiz #215 - Part 2 - "Toggling" Bits with "Forces"

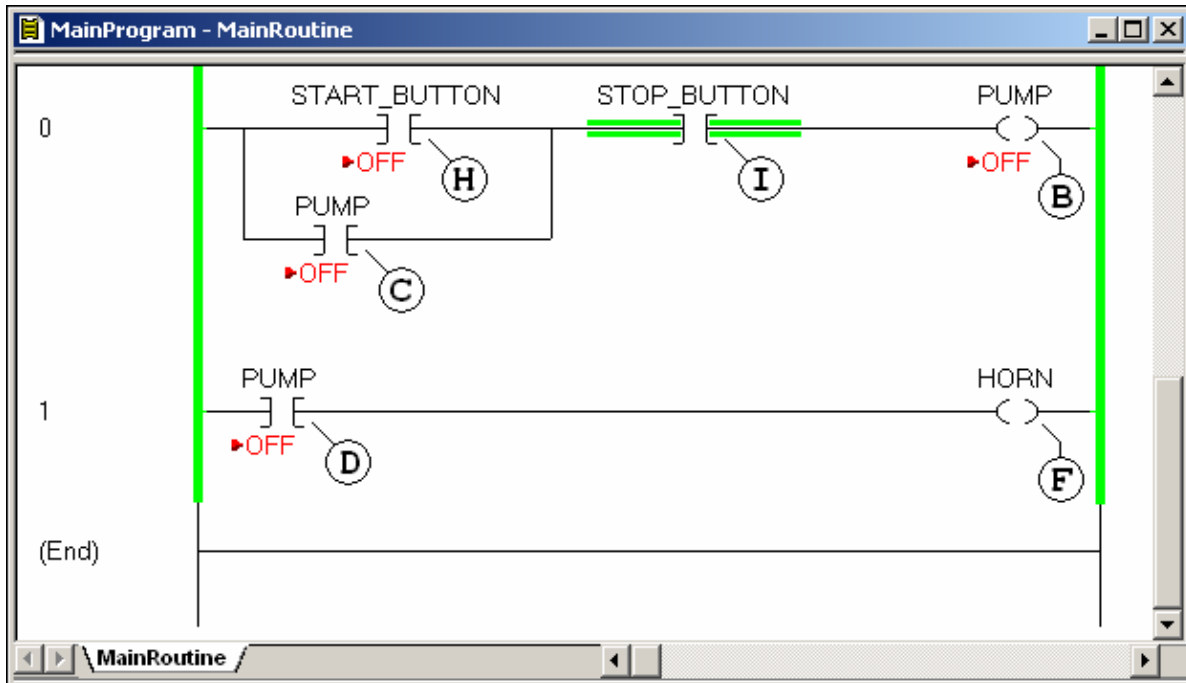


Figure 3 - Ladder Logic with Forces Applied and Enabled

The screen shot for Figure 3 is taken from Version 15 of RSLogix5000 for a ControlLogix system. The ladder logic rungs follow exactly the same pattern as the PLC/SLC system that we used in Figure 2. Notice that forces have now been applied (and enabled) to some of the inputs and outputs.

Many (actually most) technicians become thoroughly confused whenever the "Toggle Bit" operation is performed while forces are installed. The question quickly becomes: "Which is more powerful - the toggle or the force?" As you might suspect, there is no "one size fits all" answer for what seems to be such a simple question.

Good luck on the rest of the quiz.

Begin with the conditions shown in Figures 1 and 3. Notice that forces have been applied – and these forces are enabled. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a “Toggle Bit” operation at **Position B**. Notice that Position B is an OTE to control the **Pump**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 10 – for a PLC-5 system

Answer 10A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 10B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 10C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 10D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 11 – for an SLC-500 system

Answer 11A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 11B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 11C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 11D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 12 – for a ControlLogix system

Answer 12A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 12B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 12C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 12D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Begin with the conditions shown in Figures 1 and 3. Notice that forces have been applied – and these forces are enabled. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a “Toggle Bit” operation at **Position D**. Notice that Position D is an XIC for the **Pump** which is located in the control rung for the Horn. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 13 – for a PLC-5 system

Answer 13A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 13B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 13C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 13D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 14 – for an SLC-500 system

Answer 14A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 14B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 14C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 14D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 15 – for a ControlLogix system

Answer 15A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 15B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 15C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 15D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Begin with the conditions shown in Figures 1 and 3. Notice that forces have been applied – and these forces are enabled. The Pump device in the field is currently OFF. The Horn device in the field is currently OFF.

Suppose that we right-click and perform a “Toggle Bit” operation at **Position H**. Notice that Position H is an XIC for the **Pump’s Start_Button**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

Question 16 – for a PLC-5 system

Answer 16A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 16B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 16C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 16D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 17 – for an SLC-500 system

Answer 17A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 17B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 17C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 17D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.

Question 18 – for a ControlLogix system

Answer 18A – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will turn OFF.

Answer 18B – The Horn probably WILL sound continuously. Later if the Stop_Button is pressed, the Horn will stay ON.

Answer 18C – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will turn ON.

Answer 18D – The Horn probably will NOT sound continuously. Later if the Start_Button is pressed, the Horn will stay OFF.