INDUSTRIAL CONTROL DIRECT
A B&D Industrial Company

TRAINING

i^3 ...Display, Control, Communicate

Tutorial

High Speed Counter

IMO

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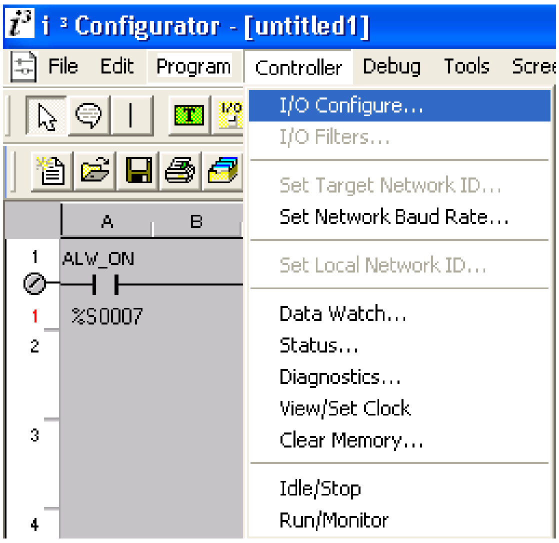
Introduction

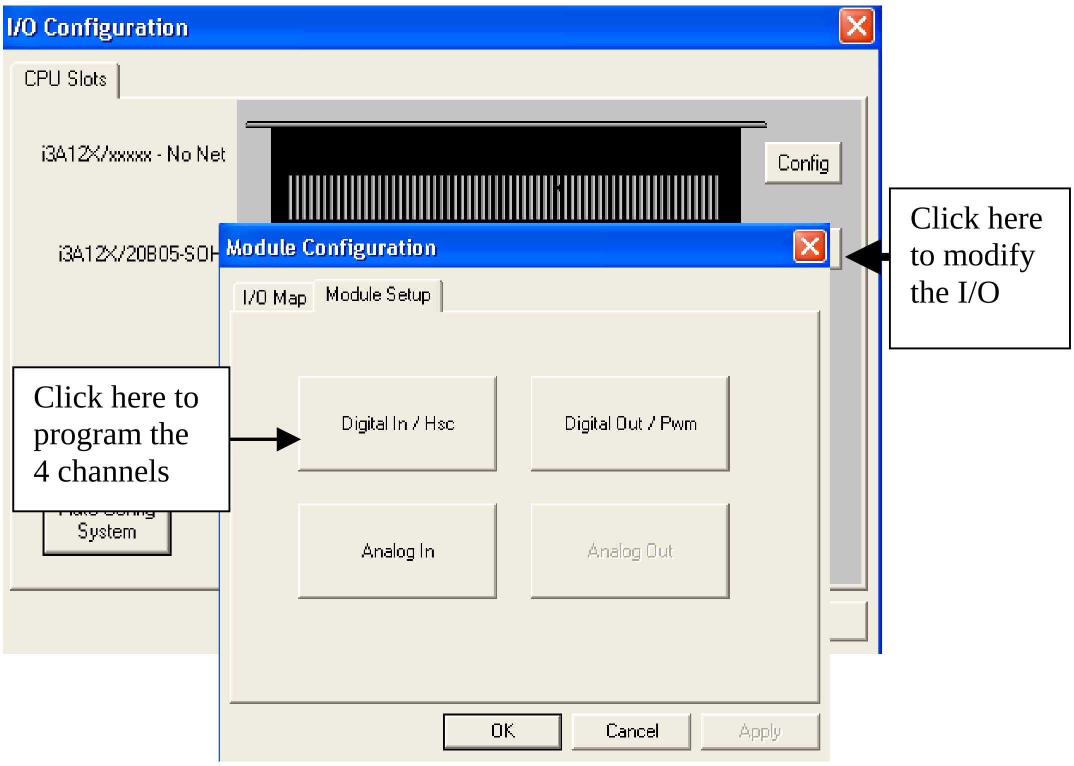
The purpose of this tutorial is to demonstrate the High Speed Counter input. The ***i***^{3} models have a 4 channel High Speed Counter. They can be set up to accept 2 quadrature inputs or act independently as Frequency, Totalise or Pulse counters.

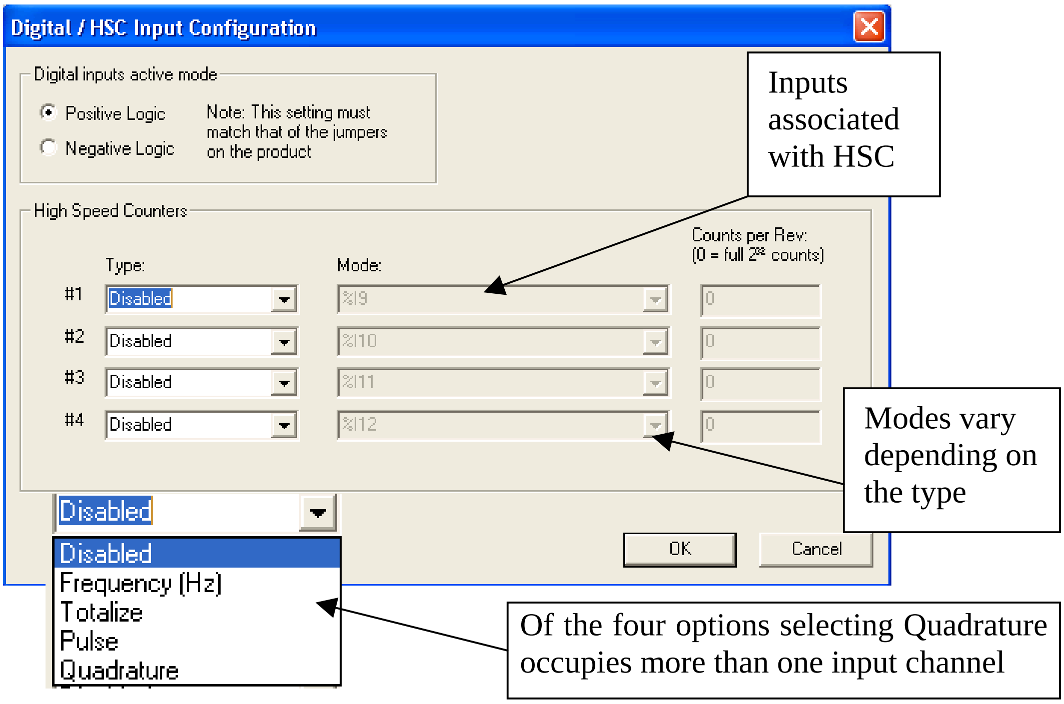
In this tutorial we will use all 4 types of high counters available.

Configuration

To Configure the HSC options we need to configure the I/O. This is best done with the *i*³ connected to your computer, although it can be done offline. Open the I/O Configure menu by clicking on the icon or selecting from the menu.







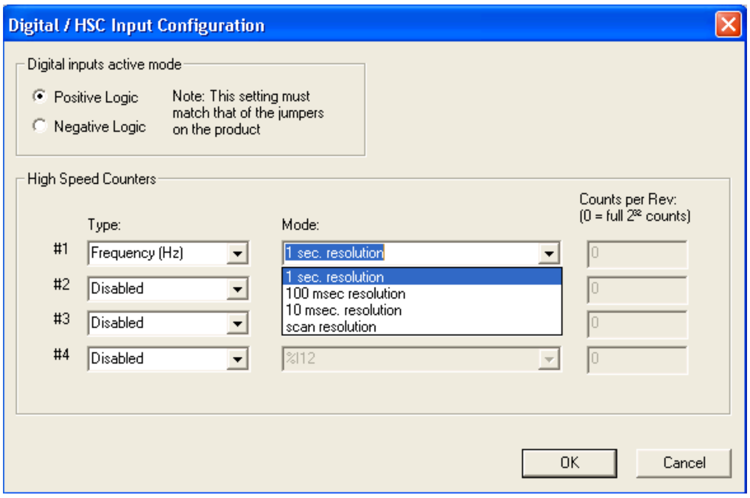
The associated inputs I09-I12 have associated analogue input registers that contain operational data.

Input	Current Value	Status Register	Reset
%I09	%AI05	%AI06	%Q17
%I10	%AI07	%AI08	%Q18
%I11	%AI09	%AI10	%Q19
%I12	%AI11	%AI12	%Q20

Once the HSC inputs are configured and assigned to the inputs %I09-%I12, click OK and close the I/O configure window. These configurations now will be downloaded to the ***i***^{3} when you next download the program into the unit.

Configuring Frequency HSC Type

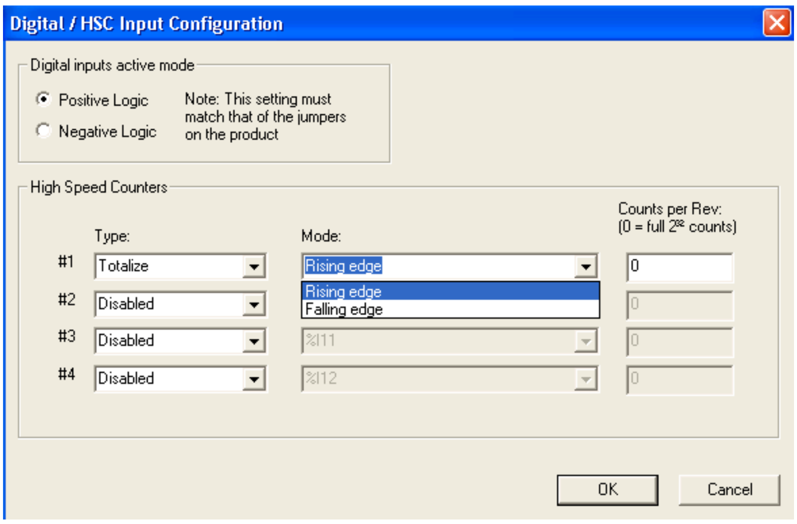
Select “Frequency (Hz)” from the drop down “Type” menu. We now have four options in the Mode menu to configure the resolution of the Frequency HSC.



The frequency input counts the frequency of the input pulses for the selected resolution.

Configuring Totalising HSC Type

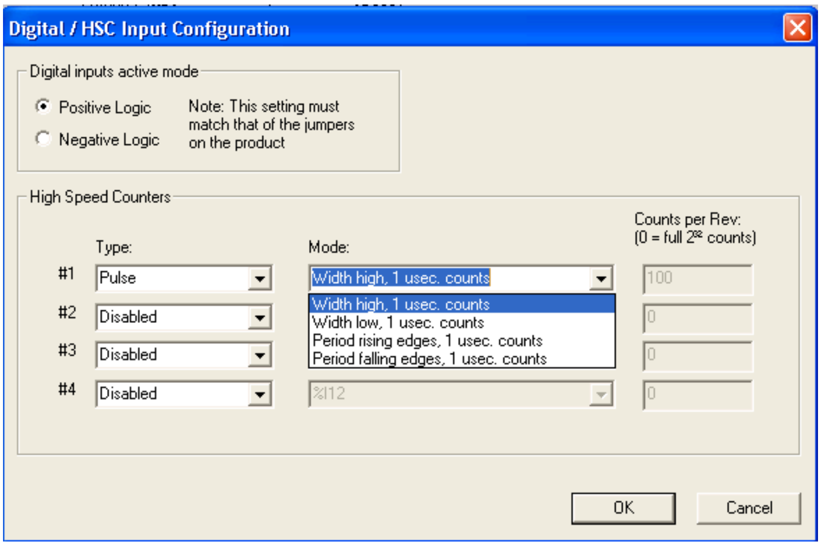
Select “Totalising” from the drop down “Type” menu. We now have two options in the Mode window - to count the rising edge or falling edge, the Counts per rev option should also be set. This value defines the HSC reset value.



The Totalising input counts the total number of Rising or Falling edges of the input pulses and resets when it reaches either the Count number inserted or the maximum value (2^{32} (4294967296 counts)).

Configuring Pulse HSC Type

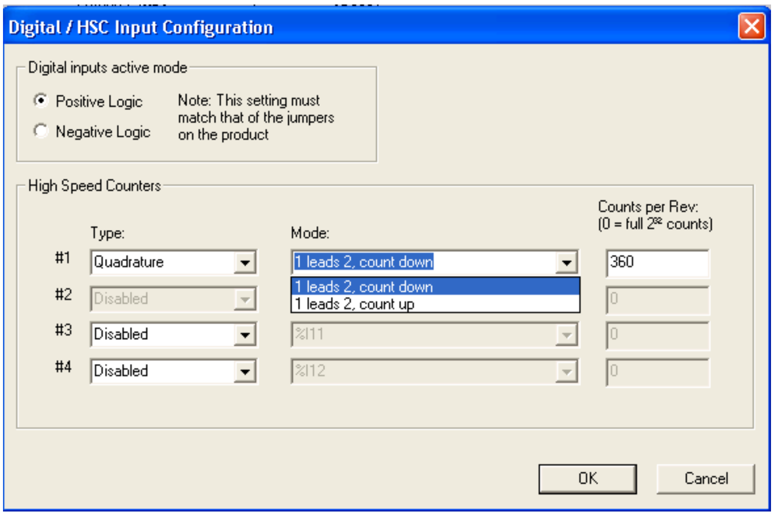
Select "Pulse" from the drop down "Type" menu. We now have four options in the "Mode" window - these options relate to the pulse properties.



The Pulse input measures the Pulse width from either the width of a high or low pulse or the period between falling edges or rising edges.

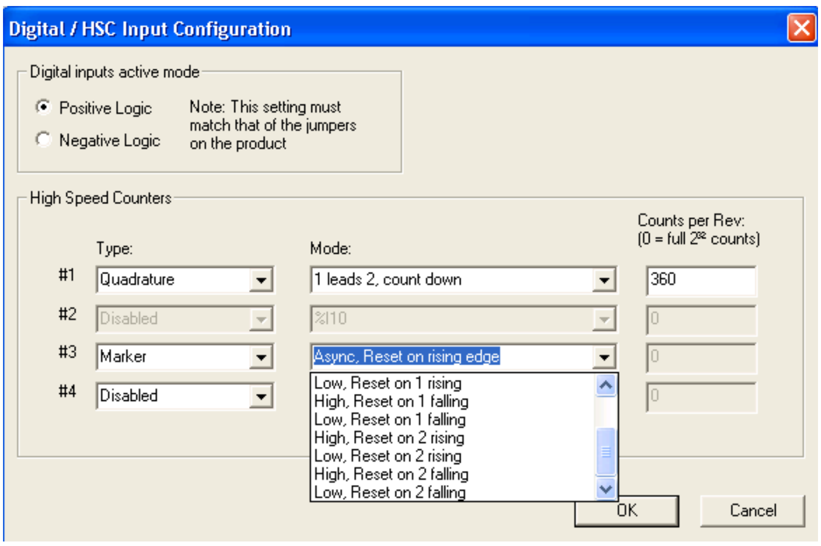
Configuring Quadrature HSC Type

Select “Quadrature” from the drop down “Type” menu. We now have two options in “Mode” window relating to the direction of the encoder. We also have the “Counts per revolution” option to define how many pulses equal a full revolution of the encoder. If we set a value in here the HSC will reset once it reaches that value.



The Quadrature input counts the total number of input pulses and resets when it reaches either the Count number inserted or the maximum value (2^{32}). The Quadrature input uses two channels to determine the position and rotation direction of the encoder.

With the Quadrature HSC input it is possible to have a third channel set up as a Marker (Z). The marker input is typically a separate channel from the encoder indicating a complete rotation.



The count can also be reset using the associated output bit.

Programming the HSC

Once the I/O has been configured and the HSC set up as required (remembering that there is the possibility of four independently configured HSC inputs) the corresponding analogue input registers are used in the program.

<table>
<tr><th>Register</th><th>Frequency</th><th>Totalize</th><th>Pulse</th><th>Quad</th></tr>
<tr><td>%AI5-6</td><td colspan="3">HSC1 (function) Accumulator</td><td>Quad 1 Acc</td></tr>
<tr><td>%AI7-8</td><td colspan="3">HSC2 (function) Accumulator</td><td></td></tr>
<tr><td>%AI9-10</td><td colspan="3">HSC3 (function) Accumulator</td><td>Quad 2 Acc</td></tr>
<tr><td>%AI11-12</td><td colspan="3">HSC4 (function) Accumulator</td><td></td></tr>
<tr><td>%AQ1-2</td><td rowspan="2"></td><td>HSC1 Preset</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>%AQ1-4</td><td>HSC2 Preset</td></tr>
<tr><td>%Q17</td><td rowspan="4"></td><td>Clear HSC1</td><td rowspan="4"></td><td>Clear Quad 1</td></tr>
<tr><td>%Q18</td><td>Clear HSC2</td><td>Set Quad 1</td></tr>
<tr><td>%Q19</td><td>Clear HSC3</td><td>Clear Quad 1</td></tr>
<tr><td>%Q20</td><td>Clear HSC4</td><td>Set Quad 1</td></tr>
</table>

Example 1. Multi-Channel HSC Input

Utilising three out of the four HSC counter functions in this example to show the varied and powerful combination of HSC facilities.

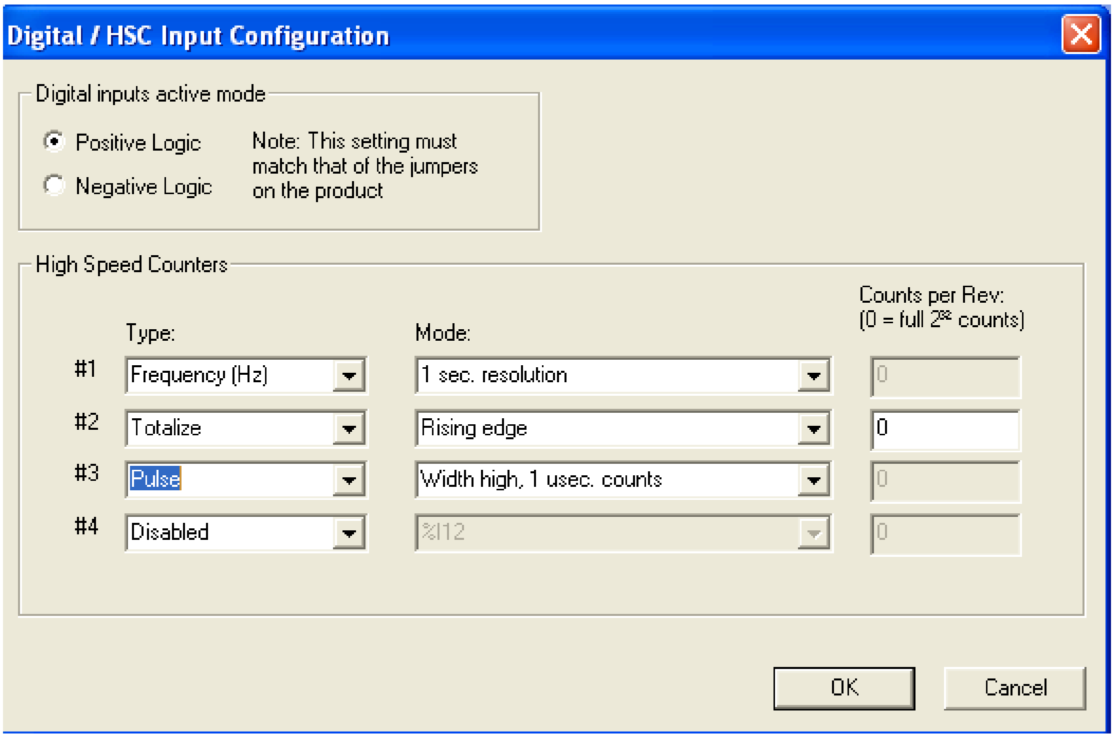
The first channel will be set to a Frequency count with I9 connected to a flow meter. If the frequency drops below the predetermined value then we will set an alarm lamp to indicate that there is a problem in the flow.

The second channel will be set to a Totalise counter to count the total number of pulses from a proximity sensor. After a preset number of products have been counted the production line will stop.

The third channel will be set as a Pulse counter to measure the period between rising pulse edges, connected to a cam switch. This will measure the time taken for one rotation.

I/O configuration

Configure the first three channels of the HSC as shown below;
Channel 1 – Frequency
Channel 2 – Totalise
Channel 3 – Pulse

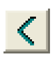


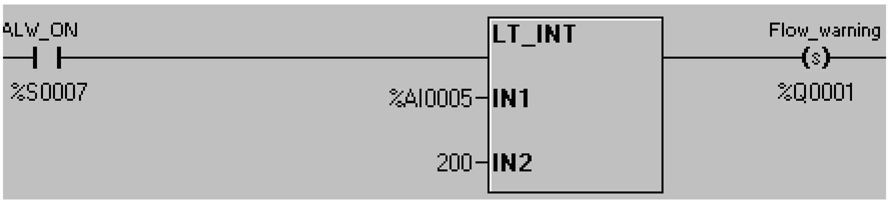
Once the high-speed counter has been configured we will use the corresponding registers in the ladder program.

Ladder Logic Programming

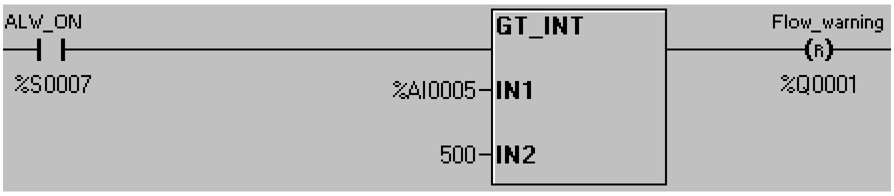
For the control aspect of this program we are going to use compare functions. For channel one we are going to use a greater than and a less than function to set and reset an output coil. With channel two we will use a greater than or equal to function operating a Normally Closed coil. In the last channel we will use a limit function block to control the output for when it is between two limits.

In the control logic for channel 1 we are going to compare the value in %AI5 to a constant value.

Insert a Less Than (LT) function by clicking on the icon  into a rung with a N/O contact assigned to "always on". On the output to the LT function insert a N/O Set coil and assign to %Q01. Double click on the function and add the properties as shown.

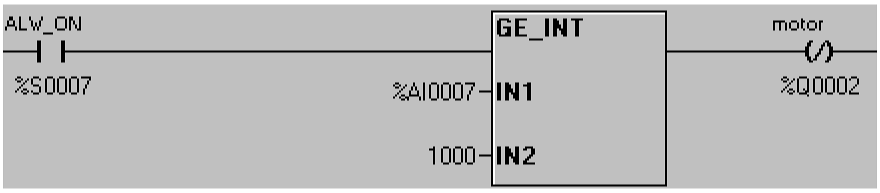


Insert a Greater Than (GT) function by clicking on the icon into a rung with a N/O contact assigned to "always on". On the output to the GT function insert a N/O Reset coil and assign to %Q01. Double click on the function and add the properties as shown.



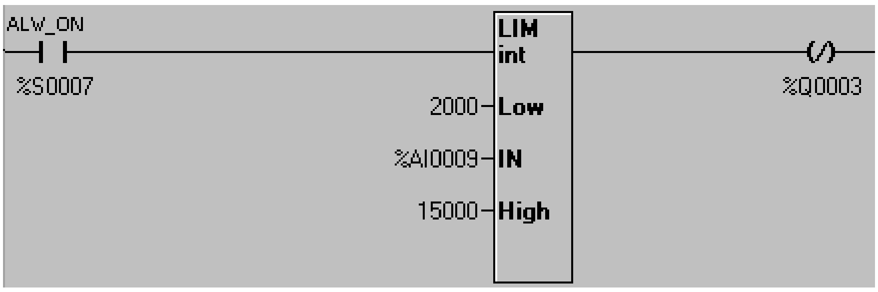
For channel 2 we are comparing %AI7 to a constant batch value. When the counted value is greater than or equal to batch value, the N/C output will open.

Enter the ladder functions as shown below.



Allocate the user key %K2 to reset the second HSC channel.

Finally for channel 3 we are going to use a limit function, select the icon LIM and insert it into a new rung. At the start of the rung insert a N/O contact and assign to "always on". On the output of the function insert a N/C coil and assign to %Q03. The HSC values in %AI9 will have the limits 5000 and 15000, if it is outside of those limits then the N/C coil will open.



Once again, assign a user key to reset the HSC channel.

Screen Editor Programming

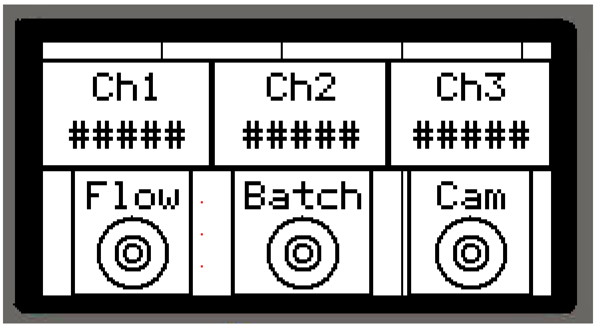
We want to display the current value of all the counters and have the output lamps displayed on the screen. To do this one screen will be sufficient.

Insert three numeric data functions 

onto the first screen and three lamps  by clicking on the icons.

Assign the lamps to the outputs %Q1, %Q2 and %Q3 by double clicking on the lamps. Now setup the numeric data functions for the three channels, %AI5, %AI7 and %AI9.

The screen should now look very similar to the one shown below.



Running to Program

After downloading the program to the $\boldsymbol{i}^{3}$, ensure you put the $\boldsymbol{i}^{3}$ into run mode. On receiving a High speed input to the HSC inputs you will see the values in the numeric functions on the screen. By pressing the appropriate keys on the front you will be able to reset the value.

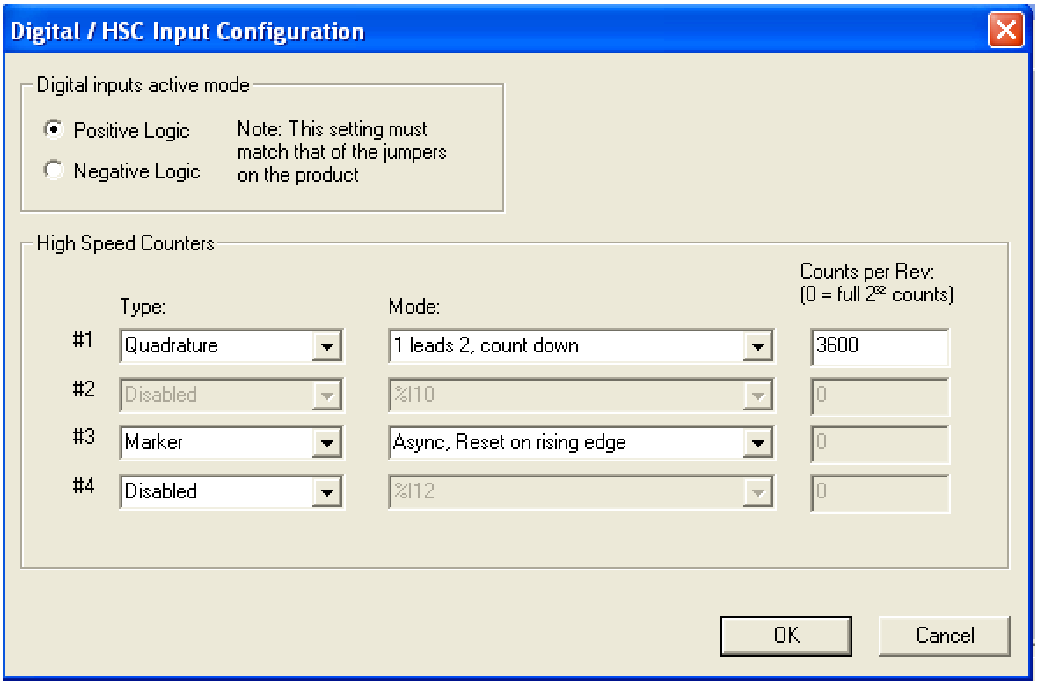
Please use the program: multi-ch-hsc.csp

Example 2. Quadrature HSC Input

The quadrature setting on the high-speed counter can use up to three channels. We will set up an encoder feed back to do just this with an Up/Down input and a marker.

Configuring the I/O

Configure the first channel to be a quadrature input and you will notice that channel 2 selection is greyed out. Select the third channel to be a marker.



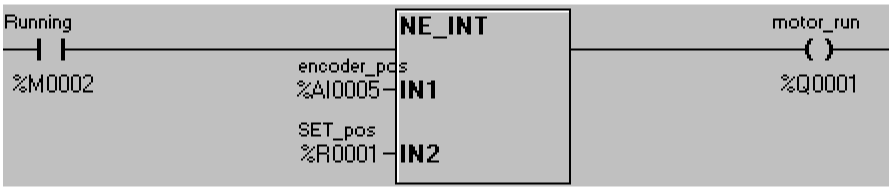
Input %I9 will lead the count up and %I10 will count in the opposite direction (i.e. down). Set the counts per rev to match the encoder, for example 3600 counts per rev has a resolution of 0.1 degrees.

Ladder Logic Programming

In the ladder program we want to drive a motor until the tool is in the correct position, as fed back by the encoder feedback. The motor will only be able to turn in one direction, and as it gets to within ten percent of the target the speed will slow to a crawl.

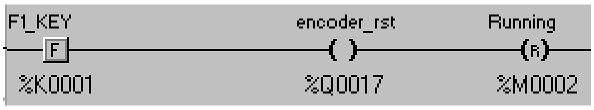
On the first rung have a N/O contact setting a latching coil on, as shown below.

Below this rung have M2 operating a Not Equal to function (selected from the comparison operations menu), the output of which will operate %Q1 the motor run signal. In the Not Equal to function we are comparing the encoder position to the set position.

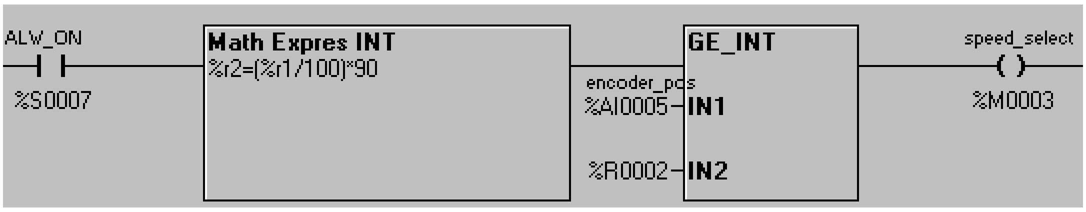


When the encoder has reached the set position the Not Equal function will go low. This will act as the reset for the running trigger for when we are in running mode.

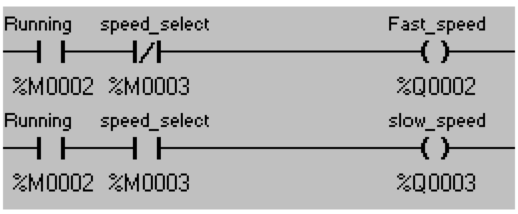
The key 1 will act as an overall reset, resetting both the Encoder and the running process.



To control the speed of the drive we are going to use an equation function (selected from the maths operations menu) and a Greater then or equal to function (selected from the compare operations menu).



The maths equation function allows the user to enter an equation that uses the basic maths operations into one function block. This has the advantage of reducing the amount of function blocks required and hence saves on memory registers. In the equation function block we are dividing the set point by 100 and multiplying by 90 to get a value 90% of the set point.

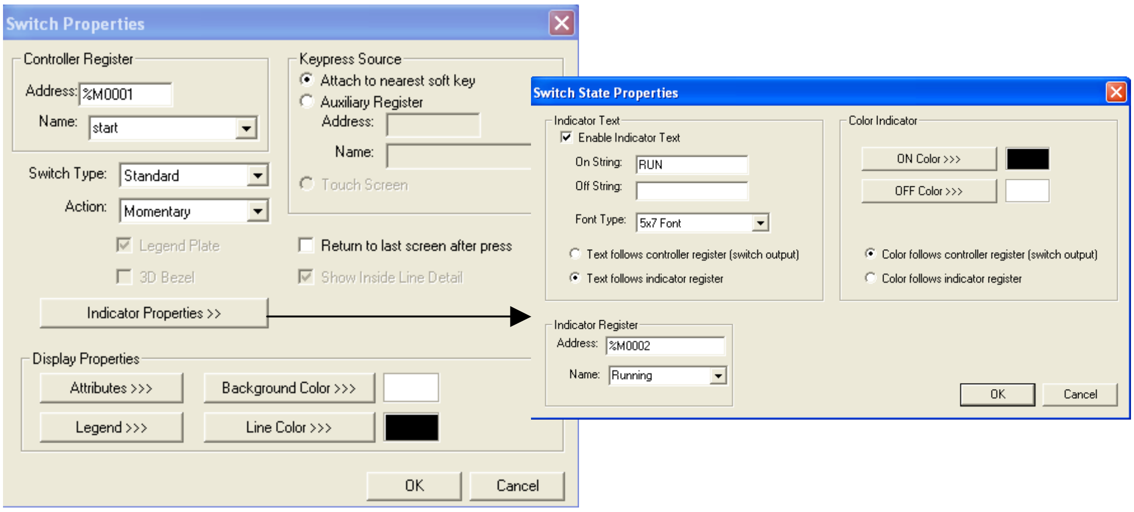


Lastly we need to insert the logic to select the correct speed. If the encoder is within 90% of the set point and the system is in run mode then the speed will be slow, otherwise it will be in fast speed mode. The logic will be as above.

Screen Editor Programming

We need to display on the screen a lamp indication for if the motor is running and what speed it is running at. We also need to have a set point data entry and a current value view of the encoder.

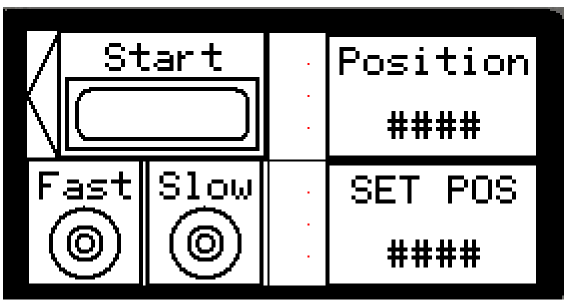
Firstly we are going to assign the top left soft key to start the running process and indicate that the motor is in running mode. Select a switch and insert it into the screen, moving it to the top left. Double click and assign it to %M01. Click on the indicator properties and enable indicator text, entering the text for the ON string to "RUN". Select the text to follow an indicator register and assign to %M02. Click OK when complete. Click on Legend and enter the text to "Start". Click ok when complete.



Next insert two lamps and assign to %Q2 and %Q3, with the legend text of "Fast" and "Slow" respectively.

Finally insert two numeric data functions assigning the first to %Ai5 to read the current position and the second to %R1 for the set position. Make the later editable with limits of 0 to 3600. Enter legend texts accordingly.

The screen should now resemble the screen below.



Running the Program

To connect the encoder into the iSmart please follow the wiring diagram as shown in the hardware manual.

After downloading the program to the ***i***^{3} ensure you put the ***i***^{3} into run mode. On rotating the encoder in one direction you should see the value increase, turn n the opposite direction and the value will decrease.

Please use the program hsc_quadrature.csp supplied

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