4

Setting Up and Controlling the Counting

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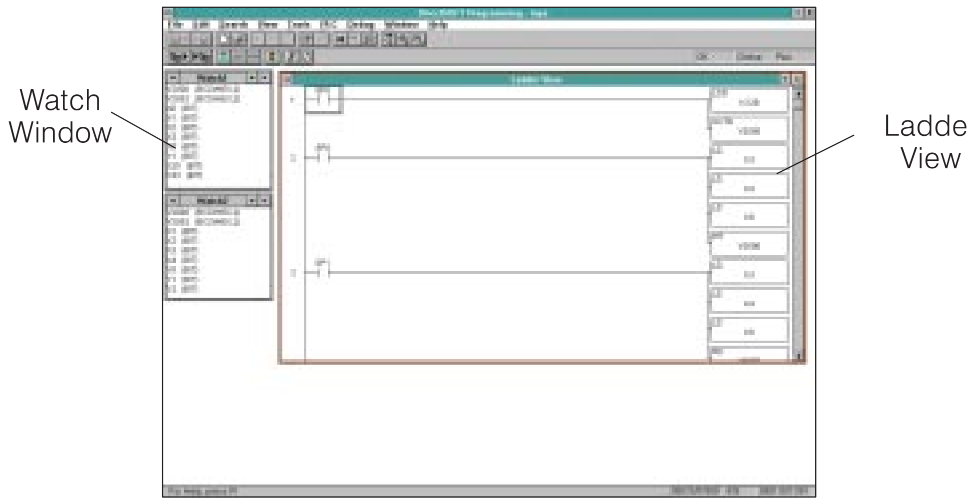
Introduction to Using *Direct*SOFT

You may recall an earlier example that showed you how to use the CPU RLL program to move the HSC parameters in and out of shared memory. The easiest way to create the RLL program is by using our Windows®-based software, ***Direct*SOFT**. We won't try to show you all of the ***Direct*SOFT** features here, but it may be helpful for you to understand a few simple concepts. You should refer to your ***Direct*SOFT** User Manual for a complete overview of the software features.

Once you enter the **Edit** mode, you will have several ways to enter your program elements. Below is a screen showing a portion of the program that has been entered while in the Edit mode. We are using the Ladder View.



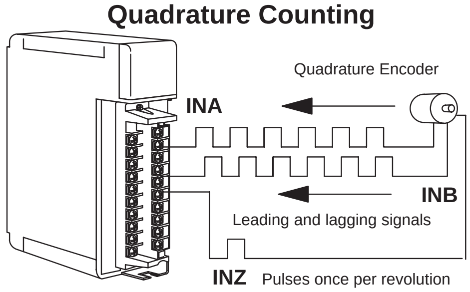
You can use a Watch Window by "clicking" on the Watch Window icon or by using the **Debug-New Watch** menu option. You can also use the hot key, **CTRL+SHIFT+F3**, to select the same option. You can open several Watch Windows if you like. Refer to your ***Direct*SOFT** documentation for details.

One example usage for the Watch Window feature (when working with the HSC) is to monitor the V-memory area where you might be exchanging information back and forth with the HSC's shared memory.

Selecting the Counting Mode

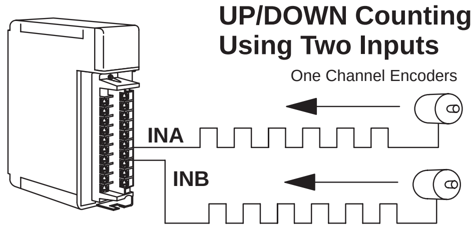
Determining Which Mode to Use

You need to decide which mode of counting to use. If you are using a quadrature signal input device, then obviously you will need to use the quadrature mode. If you are using a single-channel encoder, you will want to use the standard UP/DOWN mode. The following page shows you the RLL for selecting the counting mode.

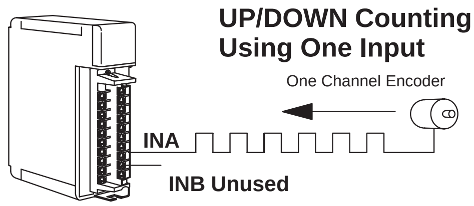


Quadrature encoders require that you connect to both the INA and INB terminals. They can sense direction and are inherently more immune to noise than single encoders. Quadrature encoders have a Z-marker that will aid in home search applications when connected to INZ by determining a zero or reference point in the angular displacement of the encoder's shaft. The single channel encoders (used for standard UP/DOWN counting) do not have Z–markers. When the HSC is not engaged in home search, you can use the Z-marker signal at INZ to reset the counter. We will show you how to do that in a moment on Page 4-10.

With standard counting you can use the two counting input signals (**INA** and **INB**)of the D4-HSC. One input is used for counting UP and the other used for counting DOWN. You can't use both inputs for the same direction of counting.

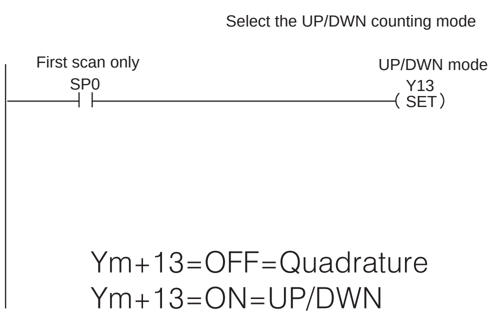


You could be using only one of the inputs if desired. In this case, the other input terminal should be left unwired. You control the direction of counting by the manner in which you set a certain bit in your control program (shown later).



Ladder Logic for Determining the Counting Mode

You will recall from the I/O configuration table that the HSC uses Ym+13 to control the counting mode. If you have your HSC in slot 0, this means Y13 is the data point you use in your ladder logic. By default, the mode is set to count as if the signals at INA and INB are from a quadrature encoder (Ym+13 OFF). If you want standard, non-quadrature UP/DOWN counting you have to set Ym+13 to ON. Below is a sample rung of logic that selects the UP/DOWN mode. For simplicity, we have assumed the HSC is in slot 0. When SP0 is turned ON (first scan only), the HSC will be configured to count in the UP/DOWN mode.



Selecting the Counting Direction

How Ym+13 and Ym+14 Together Determine Counting Direction

The status of Ym+14 determines the direction of the counting, that is, UP or DOWN. If you are in the quadrature mode, the HSC will determine whether it is to count UP or DOWN by looking at the status of Ym+14 and seeing which of the signals (INA or INB) is leading.

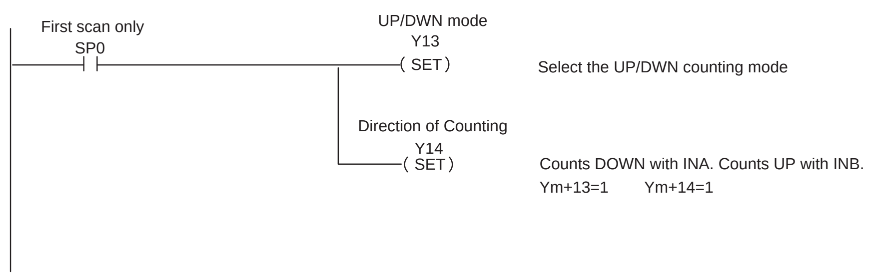
The HSC will determine direction of counting by looking at the status of Ym+14, the counting mode Ym+13, and (if a quadrature signal), whether INA or INB is leading or lagging. The table below summarizes how this information is used.

Mode Status	Direction	Criteria Used For Determining Direction
Ym+13=0	Ym+14=0	Counts UP if INA leads INB. Counts DOWN if INB leads INA (quadrature)
Ym+13=0	Ym+14=1	Counts UP if INB lead INA. Counts DOWN if INA leads INB (quadrature)
Ym+13=1	Ym+14=0	Counts UP with INA. Counts DOWN with INB (standard UP/DOWN)
Ym+13=1	Ym+14=1	Counts DOWN with INA. Counts UP with INB (standard UP/DOWN)

Using this criteria, the following sample ladder logic would cause the HSC to count in the UP/DOWN mode. The count from INA would be DOWN and the count from INB would be UP.

Ladder Logic to Select Counting Direction

Assuming that the HSC is in Slot 0:



Selecting the Counting Resolution

Choose From 3 Resolution Settings

In the UP/DOWN mode, the resolution is fixed at 1x. However, in the quadrature mode, you can control which signal (INA or INB) and what edges of the signal cause a count change. This allows you to effectively double or quadruple the resolution. You have three choices:

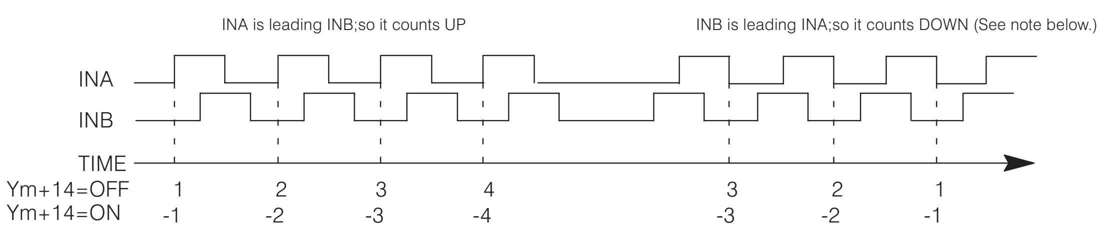
- 1x: One edge of INA causes count change
- 2x: Both edges of INA cause count change
- 4x: All edges of INA and INB cause count change

Ym+14 controls the direction of the counting, but Ym+16 and Ym+17 in combination control which signal and how many edges will cause the count to change.

Ym+16	Ym+17	What Causes Count Change
OFF	OFF	1x: One edge of INA
ON	OFF	2x: Both edges of INA
OFF	ON	4x: All edges of INA and INB
ON	ON	4x: All edges of INA and INB

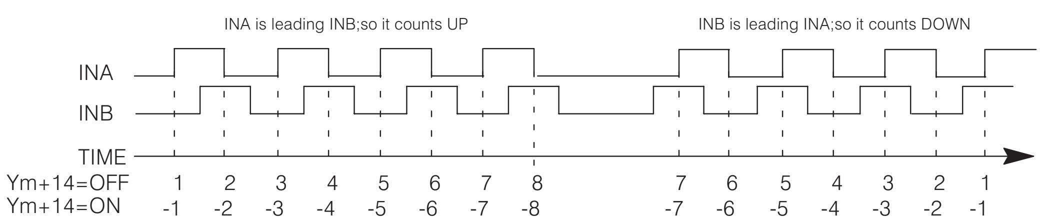
Y No.	Function
Ym+14	Change state to change count direction
Ym+15	ON will invoke home search
Ym+16	ON for x2 count operation (quadrature mode only/Ym+17 must be OFF)
Ym+17	ON for x4 count operation (quadrature mode only)

Quadrature 1x Operation (One Edge: INA trigger)

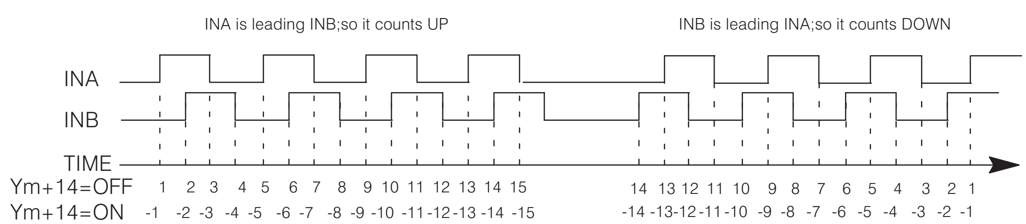


Note: In this resolution mode, the reason the trailing edge causes a count change (when INB leads INA) is the change will occur when INB is low only.

Quadrature 2x Operation (Two Edge: INA trigger)



Quadrature 4x Operation (All Edges: INA and INB trigger)

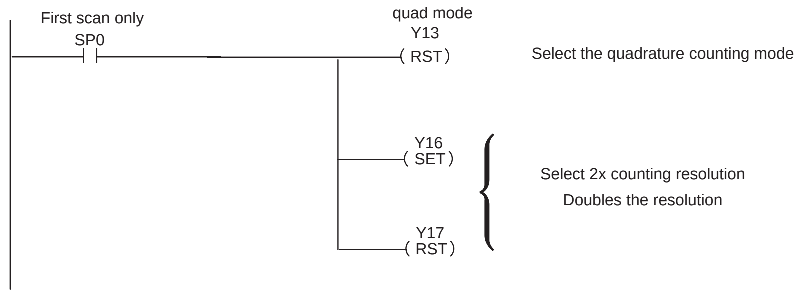


Why Change the Counting Resolution?

The answer to “Why change the counting resolution”? is simply a matter of how much control you need for precise positioning. You may want to increase the resolution so that you receive a higher number of counts per encoder shaft revolution. This gives you more control.

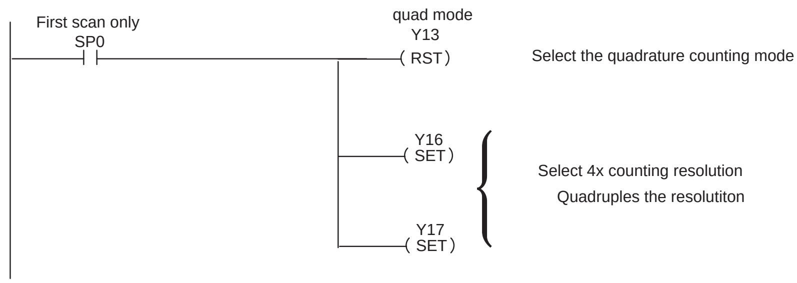
Example RLL: 2x Resolution

Assuming that the HSC is in Slot 0, the following logic would select 2x resolution:



Example RLL: 4x Resolution

Assuming that the HSC is in Slot 0, the following logic would select 4x resolution:



Default Setting

By default, Ym+16=0 and Ym+17=0. This means that **you are in the 1x resolution mode for quadrature counting until you change the resolution in your ladder logic.**

Specifying an Offset

What is an Offset?

This is an optional feature, but sometimes you may want to start your counting with some number other than zero. This is a perfect example of using an offset. You can also change the current count "on the fly" by using an offset. Either way, it is a three step process:

Step1 – Load the offset value (Range=–8388608 to 8388607) into V-memory

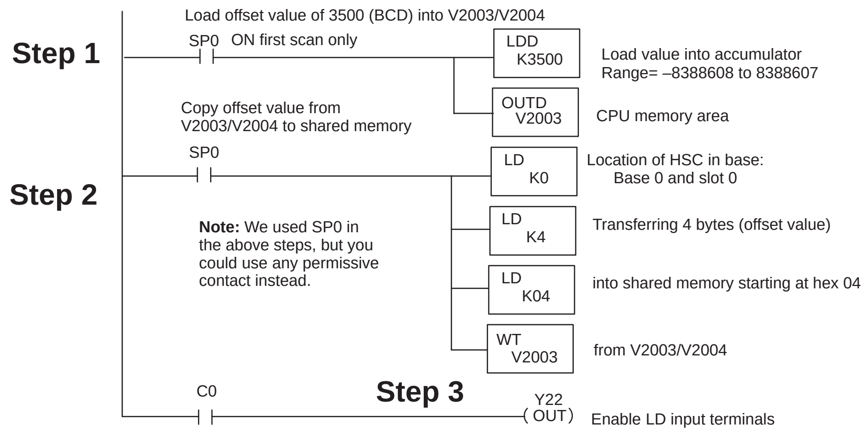
Step2 – Transfer the value out of V-memory by writing it to shared memory.

Step3 – Write the offset value to the current count by either of two ways:

- Send a signal from a field device attached to the external LD input of the module. Ym+22 must be ON to enable this feature. This is the **external method**.
- Use your ladder logic to turn ON Ym+2. This is the **internal method**.

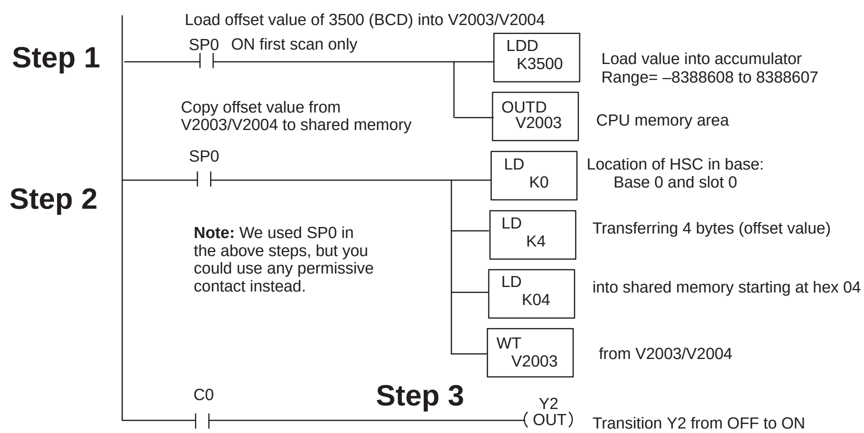
External Method

For simplification purposes, let's look at an example where you have your HSC in Slot 0 of your base. The rung of logic shown below will prepare the HSC to use an offset value. Then, if you have a field device hooked to the LD terminal connections, and you turn the device ON, the HSC will will copy the value stored in the shared memory address 04 to 07 (offset) to the current count. In contrast, if Ym+22 was OFF, the HSC would not respond to any signal at the LD connection. In the example below, C0 will determine if the offset gets written to current count.



Internal Method

If you are using the internal method, everything would remain the same except the final rung of logic (Step 3). Here you would use C0 to turn ON Y2.



Specifying a Preset

What is a Preset?

Another way of saying “preset” is to use the word “target”. When you place a preset in shared memory, it tells the HSC, “This is my target!”. Your target can be any number of pulses in the range –8388608 thru 8388607. (Remember, negative presets must have an “8” in front of them.)

NOTE: If you do not use a preset (i.e. you have no target count), **always set Ym+20 = ON** to ensure continuous counting without inadvertent resets.

How Does the Preset Affect the Outputs?

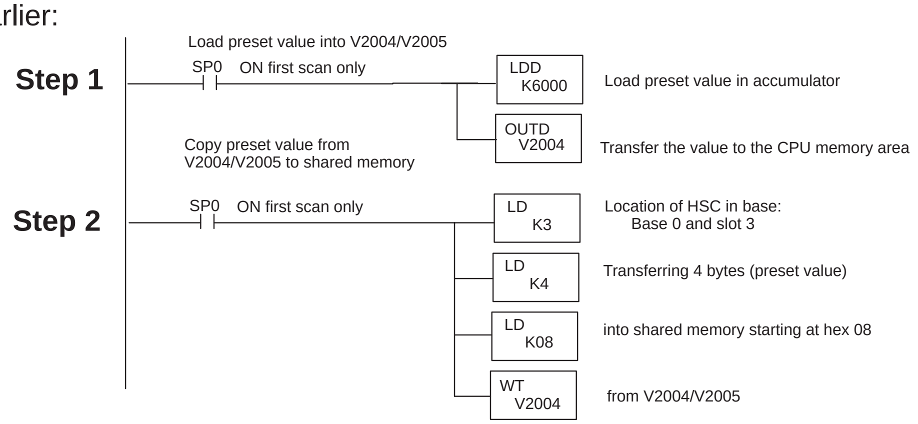
Each time your ladder logic instructs the HSC to enable your HSC outputs, the HSC will look at three parameters that are stored in shared memory in order to know which output to turn ON:

Step1 – Current count
Step2 – Preset
Step3 – Deceleration.

The HSC then makes a decision on what to do with the outputs, CW, CCW, OUT1 and OUT2 based on the relationship that it sees. (On Pages 5–4 and 5–5, we will show you how the relationship between preset and current count determines the status of each output.)

Loading the Preset Into Shared Memory

First, you load a preset into shared memory using the same 2-step procedure shown earlier:



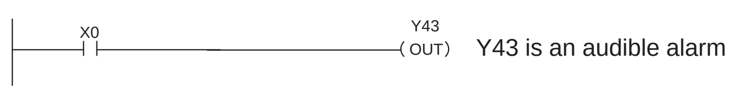
NOTE: Preset may be loaded at any time, but it is not accepted by the HSC until the HSC run bit transitions from off to on.

Checking the Status of a Preset Relative to Current Count

There are three X inputs in the I/O assignment table that report the status of preset versus the current count. You can use the status of each of these in your RLL to trigger events. Here is the portion of the table showing you the three X assignments.

X No.	Function
Xn+0	ON if current count is greater than preset
Xn+1	ON if current count is equal to preset
Xn+2	ON if current count is less than preset

For example, the one line of logic below could turn on an alarm when the current count **exceeds** preset. Assume that the HSC is in Slot 0:



Starting and Resetting the Current Count

Starting the Counter

Assuming you have installed the HSC module in the base properly and connected an encoder to the proper inputs, you are ready to start the counting process. All that is required is to put the PLC in RUN mode, and have the encoder (or encoders) sending valid signals. With this done, the HSC will start counting any pulses received at INA or INB. It will automatically be storing the accumulated count as the current count in the shared memory.

Automatically Resetting the Counter

Ym+20 determines when the current count is reset to zero. You have two options:

- (A.) If Ym+20=OFF, the counter will reset to 0 when current count = preset.
- (B.) If Ym+20=ON, the counter will reset to 0 when it reaches the maximum number (8388607) or the minimum number (–8388608).

Internal Reset

You can also use Ym+12 to reset your counter. Simply turn it ON in your ladder logic. As long as you have Ym+12 ON, the current count will remain zero.

External Reset Using RST

In order to reset the counter externally, you can turn ON the device connected to the RST terminals of the HSC. As long as this signal stays HIGH, the current count will remain zero.

Summary of Reset Count Relays

The chart below summarizes the Y output assignments discussed above.

Y No.	Function
Ym+12	When set to ON, HSC resets current count to zero.
Ym+20	If OFF, counter will reset to 0 when current count = preset. If ON, counter will reset when count is at max. or min.

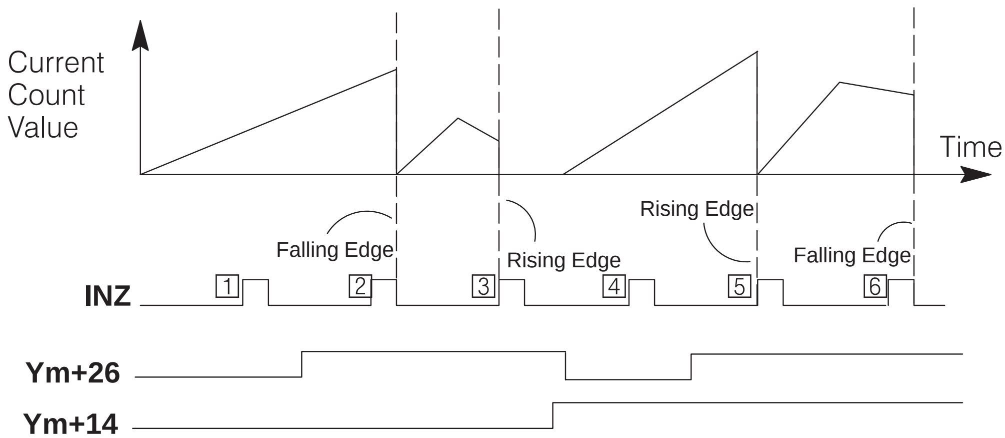
External Reset Using INZ

If you have not invoked Home Search with Ym+15, you can use INZ to reset the counter. You enable the INZ reset feature by turning Ym+26 ON. Since direction of the encoder shaft rotation affects when the Z–marker will send the reset pulse, the status of Ym+14 (change direction output) affects which edge of the pulse actually triggers the reset. By using INZ to reset the counter, you are able to trigger reset at the same shaft position every time.

The table below shows the relationships of the various outputs,the count direction, the INZ signal and which part of the pulse actually resets the counter:

Home Search Ym+15	INZ Reset Ym+26	Count Direction- Ym+14	Characteristics of the Reset Using INZ
OFF	ON	OFF	Resets on rising edge when counting DOWN Resets on falling edge when counting UP
OFF	ON	ON	Resets on rising edge when counting UP Resets on falling edge when counting DOWN

An Example of INZ Resetting Current Count Under Various Conditions



1 On the first pulse of INZ, there is no reset because Ym+26 is OFF.

2 On the second pulse of INZ, there is a reset because Ym+26 is ON. Ym+14 is OFF and we're counting UP; so the counter resets on the falling edge.

3 On the third pulse of INZ, there is a reset because Ym+26 is ON. Ym+14 is OFF and we are counting DOWN; so the counter resets on the leading edge.

4 On the fourth pulse of INZ, there is no reset because Ym+26 is OFF

5 On the fifth pulse of INZ, Ym+26 is ON and Ym+14 is ON. Because we were counting UP, there is a reset on the rising edge.

6 On the sixth pulse of INZ, Ym+26 is ON and Ym+14 is ON. Because we were counting DOWN, there is a reset on the falling edge.

Latching or Inhibiting the Current Count

What Does Latching Do?

There may be an application where you want to store the current count after a certain amount of time passes or when a certain event has taken place. You can capture this information and store it in shared memory without stopping the counting. This is called “latching”. It gives you a “snap shot” of the pulse count for later use in your program.

How Do You Trigger the Latching Process?

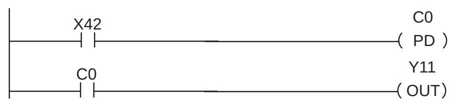
You have two options for triggering the latching process:

- You can do it **externally** via a field device attached to the terminals marked “LATCH”, or
- you can do it **internally** by using Ym+11.

In both cases, the latching will take place each time there is a transition from OFF to ON. If you leave either the field device or Ym+11 in the ON state, it will only latch one time at the OFF to ON transition. You will have to do a separate transition from OFF to ON every time you make a LATCH request in order for values to actually be stored.

Sample RLL for Latching

Here is a short segment of ladder logic showing you how to latch the count by using the internal output Ym+11. We have assumed your HSC is in Slot 0 of the base. We have used a one-shot command here so that C0 and Y11 would be ON for only one scan when the CPU sees that X42 is ON.



If X42 turns ON, C0 will turn ON for one scan.

Latch the current count.

What Is Meant By Inhibiting the Count?

There may be some reason, during the course of the program, that you want the counter to temporarily suspend its counting without resetting or in any way disturbing the the current count. This is what the “inhibiting” feature does. When this feature is ON, inputs from INA and INB are ignored.

How Do You Inhibit the Count?

You have two options here also:

- You can do it **externally** via a field device attached to the terminals marked “C.INH”.
- You can do it **internally** by using Ym+10.

Sample RLL for Inhibiting the Count

Here is a short segment of ladder logic showing you how to inhibit the count by using the internal output Ym+10. We have assumed your HSC is in Slot 0 of the base.

Inhibit the count.

Summary of Latch and Inhibiting Output Relays

The chart below summarizes the Y output assignments discussed above.

Y No.	Function
Ym+10	If turned ON, the HSC will temporarily inhibit (suspend) the count.
Ym+11	If turned ON, the HSC will latch the current count into shared memory. Rising edge triggered.

Monitoring Overflow and Resetting Flags

What is a Counting Overflow?

As mentioned earlier, the HSC counter can count UP to +8388607 maximum or count DOWN to –8388608. If you pulse the counter beyond these two maximum counts (and Ym+20 ,reset, is OFF), the following will happen:

- Counting UP past +8388607 will cause the count to wrap around and start counting from –8388608 UP. (i.e. –8388608, –8388607, –8388606, etc.)
- Counting DOWN past –8388608 will cause the count to wrap around and start counting from +8388607 DOWN (i.e. 8388607, 8388606, 8388605, etc.).

If this happens, the overflow LED will come ON to let you know this has occurred. It would remain ON until power is removed, or you manually reset it using by Ym+1**.**

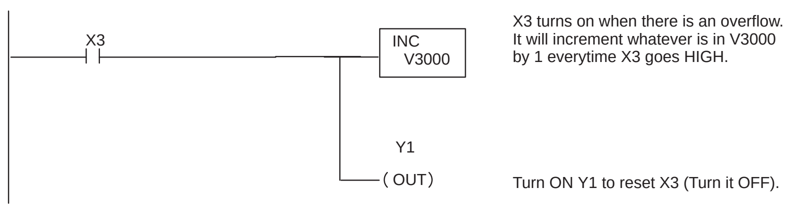
Status Flag for Overflow

In addition to turning on the OVF LED when there is a counting overflow, the HSC will also mirror the status in Xn+3**.** This flag will stay ON until Ym+1 is turned ON or power is removed. You can use this flag to sound an alarm, trigger other events, etc.

Tracking Overflows

You may want to track the total number of overflows that occur. The program below shows you some example logic that could accomplish this task.

Assuming that the HSC is in Slot 0 of the base



When Ym+1 goes HIGH, the overflow flag will not be set again until an overflow occurs again.

Summary of Input and Output Relays for Overflow and Flag Reset

The chart below summarizes the X and Y output assignments discussed above.

X or Y No.	Function
Xn+3	If ON, it means that you are in overflow. If OFF, it means you are not in overflow.
Ym+1	This output relay will reset (turn OFF) the overflow flag Xn+3 and the OVF LED.