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HCTL-1100 Commonly Asked Questions and Answers

Application Brief M-010

Introduction

This guide answers the most often asked questions of the HCTL-1000 and HCTL-1100. It is organized into 5 sections: Registers, Control Modes, Amplifier Ports, Timing, and Miscellaneous.

Throughout this note, reference is made to the HCTL-1000 and the HCTL-1100. When either the HCTL-1000 or HCTL-1100 is used, the topic is specific to that part.

Registers

1. *QUESTION:* Does the Actual Velocity register latch like the Actual Position register does?

ANSWER: No, Actual Velocity register is NOT latched. It is updated once per sample time. Therefore, it is possible to read in the middle of an update and get incorrect data. This problem can be avoided by proper timing of the read. Please see the section on “Sample Timer” in the HCTL-1100 data sheet.

2. *QUESTION:* When I read the Actual Position registers of the HCTL-1100 I get one value that looks good, but two look like they were from the last read. What is happening?

ANSWER: Make sure you are reading R14H first. Reading this register latches the other two so the entire three bytes can be read.

3. *QUESTION:* Can I preset the Actual Position registers?

ANSWER: With the HCTL-1100, you can preset the Actual Position Registers by writing to registers R15H, R16H, R17H. Writing anything to R13H clears all three registers of the Actual Position to ZERO on the HCTL-1100.

4. *QUESTION:* Can I always read the Actual Position registers?

ANSWER: YES, whether you are in a control mode, or idle mode, the Actual Position registers always contain the current encoder count. Even if you go from a control mode to idle mode, the transition will not cause the Actual Position to lose counts. By reading the LSB (R14H) first, the other two registers are latched into a temporary buffer until they are read. This process maintains all three bytes while allowing the ACTUAL POSITION register to continue counting the encoder.

5. *QUESTION:* Can I always read the COMMAND POSITION registers?

ANSWER: Yes, in a control mode (or IDLE), you can constantly monitor the COMMAND POSITION registers. However, unlike the ACTUAL POSITION, the COMMAND POSITION registers are not latched. If the HCTL-1100 is in a control mode (where the IC updates the COMMAND POSITION every sample time) and you read one of the three bytes, the other two could change before you have a chance to read them – possibly giving a false reading of the COMMAND POSITION. This is important in Trapezoid Profile and Integral Velocity. This problem can be avoided by proper timing of the read. Please see the section on “Sample Timer” in the HCTL-1100 data sheet.

6. *QUESTION:* What happens if the ACTUAL POSITION registers overflow (or underflow)?

ANSWER: The ACTUAL POSITION registers are treated as one 24-bit two’s-complement number, with 7FFFFFH the most positive and 800000H the most negative. Therefore, when the ACTUAL POSITION Counter overflows, it goes from the most positive to the most negative (7FFFFFH +1 = 800000H) and vice-versa for underflow. In velocity mode, this will not affect the system. There is a smooth transition between positive and negative positions. In position control mode, however, the user needs to be aware of this for position moves. The largest single position move that can be made is 1/2 the maximum count of the position registers (7FFFFFH). A number larger than this will cause the motor to move in the opposite direction.

7. *QUESTION:* How do I clear the ACTUAL POSITION and COMMAND POSITION registers at the same time?

ANSWER:
Go into INITIALIZATION/IDLE mode and clear both registers.

8. *QUESTION:* What happens during a read sequence from the HCTL-1100 if I toggle OE too soon?

ANSWER: If $\overline{\text{OE}}$ is toggled too soon, whatever was last in the OUTPUT buffer will be the acquired data. Reading too fast means that the HCTL-1100 did not have time to put the data in the output buffer for reading, and whatever was in there before is still there.

9. *QUESTION:* Can I use the ACTUAL VELOCITY registers in all modes?

ANSWER: No, the ACTUAL VELOCITY registers are only valid while in Proportional Velocity mode. These registers are used for internal purposes in the other modes.

Control Modes

10. *QUESTION:* When should I initiate a trapezoid profile or velocity mode?

ANSWER: As the operating flowchart shows. It is recommended that the HCTL-1100 be in position control before setting a flag for trapezoid or velocity mode.

11. *QUESTION:* While in TRAPEZOID PROFILE mode, can I change the acceleration, maximum velocity, or final position?

ANSWER: No, the calculations done internal to the HCTL-1100 rely on these values NOT changing until the end of the move. Of course, the limit flag will break a trapezoid (the motor will coast) and send the HCTL-1100 to IDLE mode.

12. *QUESTION:* In TRAPEZOID PROFILE mode, every once in a while, the move does not look like a trapezoid, but instead it is a position move. What is happening?

ANSWER: There are two possible causes:
1. If the system cannot keep up with the programmed profile (if there is friction in the system, or the motor cannot physically turn the programmed speed) it will lag behind until the error becomes large enough to saturate the output, and act like a position move.

2. This can also happen if you are writing a 03H to R05H more than once. After writing 03H to the Program Counter (R05H), do not repeat it unless the HCTL-1100 goes into reset or IDLE. Refer to the operating mode flowchart in the data sheet.

Amplifier Ports

13. *QUESTION:* Can the user write to the output ports of the HCTL-1100?

ANSWER: Yes, while in IDLE mode, the value written to the output registers (R08H or R09H) will appear directly on the port in its respective form – 8 bits for the Motor Command output, and a pulse with a corresponding duty cycle on the PWM port.

14. *QUESTION:* What is the frequency of the PWM port?

ANSWER: The frequency is the external clock divided by 100. A 2 MHz clock produces a 20 kHz PWM signal.

15. *QUESTION:* Do I need a full H-bridge for my amplifier if I am only using the HCTL-1100 for velocity in one direction?

ANSWER: Yes, the HCTL-1100 needs full control of the motor even for one direction because it will actually command the motor the opposite direction if it goes faster than programmed.

16. *QUESTION:* When the Motor Command output saturates, the output shows F0H instead of FFH. Is this correct?

ANSWER: Yes, when the Motor Command output saturates, it will go to FFH for a short time, then level off at F0H for positive output. For negative output, the HCTL-1100 will saturate at 00H for a short time, then level off at 0FH.

17. *QUESTION:* Can I use the MOTOR COMMAND output in Unipolar mode AND the SIGN bit (of the PWM output) to control an amplifier?

ANSWER: Yes, both amplifier ports are always operating at the same time.

18. *QUESTION:* How long should I wait after reset before going to control?

ANSWER: After the RESET pin is brought high, wait at least 30 seconds before going to control. This will allow the HCTL-1100 to execute its initialization code.

19. *QUESTION:* Is there a serial interface to the HCTL-1100?

ANSWER: No.

20. *QUESTION:* What is "Following Error", and how can I calculate it with the HCTL-1100?

ANSWER: "Following Error" can be defined as the difference between the calculated desired position and the actual position of the servo system. In other words, "Following Error" indicates how closely a system follows a desired profile. Calculating the error with the HCTL-1100 is simply the COMMAND POSITION minus the ACTUAL POSITION at distinct points in time. However, since the COMMAND POSITION registers are not latched, the data must be read when the controller is not updating the registers (in Trapezoid mode and integral Velocity mode only). Please see the section on "Sample Timer" in the HCTL-1100 data sheet.

21. *QUESTION:* Can I put my encoder on a shaft of a gear train instead of the motor?

ANSWER: Yes, but be aware that the HCTL-1100 controls the motor based on input from the encoder. If there are any mechanical slips between the motor shaft and encoder shaft, the system could go unstable.

22. *QUESTION:* Can I read the HCTL-1100 to find out which mode it is in?

ANSWER: Reading the FLAG (R00H) register will return the status of the five control flags. Please refer to the HCTL-1100 data sheet for specifics.

23. *QUESTION:* How does the PROFILE PIN and PROFILE FLAG work?

ANSWER: The two are identical in operation and indicate when command profile has finished. It DOES NOT indicate when the motor has actually finished a profile. The Profile generator of the HCTL-1100 generates position moves based on the information in certain registers to perform the overall profile. When the generator is done, the HCTL-1100 sets the PROFILE FLAG and PIN. This flag will usually be cleared at the same time a move is complete. However, if there is friction in the system, or some external force stalls the motor, the flag will be cleared before the motor reaches the final position. To find out exactly when the profile is complete follow this procedure:
1. While the system is in the Trapezoid Profile mode, monitor the Profile Pin (or wait for it to cause an interrupt).
2. When the profile pin is cleared (done with profile), compare the Actual and Command Position registers. If they are the same (± a small error) then the profile is complete.

24. *QUESTION:* Do the control status flags get cleared when writing a 00H or 01H to the program counter (SOFT RESET)?

ANSWER: No. If the HCTL-1100 is in a control mode and a 01H or 00H is written to the Program Counter (R05H), the flags are not cleared. Therefore, when you write 03H to the Program Counter again, the system will go back to the mode it was in prior to the break.

25. *QUESTION:* The HCTL-1100 is in trapezoid mode or a velocity mode, and I write a 00 or 01 to the program and I write a 00 or 01 to the program counter (R05H). When I write a 03H again to the program counter, the HCTL-1100 goes back to the prior mode.

ANSWER: As in the above question, the flags are not cleared by a 00H or 01H write to the Program Counter. Therefore, when you write 03H to the Program Counter, the HCTL-1100 still has the flags set, and continues the mode. Before writing 03H to the program counter, clear the flags. Note that while the HCTL-1100 is in trapezoid mode, two flags can be set: F0 and F5. Both of these flags must be cleared.

26. *QUESTION:* Can I change the gain term and other filter parameters on the fly?

ANSWER: Yes.

27. *QUESTION:* When I power up the HCTL-1100, the PWM port modulates and continues to output a signal on a random basis.

ANSWER: Chances are the clock to the HCTL-1100 is not in spec. If it does not have a consistent duty cycle, or a duty cycle within the allowable range, the chip will not operate properly.

28. *QUESTION:* What is the operating frequency of the HCTL-1100?

ANSWER: The HCTL-1100 will operate with an external clock rate between 100 kHz and 2 MHz.

29. *QUESTION:* What is the range for velocity on the HCTL-1100?

ANSWER: The dynamic range for velocity on the HCTL-1100 is dependent upon the encoder CPR, and the sample time.

The Maximum Velocity is:

$$\text{Max. Vel} = \frac{127 \times 60}{4 \times N \times t}$$

$$\text{Min. Vel} = \frac{1 \times 60}{4 \times N\, t}$$

where: N = CPR of codewheel
t = sample time in seconds

Knowing the range of velocities needed for your application will help determine the codewheel CPR and sample time. Of course other factors must be considered also, such as velocity resolution needed. Since the sample timer plays an important role in system stability and stiffness, this also needs to be taken into account.

30. *QUESTION:* How do I convert HCTL-1100 velocity units to RPMs?

ANSWER: Use the following equation:

$$\frac{\text{Revolutions}}{\text{Minute}} = \frac{\text{QUAD CTS}}{\text{T (sec)}} \times \frac{1}{4 \text{ X CPR}} \times \frac{60 \text{ sec}}{1 \text{ min}}$$

31. *QUESTION:* How can I improve the velocity control of the HCTL-1100 (Integral velocity)? It presently runs rough.

ANSWER: Integral velocity is calculated by the HCTL-1100 as QUADRATURE COUNTS PER SAMPLE or Cts/Sample. Every sample time the HCTL-1100 has calculated the number of counts the motor should have gone, and compares it to the actual counts traveled (COMMANDED-ACTUAL). This becomes the velocity error that is passed through the digital filter. For example, if you want a velocity of 1 CT/Sample time and the actual is 2, then the error is 2 -1 = 1 which is 100% error. On the other hand, if you adjust the sample time such that the same physical velocity is 10 Cts/Sample time, control will be much smoother. If the actual is 11 the error is 11 - 10 = 1 which is only a 10% error – thus giving a smoother velocity control. Therefore, ***more*** Cts per Sample time will make the HCTL-1100 run a smoother velocity control.

32. *QUESTION:* After the LIMIT or STOP is set, what needs to be done before returning to control?

ANSWER: Three things need to be done before control can resume:
1. The external signal needs to return to the high state.
2. The STOP or LIMIT flag internal to the HCTL-1100 needs to be cleared by writing a value to R07H.
3. Control flags must also be cleared if the controller was in Trapezoid, Proportional Velocity, or Integral Velocity mode prior to the break.

Timing

33. *QUESTION:* My system has $\overline{\text{ALE}}$ tied common to many HCTL-1100 ICs and a memory chip. The HCTL-1100 data sheet shows an $\overline{\text{ALE}}$ to $\overline{\text{ALE}}$ timing specification, but since I am accessing many ICs with one $\overline{\text{ALE}}$, this timing specification could be violated for the HCTL-1100 ICs even though I am not currently accessing them. Is this okay?

ANSWER: Yes. $\overline{\text{ALE}}$ can be tied common to many HCTL-1100s, and even other ICs (such as memory). The $\overline{\text{ALE}}$ timing constraint pertains only when accessing a particular HCTL-1100. The $\overline{\text{ALE}}$-$\overline{\text{CS}}$ timing MUST be observed. In other words, when accessing a certain HCTL-1100, no additional $\overline{\text{ALE}}$ pulses can occur between the $\overline{\text{ALE}}$ pulses and the $\overline{\text{CS}}$ pulse.

34. *QUESTION:* Why is there a long delay between Toggling $\overline{\text{CS}}$ and $\overline{\text{OE}}$ during a read operation form the HCTL-1100?

ANSWER: The HCTL-1100 is an actual custom microprocessor running its own microcode. Therefore, a read is actually in interrupt to the HCTL-1100. The HCTL-1100 must respond to the interrupt, then transfer the information from the desired register to the output buffer for reading. This process takes about two clock cycles.

35. *QUESTION:* What is the maximum number of I/O operations available per sample time with the HCTL-1100?

ANSWER: The maximum number of I/O operations per sample depends on the Mode and the value in the sample timer register (ROFH). Table 4 in the HCTL-1100 data sheet shows the number of I/O operations allowed with the lowest number possible in the Sample Timer Register. For every unit increase in the Sample Timer register above these minimums (Table 4), there are 16 additional I/O operations allowed.

36. *QUESTION:* How can I use the HCTL-1100 in multi-axis mode? How do I synchronize two or more HCTL-1100s?

ANSWER: The goal here is to be able to
1) get all the servo cycles to begin at the same time, and
2) write to all HCTL-1100s at the same time. The following procedure will get all the servo cycles to begin at the same time with the HCTL-1100:
1. Tie all $\overline{\text{SYNC}}$ pins together.
2. Strobe the $\overline{\text{SYNC}}$ Signal the required time as outlined in the data sheet.

Miscellaneous

37. *QUESTION:* What is the bond wire on the HCTL-1100?

ANSWER: Gold.

38. *QUESTION:* Is there any REL data of the HCTL-1100 with regards to radiation?

ANSWER: No.
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39. QUESTION: What is the flame rating of the HCTL-1100?

ANSWER: The package is made of the plastic material HC-10-2 and has a UL rating of 94V-0.

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Data subject to change.

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