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**Hands-On Technical Workshops**
by Ron Beaufort

**Email PLC Quiz #115 – Questions**

Greetings ...

This edition of our **Email PLC Quiz** contains questions intended for technicians at a **Beginner Level**. 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.



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 ...

**Beginner Level Quiz #115 - Part 1 – "Toggling" Output Bits**

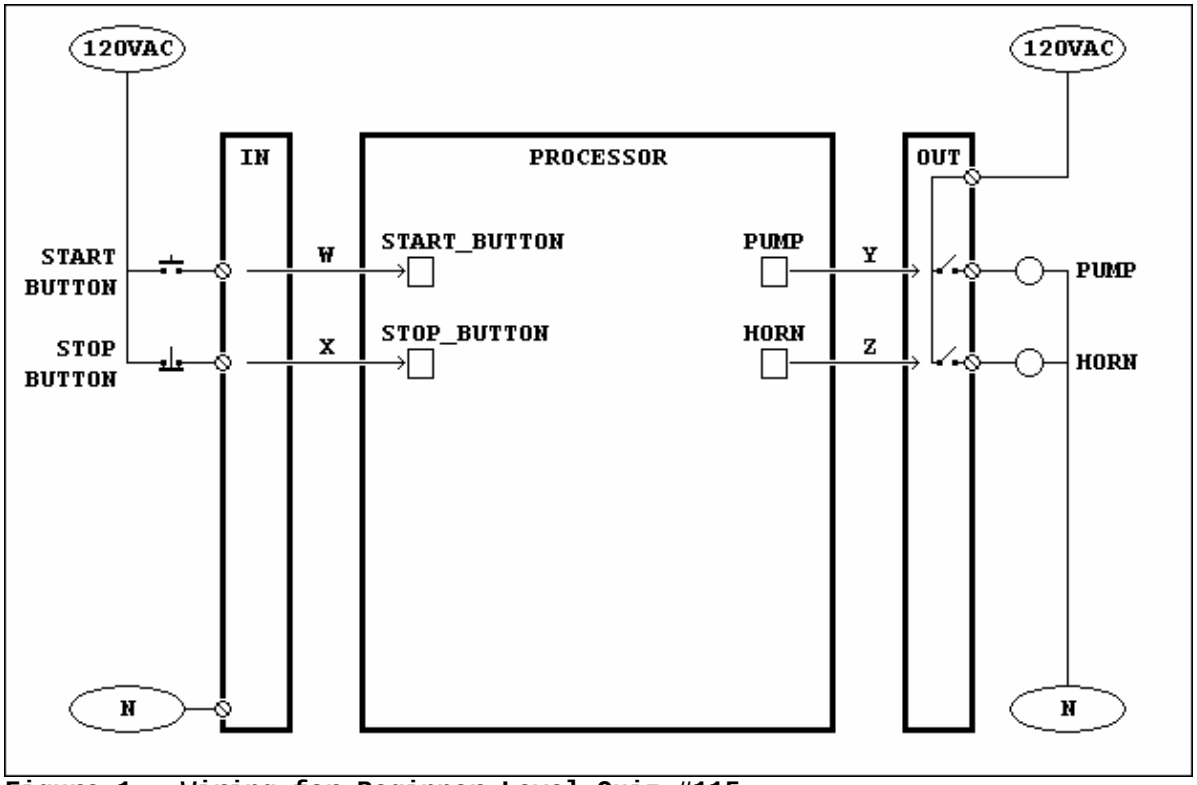


**Figure 1 – Wiring for Beginner Level Quiz #115**

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.

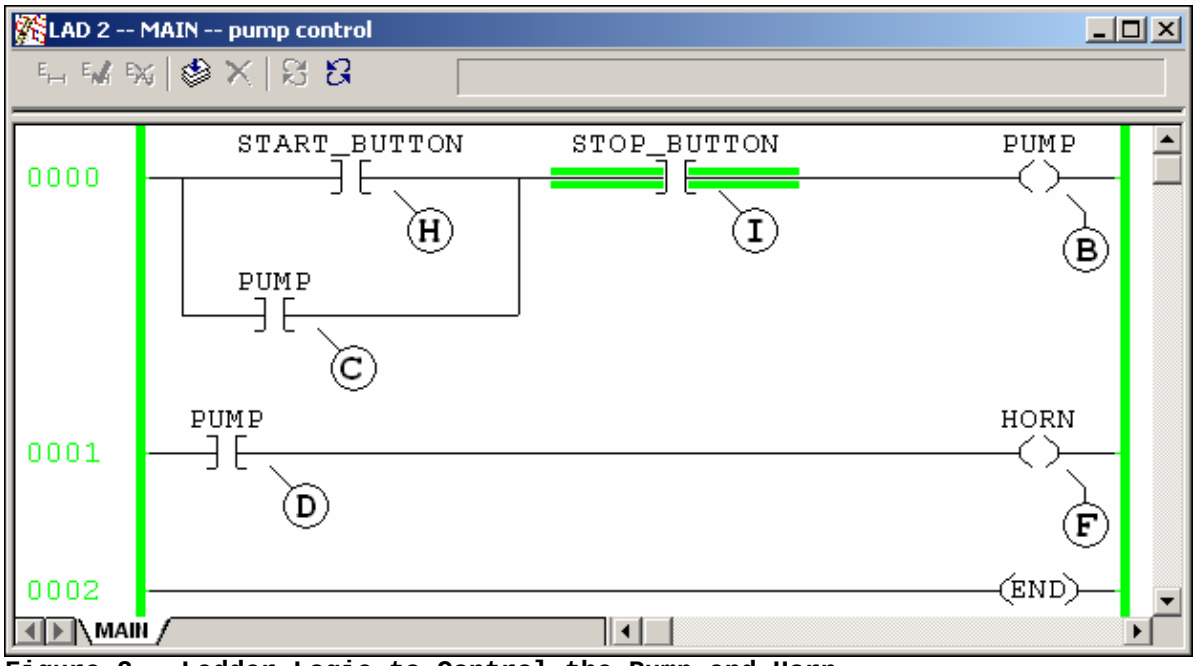


**Figure 2 – Ladder Logic to Control the Pump and Horn**

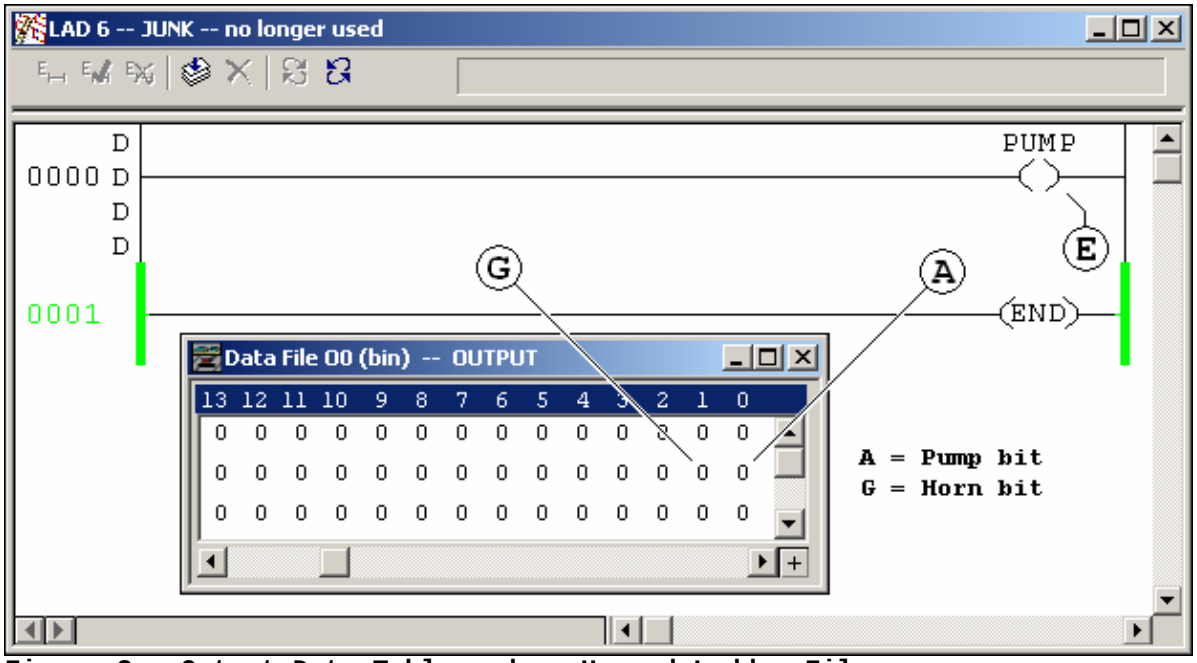


**Figure 3 – Output Data Table and an Unused Ladder File**

Note that Figures 2 and 3 together show the entire ladder logic program. Figure 3 also shows part of the processor's Output Data Table.

The rungs in File #2 (shown in Figure 2) are being properly scanned as in a normal simple program.

The rung in File #6 (shown in Figure 3) is NOT being scanned by the processor. In other words, there is no JSR, STI, MCP, or any other mechanism which would cause the processor to execute the ladder logic in this file. Specifically, this ladder file is an unused "junk" file which has been left in the system by a former programmer. Also notice that the only rung in this file has been marked for "deletion" as shown by the letters "D" in the window's margin. This edit for deletion is currently being "Tested" as shown by the unhighlighted condition of the rung's "power rails". All of this discussion boils down to the fact that the processor is NOT currently using this particular rung to control the operation of the system.

While taking this particular quiz, you may assume that the questions being asked will all have identical answers for any of the three main Allen-Bradley platforms. Specifically, PLC-5, SLC-500, and ControlLogix processors will all respond identically in the following tests. Keep in mind that this will NOT always be true while working in the field – and there can be significant differences between the various platforms.

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.

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.

Actually the questions are quite simple – it's the answers which can make things seem so confusing. Even "Top Gun" students with several years of experience often arrive at our PLC Boot Camp classes with serious misconceptions about how PLC ladder logic really works. All of the tricky incorrect answers below are based on some of the most common of those mistaken ideas. In other words, we didn't just "dream up" a series of wrong answers to make the quiz more challenging. All of the confusing material below is taken directly from what many technicians incorrectly believe to be true.

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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.

**Question 1** - Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a "Toggle Bit" operation at **Position A**. Notice that Position A is the **Pump's** bit on the Output Data Table. Will the **Horn** sound continuously?

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**Answer 1A** - Yes, the Horn will sound continuously because the manual "Toggle Bit" operation will permanently change the status of the Pump's bit from FALSE to TRUE. In other words, the program's ladder logic will be unable to control the Pump bit after it has been manually toggled directly in the Output Data Table. Specifically, once the data table bit has been manually toggled ON, the only way to turn the bit's status back OFF is to manually toggle the bit again. So after the "Toggle Bit" operation at Position A, the XIC at Position D will test TRUE and the OTE at Position F will keep the Horn ON. The Horn will then remain ON even if we later press the Stop_Button.

**Answer 1B** - No, the Horn will not sound continuously. Toggling the Pump's bit on the Output Data Table will only temporarily change the bit's status to a ONE. The next time that Rung #0000 in File #2 is executed, the "top-to-bottom" sequence of scan operations will cause the OTE at Position B to change the status of the Pump bit right back to a ZERO again. Specifically, the OTE at Position B will write a ZERO to the Pump's bit BEFORE the "seal in" XIC at Position C even comes into play. Due to the ZERO status of the Pump's bit, the XIC at Position D will test FALSE. This FALSE condition will cause the OTE at Position F to leave the Horn OFF.

**Answer 1C** - Yes, the Horn will sound continuously because the toggling operation will change the status of the Pump's bit on the Output Data Table to a ONE. The ONE status of this Pump bit will then be maintained by the "seal in" action at Position C. Then the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Later if the Stop_Button is pressed, the Horn will turn OFF.

**Answer 1D** - No, the Horn will not sound continuously. Notice that the program contains valid ladder logic at Position B which actually controls the status of the Pump's bit. In such cases, the ladder logic will prevent any attempted manual toggling action. In other words, trying to toggle the status of the Pump's bit on the Output Data Table will have absolutely no effect on the system. Since the Pump will not run, the Horn device in the field will remain OFF.

**Question 2** - Begin with the conditions shown in Figures 1, 2 and 3. 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**. Will the **Horn** sound continuously?

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**Answer 2A** - No, the Horn will not sound continuously because toggling an output bit can only reliably be done directly at the bit's location on the Output Data Table. Specifically, the only way to manually change the status of the OTE at Position B is to "Force" the OTE. More specifically, toggle operations only act on bits within the processor's memory tables – but the more powerful forces must be used to manually control outputs such as the OTE at Position B. Since the Pump will not run after attempting a toggle at Position B, the XIC at Position D will test FALSE - and the OTE at Position F will keep the Horn OFF.

**Answer 2B** - Yes, the Horn will sound continuously because the toggling operation will change the status of the Pump's bit on the Output Data Table to a ONE. The ONE status of this Pump bit will then be maintained by the "seal in" action at Position C. Then the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Later if the Stop_Button is pressed, the Horn will turn OFF.

**Answer 2C** - No, the Horn will not sound continuously because of the processor's "top-to-bottom-left-to-right" rung execution pattern. Specifically, even though the "Toggle Bit" operation at Position B does indeed write a ONE status into the Pump's control bit, the "seal in" operation of Rung #0000 in File #2 will not function as intended to keep the Pump running. This is because the OTE at Position B is located "downstream" of the XIC for the Start_Button at Position H - and also "downstream" of the XIC for the Pump at Position C. This means that on the next scan after the toggle operation, both of these XIC instructions will still test FALSE – and therefore the "seal in" operation of the rung will fail. Then since the Pump will not run after attempting a toggle at Position B, the XIC at Position D will test FALSE - and the OTE at Position F will keep the Horn turned OFF. The toggle operation will cause the Horn device in the field to receive a momentary command to turn ON – but this will last for only one scan. In other words, the Horn will not sound continuously since the next scan of Rung #0001 in File #2 will turn the Horn back OFF again.

**Answer 2D** - Yes, the Horn will sound continuously because toggling the OTE at Position B causes the OTE to turn on the Pump. Rung #0000 in File #2 will therefore act as a common "seal in" circuit and keep the Pump running. In this condition, the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Since we have toggled an OTE (the "output" at Position B) and not just a status bit in the processor's memory, the Pump and the Horn will both remain ON even if we later press the Stop_Button.

**Question 3** - Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a "Toggle Bit" operation at **Position C**. Notice that Position C is an XIC used in a "seal in" branch to control the **Pump**. Will the **Horn** sound continuously?

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**Answer 3A** - Yes, the Horn will sound continuously because the toggling operation will change the status of the Pump's bit on the Output Data Table to a ONE. The ONE status of this Pump bit will then be maintained by the "seal in" action at Position C. Then the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Later if the Stop_Button is pressed, the Horn will turn OFF.

**Answer 3B** - No, the Horn will not sound continuously because any XIC instruction is used only to "examine a bit for an ON condition". Specifically, the XIC at Position C cannot "control" the Pump's bit in the processor's memory – therefore any attempt to toggle the XIC will have no effect on the operation of the program. Since toggling the XIC will not affect the program, the Pump will not run. Since the Pump will not run, the XIC at Position D will test FALSE - and the OTE at Position F will keep the Horn turned OFF.

**Answer 3C** - Yes, the Horn will sound continuously because toggling the XIC at Position C will manually change its status from FALSE to TRUE. Specifically, toggling the XIC will not affect the actual status of the Pump's bit on the Output Data Table – but nevertheless, the toggle operation will make the XIC itself test TRUE. This TRUE status at Position C will cause Rung #0000 in File #2 to "seal in" and keep the Pump running. Then since the Pump will be running, the XIC at Position D will test TRUE - and the OTE at Position F will turn the Horn ON. Since the toggle operation was applied to an XIC (at Position C) and not just to a bit in memory, the XIC will remain TRUE until it is manually toggled again. Therefore the Pump and the Horn will both remain ON even if we later press the Stop_Button.

**Answer 3D** - No, the Horn will not sound continuously because the XIC at Position C is located "after" the OTE at Position B. Specifically, toggling the XIC at Position C will indeed cause a ONE to be written into the Pump's control bit in the Output Data Table. However, during the next scan of the ladder logic, the processor will execute the OTE at Position B BEFORE it has a chance to examine the XIC at Position C. The processor will not see the ON status of the bit at Position C. This is due to the "top-to-bottom-left-to-right" execution of all Allen-Bradley processors. Following this pattern, the processor evaluates the XIC at Position H as FALSE; and then evaluates the XIC at Position I as TRUE; and then executes the OTE at Position B with FALSE logic – and therefore writes a ZERO status to the Pump's bit on the Output Data Table. Then the processor moves "top-to-bottom" and examines the XIC at Position C – and (due to its ZERO status) this condition is evaluated as FALSE. Rung #0000 in File #2 therefore does not "seal in" and the Pump will not run. Since the Pump will not run, the XIC at Position D will test FALSE - and the OTE at Position F will keep the Horn turned OFF.

**Question 4** - Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a "Toggle Bit" operation at **Position D**. Notice that Position D is an XIC for the **Pump** – but it is NOT located in the Pump's "seal in" control rung. Specifically, Position D is located in a rung completely separate from the control of the Pump. Will the **Horn** sound continuously?

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**Answer 4A** - No, the Horn will not sound continuously because the XIC instruction at Position D is not located in the same rung which actually CONTROLS the Pump. In other words, the OTE instruction which actually turns the Pump ON or OFF is located "upstream" in Rung #0000 of File #2. Notice that the XIC at Position D is not even located in that same "controlling" rung, and so performing a toggle operation at Position D will have no effect on the operation of the Pump. On the other hand, toggling the XIC at Position D will cause the OTE at Position F to turn the Horn ON – but only for one scan. Due to the processor's rapid scan time, the Horn will not be on long enough to make a detectable sound. On the very next scan after the toggle operation, the Pump will not still be running. This means that the XIC at Position D will test FALSE and the OTE at Position F will turn the Horn right back OFF again.

**Answer 4B** - Yes, the Horn will sound continuously because performing a toggle at Position D will manually change the status of the XIC from FALSE to TRUE. Once this has been done, the Horn will sound continuously regardless of the ON or OFF operation of the Pump. Even if the Stop_Button is later pressed, the Horn will not turn OFF. Specifically, the XIC at Position D will require an additional manual toggle action in order to return the Horn to its normal automatic operation.

**Answer 4C** - No, the Horn will not sound continuously. The simple "no branch" arrangement of Rung #0001 in File #2 means that the XIC at Position D is being used as an "input" type instruction. With Allen-Bradley processors only the powerful "Force" feature is able to override the TRUE or FALSE status of such an input. Specifically, the relatively weaker "Toggle Bit" feature will have no effect on the status of the XIC at Position D. Since the Pump is not running, the XIC at Position D cannot effectively be toggled to a TRUE state. Therefore, the processor will continue to evaluate this XIC instruction as FALSE and the OTE at Position F will keep the Horn turned OFF.

**Answer 4D** - Yes, the Horn will sound continuously because the toggling operation will change the status of the Pump's bit on the Output Data Table to a ONE. The ONE status of this Pump bit will then be maintained by the "seal in" action at Position C. Then the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Later if the Stop_Button is pressed, the Horn will turn OFF.

**Question 5** - Before you continue, remember that (as shown in Figure 3) Rung #0000 in File #6 is NOT being executed by the processor.

Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a "Toggle Bit" operation at **Position E**. Notice that Position E is an "unused" OTE for the **Pump**. Specifically, this instruction is not even being scanned by the processor. Will the **Horn** sound continuously?

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**Answer 5A** - Yes, the Horn will sound continuously because although the processor does not use this rung for AUTOMATIC control, the OTE at Position E is still fully capable of "controlling" the Pump whenever manual toggle operations are used to turn the OTE either ON or OFF. Toggling this unconditional and unused rung ON may raise some safety issues. Specifically, once the OTE at Position E has been manually toggled ON, the Pump will run and pressing the Stop_Button will not be able to stop it from running. Regardless of any safety issues, while the OTE at Position E is toggled ON, the Pump will run and the XIC at Position D will test TRUE. This will cause the OTE at Position F to turn the Horn ON.

**Answer 5B** - No, the Horn will not sound continuously because Rung #0000 in File #6 is not being executed by the processor. Since the processor does not even scan this particular rung, toggling the OTE at Position E will have no effect on the operation of the program. Specifically, the Pump will not run after this "unused" OTE has been toggled ON. Since the Pump will not run, the XIC at Position D will test FALSE - and the OTE at Position F will keep the Horn turned OFF.

**Answer 5C** - Yes, the Horn will sound continuously because the toggling operation will change the status of the Pump's bit on the Output Data Table to a ONE. The ONE status of this Pump bit will then be maintained by the "seal in" action at Position C. Then the XIC at Position D will test TRUE and so the OTE at Position F will turn the Horn ON. Later if the Stop_Button is pressed, the Horn will turn OFF.

**Answer 5D** - No, the Horn will not sound continuously because toggle operations on unscanned rungs have no effect on the status of bits in the processor's data tables. In other words, since the processor does not even scan this "deleted" rung, toggling the OTE at Position E will affect only the Pump device in the field – but not the Pump's status bit located in the PLC's memory. So even though the actual Pump device in the field will run after this "unused" OTE has been toggled ON, the XIC at Position D will still test FALSE - and the OTE at Position F will keep the Horn turned OFF.

**Question 6** - Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a “Toggle Bit” operation at **Position F**. Notice that Position F is an OTE for the **Horn**. Will the **Horn** sound continuously?

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**Answer 6A** - No, the Horn will not sound continuously because even though the toggling operation will manually change the status of the Horn’s bit on the Output Data Table to a ONE, the processor will change the status right back to a ZERO again on the very next execution of the OTE at Position F. In some systems the Horn device in the field may receive a momentary command to turn ON – but this will last for only one scan. In other words, the Horn will not sound continuously since the next scan of Rung #0001 in File #2 will turn the Horn back OFF again.

**Answer 6B** - Yes, the Horn will sound continuously because the toggling operation will manually change the status of the Horn’s bit on the Output Data Table to a ONE. The ONE status of this Horn bit will keep the Horn ON until another manual toggle operation changes the status of the bit back to a ZERO again.

**Answer 6C** – No, the Horn will not sound continuously because toggling the OTE at Position F will affect only the status of the Horn’s bit on the Output Data Table – but not the ON or OFF status of the actual Horn device in the field. In other words, the status of the bit in the processor’s memory will be manually changed from a ZERO to a ONE by the toggle operation, but the Horn device in the field will remain OFF even while the memory bit stays ON. With Allen-Bradley processors only an enabled “Force” operation (not a simple toggle) is powerful enough to override the active programmed ladder logic and make an actual output device in the field turn ON or OFF.

**Answer 6D** - Yes, the Horn will sound continuously because the toggling operation will manually change the status of the OTE at Position F from FALSE to TRUE regardless of the status of the Horn’s bit on the Output Data Table. This TRUE condition of the OTE will turn the Horn device in the field ON until another manual toggle operation resets the status of the OTE back to FALSE again. Later if the Stop_Button is pressed, the Horn will not turn OFF.

**Question 7** - Begin with the conditions shown in Figures 1, 2 and 3. Suppose that we right-click and perform a "Toggle Bit" operation at **Position G**. Notice that G is the **Horn's** bit on the Output Data Table. Will the **Horn** sound continuously?

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**Answer 7A** - Yes, the Horn will sound continuously because the toggling operation will manually change the status of the Horn's bit on the Output Data Table to a ONE. Manually toggling the status of the bit to a ONE directly in the data table will override the action of any conflicting ladder logic instructions. In this case, toggling the bit at Position G to a ONE will have the effect of keeping the Horn turned ON until another manual toggle operation directly to the data table changes the status of the bit back to a ZERO again. In other words, toggling directly to a bit on the data table has a much more powerful effect than simply toggling an instruction (such as an OTE) in the ladder logic program.

**Answer 7B** – No, the Horn will not sound continuously because toggling the bit at Position G will affect only the status of the Horn's bit on the Output Data Table – but not the ON or OFF status of the actual Horn device in the field. In other words, the status of the bit in the processor's memory will be manually changed from a ZERO to a ONE by the toggle operation, but the Horn device in the field will remain OFF even while the memory bit stays ON. With Allen-Bradley processors only a "Force" operation (not a simple "Toggle Bit" operation) is powerful enough to override the programmed ladder logic and make an actual output device in the field turn ON or OFF.

**Answer 7C** - Yes, the Horn will sound continuously because the toggling operation at Position G will change the status of the OTE at Position F from FALSE to TRUE to match the ONE status of the Horn's bit on the Output Data Table. This TRUE condition of the OTE will control the Horn device in the field and keep it ON until another manual toggle operation at Position G resets the status of the memory bit back to FALSE again.

**Answer 7D** - No, the Horn will not sound continuously because even though the toggling operation at Position G will manually change the status of the Horn's bit on the Output Data Table to a ONE, the processor will change the status right back to a ZERO again on the very next execution of the OTE at Position F. In some systems the Horn device in the field may receive a momentary command to turn ON – but this will last for only one scan. In other words, the Horn will not sound continuously since the next scan of Rung #0001 in File #2 will turn the Horn back OFF again.

**Beginner Level Quiz #115 - Part 2 – "Toggling" Output Bits and "Force Off"**

Over the years, we've found that many (if not most) PLC technicians tend to confuse the "Toggle Bit" feature that we've been discussing above with the totally unrelated "Force" function. In fact, it's usually the "Top Gun" technicians with the greatest amount of prior experience who have the most trouble in mastering the differences between these two completely separate operations. In many cases our "green" students have far fewer mistakes and misconceptions to "unlearn" about these particular subjects.

The simple exercises below are similar to those used in our PLC Boot Camp classes to drill every student on the differences between how the "Toggle Bit" feature and the "Force" feature each affect the control system. We'll keep it as simple as possible by using the same wiring and rung structure that we used in the first part of this quiz. Figure 4 shows that we've forced the Pump OFF for our next series of questions.

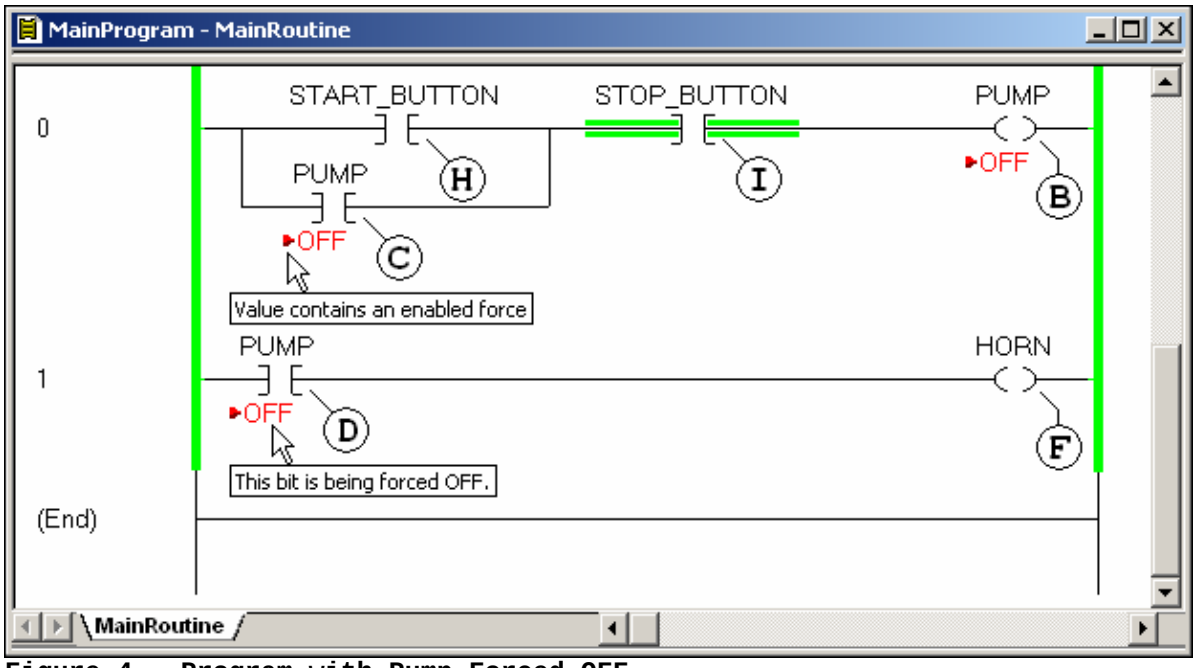


**Figure 4 – Program with Pump Forced OFF**

The screen shot for Figure 4 is taken from Version 15 of RSLogix5000 for a ControlLogix system. Notice that the RSLogix5000 software has "Tool Tips" that pop up when the mouse is held over the "Force" items on the screen. Pointing to the word "OFF" (as shown at Position D) tells us: "This bit is being forced OFF". Pointing to the little "Force Enabled Icon" (as shown at Position C) tells us that the: "Value contains an enabled force".

The ladder logic rungs shown above follow exactly the same pattern as the PLC/SLC system that we used in Figure 2. You may assume that the questions being asked in this particular quiz will all have identical answers for any of the three main Allen-Bradley platforms. Specifically, PLC-5, SLC-500, and ControlLogix processors will all respond identically in the following tests. Keep in mind that this will NOT always be true while working in the field – and there can be significant differences between the various platforms.

**Question 8** - Begin with the conditions shown in Figure 4. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced OFF and that the forces are currently enabled. The **Pump** device in the field is OFF. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

**Answer 8A** – The Horn device in the field is OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 8B** – The Horn device in the field is OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 8C** – The Horn device in the field is ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 8D** – The Horn device in the field is ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

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**Question 9** - Begin with the conditions shown in Figure 4. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced OFF and that the forces are currently enabled. The Pump device in the field is 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**.

**Answer 9A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 9B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 9C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 9D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

**Question 10** - Begin with the conditions shown in Figure 4. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced OFF and that the forces are currently enabled. The Pump device in the field is 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**.

**Answer 10A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 10B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 10C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 10D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

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**Question 11** - Begin with the conditions shown in Figure 4. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced OFF and that the forces are currently enabled. The Pump device in the field is OFF. Suppose that we right-click and perform a "Toggle Bit" operation at **Position F**. Notice that Position F is an OTE to control the **Horn**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

**Answer 11A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 11B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 11C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 11D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

**Beginner Level Quiz #115 - Part 3 – "Toggling" Output Bits and "Force On"**

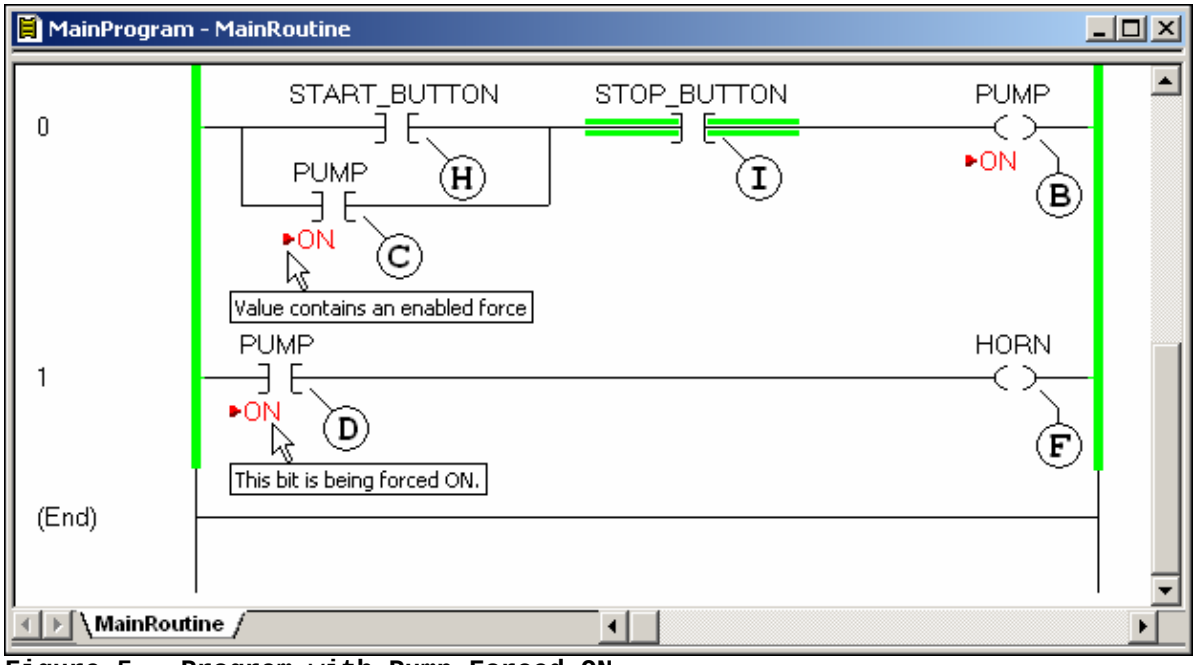


**Figure 5 – Program with Pump Forced ON**

Notice that the screen shot for Figure 5 is taken from Version 15 of RSLogix5000 for a ControlLogix system. Notice that the pop up "Tool Tip" for the word "ON" at Position D tells us: "This bit is being forced ON". Pointing to the little triangular "Force Enabled Icon" at Position C tells us that the: "Value contains an enabled force".

The ladder logic rungs shown above follow exactly the same pattern as the PLC/SLC system that we used in Figure 2. You may assume that the questions being asked in this particular quiz will all have identical answers for any of the three main Allen-Bradley platforms. Specifically, PLC-5, SLC-500, and ControlLogix processors will all respond identically in the following tests. Keep in mind that this will NOT always be true while working in the field – and there can be significant differences between the various platforms.

**Question 12** - Begin with the conditions shown in Figure 5. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced ON and that the forces are currently enabled. The **Pump** device in the field is ON. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

**Answer 12A** – The Horn device in the field is OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 12B** – The Horn device in the field is OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 12C** – The Horn device in the field is ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 12D** – The Horn device in the field is ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

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**Question 13** - Begin with the conditions shown in Figure 5. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced ON and that the forces are currently enabled. The Pump device in the field is ON. 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**.

**Answer 13A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 13B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 13C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 13D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

**Question 14** - Begin with the conditions shown in Figure 5. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced ON and that the forces are currently enabled. The Pump device in the field is ON. 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**.

**Answer 14A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 14B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 14C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 14D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

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**Question 15** - Begin with the conditions shown in Figure 5. Notice that all of the OTE and XIC instructions associated with the Pump are marked as forced ON and that the forces are currently enabled. The Pump device in the field is ON. Suppose that we right-click and perform a "Toggle Bit" operation at **Position F**. Notice that Position F is an OTE to control the **Horn**. Choose the BEST answer which MOST LIKELY describes the operation of the **Horn**.

**Answer 15A** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will stay OFF.

**Answer 15B** – The Horn device in the field will be OFF. Later if the Start_Button is pressed, the Horn device in the field will turn ON.

**Answer 15C** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will stay ON.

**Answer 15D** – The Horn device in the field will be ON. Later if the Stop_Button is pressed, the Horn device in the field will turn OFF.

## Summing up Beginner Level Quiz #115

As we said before, the reason that the “wrong” answers to our quizzes seem so confusing is that they are based on the same common misconceptions that many technicians believe to be true. Unfortunately much of this material “sounds right” even though it happens to be totally wrong. The fact that these wrong ideas are so commonly believed and so widely circulated helps explain why many people find PLC skills difficult to master. If you’re interested in how our PLC Boot Camp classes are specifically designed to weed out and correct these types of mistakes and misconceptions, you can find a lot of detailed information on our website.

The answers for the quiz are available for downloading from our company website at www.ronbeaufort.com – look in the “Sample Lessons” section. Absolutely no registration or visitor information is ever required for access to any part of 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.