High Speed Counter (HSC) Self-Help Guide

This guide covers:

HE*800*HSC600/601 and HE*820*HSC600/601 **SmartStack** modules.
HE500OCS033/063 and HE500OCS034/064 **MiniOCS** modules
HE500RCS063 and HE500RCS064 **MiniRCS** modules.
This guide also covers HSC products starting with IC300.

NOTE: Examples in this guide refer to SmartStack modules, but information applies to other products listed above.

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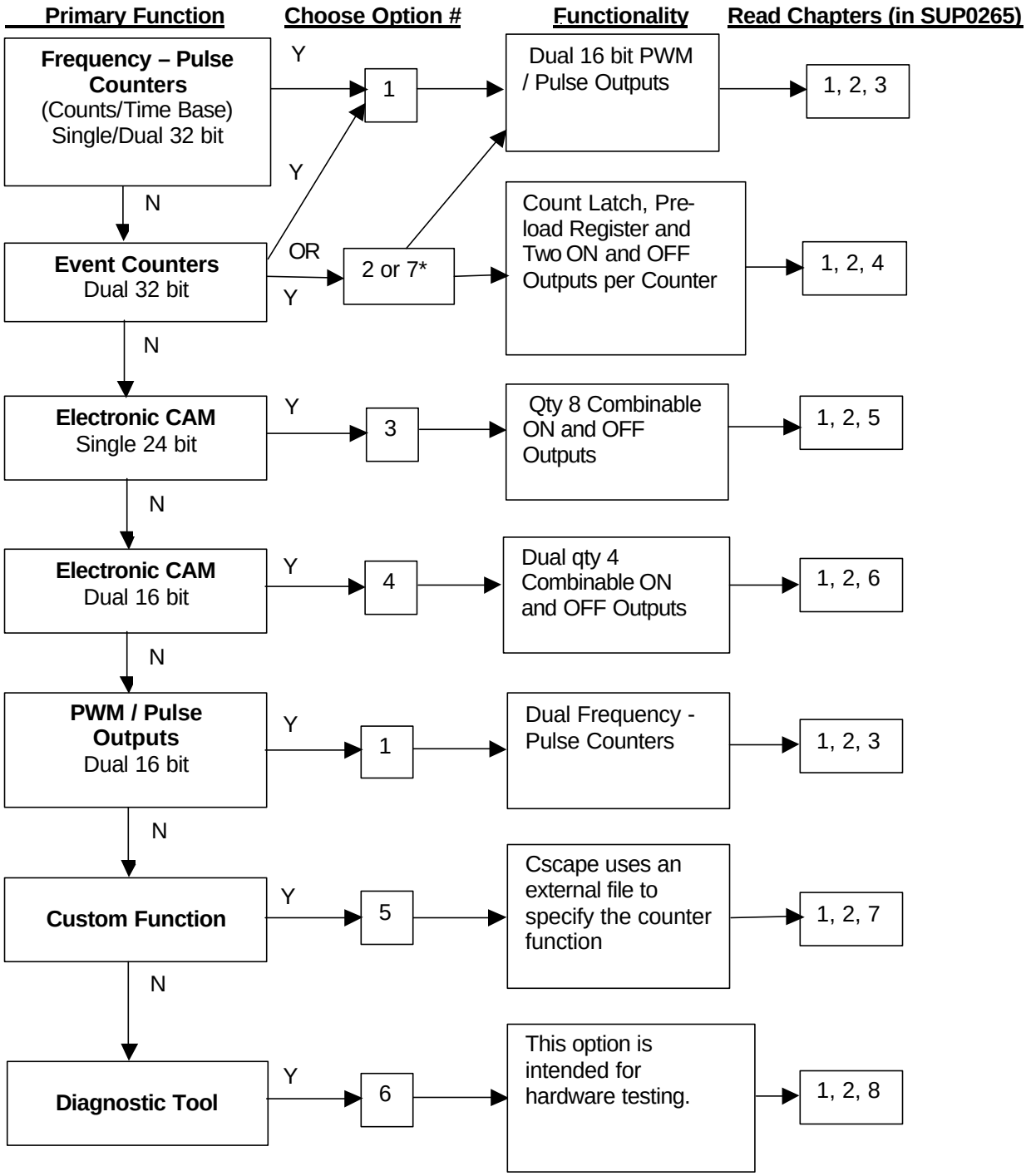
What High Speed Counter Option do I choose?

Note: The Selection Guide below refers to chapters found in the HSC Supplement (SUP0265). See ***Technical Support*** at the end of this document to locate and download the supplement from the web.

High Speed Counter Option Selection Guide



* Option 7 is Similar to Option 2 except edge triggered enable and one shot on clear. See Chapter 4 in the HSC Supplement (SUP0265) for details.

NOTES

Which OCS Registers are used with the High Speed Counter?

High Speed Counter Cscape I/O Summary

Note: The summary below refers to chapters found in the HSC Supplement (SUP0265). See ***Technical Support*** at the end of this document to locate and download the supplement from the web.

%I Data Registers

Note: A key is attached to this table that explains conventions used in the HSC register tables.

Register	Option 1	Option 2 /7	Option 3	Option 4
%I1	I1 / CLK 1	I1 / CLK 1	I1 / Encoder A	I1 / Encoder A1
%I2	I2 / DIR 1	I2 / DIR 1	I2 / Encoder B	I2 / Encoder B1
%I3	I3 / CNTRL 1	I3 / CNTRL 1	I3 / Encoder M	I3 / Encoder M1
%I4	I4 / CNTRL 1	I4 / CNTRL 1	I4 / Enc. M Disable	I4 / Enc. M1 Disable
%I5	I5 / CLK 2	I5 / CLK 2	I5	I5 / Encoder A2
%I6	I6 / DIR 2	I6 / DIR 2	I6	I6 / Encoder B2
%I7	I7 / CNTRL 2	I7 / CNTRL 2	I7	I7 / Encoder M2
%I8	I8 / CNTRL 2	I8 / CNTRL 2	I8	I8 / Enc. M2 Disable
%I9	Gate for Freq.	**Not Applicable to Option.**	%Q1 Image	**Not Applicable to Option.**
%I10	PWM 1		%Q2 Image	
%I11	PWM 2		%Q3 Image	
%I12	***Reserved***		%Q4 Image	
%I13	***Reserved***		%Q5 Image	
%I14	***Reserved***		%Q6 Image	
%I15	***Reserved***		%Q7 Image	
%I16	***Reserved***		%Q8 Image	

Key For Register Tables	
Reserved	Registers are set to 0.
Not Applicable to Option.	These tables serve as a general reference for the starting location of the registers. To determine the *actual* starting location of the various registers, it is necessary to consult the I/O Map screen in the Cscape Software *after* configuration.
%I1-8	User Inputs if not assigned to another function.
CLK 1 / 2 **DIR 1 / 2**	Refers to Clock 1 / Clock 2. The Counter counts on each positive **Clock** edge. Refers to Direction 1 / Direction 2. The **Clock Direction** input (if used) causes an up count (when the input is a logic high) and a down count (when the input is a logic low). **Note:** The Quadrature Mode of Option 1, 2, and 7 counters operates much the same as the Count/Direction Mode, but it operates with the **Clock** and **Direction** inputs conditioned as Encoder Channel A and Channel B. The normal **Clock** input becomes Channel A, and the normal **Direction** input becomes Channel B. The phase relationship of Channel A and Channel B determines the count direction.
CNTRL 1 / 2	Refers to Control 1/ Control 2. See *Types of Control Signals* in this guide (page **Error! Bookmark not defined.**).

%AI Data

Note: A key is attached to this table that explains conventions used in the HSC register tables.

Register	Option 1	Option 2 / 7	Option 3	Option 4
%AI1	Option Number	Option Number	Option Number	Option Number
%AI2	Cntr. 1 Value or Freq. LW	Cntr. 1 Value LW	Cntr. 1 Value LW	Cntr. 1 Value
%AI3	Cntr. 1 Value or Freq. HW	Cntr. 1 Value HW	Cntr. 1 Value HW	Cntr. 2 Value
%AI4	Cntr. 2 Value or Freq. LW	Cntr. 2 Value LW	**Not Applicable to Option.**	**Not Applicable to Option.**
%AI5	Cntr. 2 Value or Freq. HW	Cntr. 2 Value HW		
%AI6	Cntr. 1 Latch Value LW	Cntr. 1 Latch Value LW		
%AI7	Cntr. 1 Latch Value HW	Cntr. 1 Latch Value HW		
%AI8	Cntr. 2 Latch Value LW	Cntr. 2 Latch Value LW		
%AI9	Cntr. 2 Latch Value HW	Cntr. 2 Latch Value HW		

Key For Register Tables

Not Applicable to Option.	These tables serve as a general reference for the starting location of the registers. To determine the *actual* starting location of the various registers, it is necessary to consult the I/O Map screen in the Cscape Software *after* configuration.
LW	Low Word of DINT.
HW	High Word of DINT.
CNTR 1 / 2	Refers to Counter 1 / Counter 2.

%Q Data

Note: A key is attached to this table that explains conventions used in the HSC register tables.

Register	Option 1	Option 2/7	Option 3	Option 4
%Q1	Q1 / PWM 1	Q1 / Cntr. 1 SP 1	Q1 / CAM 1	Q1 / CAM 1-1
%Q2	Q2	Q2 / Cntr. 1 SP 2	Q2 / CAM 2	Q2 / CAM 2-1
%Q3	Q3	Q3	Q3 / CAM 3	Q3 / CAM 3-1
%Q4	Q4	Q4	Q4 / CAM 4	Q4 / CAM 4-1
%Q5	Q5 / PWM 2	Q5 / Cntr. 2 SP 1	Q5 / CAM 5	Q5 / CAM 1-2
%Q6	Q6	Q6 / Cntr. 2 SP 2	Q6 / CAM 6	Q6 / CAM 2-2
%Q7	Q7	Q7	Q7 / CAM 7	Q7 / CAM 3-2
%Q8	Q8	Q8	**AF** / CAM 8	**AF** / CAM 4-2
%Q9	**AF**	**AF**	**AF**	**AF**
%Q10	**AF**	**AF**	**AF**	**AF**
%Q11	**AF**	**AF**	**AF**	**AF**
%Q12	**AF**	**AF**	**AF**	**AF**
%Q13	**AF**	**AF**	**AF**	**AF**
%Q14	**AF**	**AF**	**AF**	**AF**
%Q15	**AF**	**AF**	**AF**	**AF**
%Q16	**AF**	**AF**	***Reserved***	***Reserved***
%Q17	**AF**	***Reserved***	**AF**	**AF**
%Q18	**AF**	***Reserved***	**AF**	**AF**
%Q19	**AF**	**AF**	**AF**	**AF**
%Q20	***Reserved***	**AF**	Reset	Reset 1
%Q21	***Reserved***	**AF**	***Reserved***	**AF**
%Q22	***Reserved***	**AF**	***Reserved***	**AF**
%Q23	***Reserved***	***Reserved***	***Reserved***	**AF**
%Q24	***Reserved***	***Reserved***	***Reserved***	Reset 2
%Q25	Load 1	Load 1	**AF**	**AF**
%Q26	Enable 1	Enable 1	**AF**	**AF**
%Q27	Clear 1	Clear 1	**AF**	**AF**
%Q28	Latch 1	Latch 1	**AF**	**AF**
%Q29	Load 2	Load 2	**AF**	**AF**
%Q30	Enable 2	Enable 2	**AF**	**AF**
%Q31	Clear 2	Clear 2	**AF**	**AF**
%Q32	Latch 2	Latch 2	**AF**	**AF**

This table is continued on next page.

Key For Register Tables

Reserved	Registers are set to 0.
AF	See manual - refers to **Advanced Functions** covered in the HSC Supplement (SUP0265).
%Q1-8	User Outputs if not assigned to another function.
CNTR 1 / 2	Refers to Counter 1 / Counter 2.
SP1 / 2	Refers to Setpoint 1 / Setpoint 2.

%Q Data continued

Register	Option 1	Option 2/7	Option 3	Option 4
%Q33	**AF**	**AF**	**AF**	**AF**
%Q34	**AF**	**AF**	**AF**	**AF**
%Q35	**AF**	**AF**	**AF**	**AF**
%Q36	**AF**	**AF**	**AF**	**AF**
%Q37	**AF**	**AF**	**AF**	**AF**
%Q38	**AF**	**AF**	**AF**	**AF**
%Q39	**AF**	**AF**	***Reserved***	**AF**
%Q40	**AF**	**AF**	***Reserved***	**AF**
%Q41	Pulse 1 Trigger	**AF**	**Not Applicable to Option.**	**Not Applicable to Option.**
%Q42	**AF**	**AF**		
%Q43	**AF**	**AF**		
%Q44	**AF**	**AF**		
%Q45	Pulse 2 Trigger	***Reserved***		
%Q46	**AF**	***Reserved***		
%Q47	**AF**	***Reserved***		
%Q48	**AF**	***Reserved***		
%Q49	**AF**	**Not Applicable to Option.**		
%Q50	**AF**			
%Q51	**AF**			
%Q52	**AF**			
%Q53	***Reserved***			
%Q54	***Reserved***			
%Q55	***Reserved***			
%Q56	***Reserved***			

Key For Register Tables

Reserved	Registers are set to 0.
AF	See manual - refers to **Advanced Functions** covered in the HSC Supplement (SUP0265).
Not Applicable to Option.	These tables serve as a general reference for the starting location of the registers. To determine the *actual* starting location of the various registers, it is necessary to consult the I/O Map screen in the Cscape Software *after* configuration.

%AQ Data

Note: A key is attached to this table that explains conventions used in the HSC register tables.

Register	Option 1	Option 2/7	Option 3	Option 4
%AQ1	Cntr. 1 Load Value or Freq. Time Base LW	Cntr. 1 Load Value LW	Low Set-Point 1 LW	Cntr. 1 Low Set-Point 1
%AQ2	Cntr. 1 Load Value or Freq. Time Base HW	Cntr. 1 Load Value HW	Low Set-Point 1 HW	Cntr. 1 High Set-Point 1
%AQ3	Cntr. 2 Load Value or Freq. Time Base LW	Cntr. 2 Load Value LW	High Set-Point 1 LW	Cntr. 1 Low Set-Point 2
%AQ4	Cntr. 2 Load Value or Freq. Time Base HW	Cntr. 2 Load Value HW	High Set-Point 1 HW	Cntr. 1 High Set-Point 2
%AQ5	Cntr. 1 PWM * Cycle Time **	Cntr. 1 ON Set-Point 1 LW	Low Set-Point 2 LW	Cntr. 1 Low Set-Point 3
%AQ6	Cntr. 1 PWM * Pulse/On Time	Cntr. 1 ON Set-Point 1 HW	Low Set-Point 2 HW	Cntr. 1 High Set-Point 3
%AQ7	Cntr. 2 PWM * Cycle Time **	Cntr. 1 OFF Set-Point 1 LW	High Set-Point 2 LW	Cntr. 1 Low Set-Point 4
%AQ8	Cntr. 2 PWM * Pulse/On Time	Cntr. 1 OFF Set-Point 1 HW	High Set-Point 2 HW	Cntr. 1 High Set-Point 4
%AQ9	**Not Applicable to Option.**	Cntr. 1 ON Set-Point 2 LW	Low Set-Point 3 LW	Cntr. 2 Low Set-Point 1
%AQ10		Cntr. 1 ON Set-Point 2 HW	Low Set-Point 3 HW	Cntr. 2 High Set-Point 1
%AQ11		Cntr. 1 OFF Set-Point 2 LW	High Set-Point 3 LW	Cntr. 2 Low Set-Point 2
%AQ12		Cntr. 1 OFF Set-Point 2 HW	High Set-Point 3 HW	Cntr. 2 High Set-Point 2
%AQ13		Cntr. 2 ON Set-Point 1 LW	Low Set-Point 4 LW	Cntr. 2 Low Set-Point 3
%AQ14		Cntr. 2 ON Set-Point 1 HW	Low Set-Point 4 HW	Cntr. 2 High Set-Point 3

This table is continued on next page.

*** PWM Cycle Time and On Time are in 100ns (0.1us) increments from 40us to 3,2767ms.**

**** Special use for 1 and 0: A value of 1 in %AQ5 or %AQ7 causes the PWM output to remain OFF. A value of 0 sets the cycle time to its maximum value of 6.5535ms.**

Key For Register Tables	
Not Applicable to Option.	These tables serve as a general reference for the starting location of the registers. To determine the *actual* starting location of the various registers, it is necessary to consult the I/O Map screen in the Cscape Software *after* configuration.
LW	Low Word of DINT.
HW	High Word of DINT.
CNTR 1 / 2	Refers to Counter 1 / Counter 2.

%AQ Data Registers continued

Register	Option 1	Option 2/7	Option 3	Option 4
%AQ15	**Not Applicable to Option.**	Cntr. 2 OFF Set-Point 1 LW	High Set-Point 4 LW	Cntr. 2 Low Set-Point 4
%AQ16		Cntr. 2 OFF Set-Point 1 HW	High Set-Point 4 HW	Cntr. 2 High Set-Point 4
%AQ17		Cntr. 2 ON Set-Point 2 LW	Low Set-Point 5 LW	Cntr. 1 Cnts per Revolution
%AQ18		Cntr. 2 ON Set-Point 2 HW	Low Set-Point 5 HW	Cntr. 2 Cnts per Revolution
%AQ19		Cntr. 2 OFF Set-Point 2 LW	High Set-Point 5 LW	**Not Applicable to Option.**
%AQ20		Cntr. 2 OFF Set-Point 2 HW	High Set-Point 5 HW	
%AQ21		**Not Applicable to Option.**	Low Set-Point 6 LW	
%AQ22			Low Set-Point 6 HW	
%AQ23			High Set-Point 6 LW	
%AQ24			High Set-Point 6 HW	
%AQ25			Low Set-Point 7 LW	
%AQ26			Low Set-Point 7 HW	
%AQ27			High Set-Point 7 LW	
%AQ28			High Set-Point 7 HW	
%AQ29			Low Set-Point 8 LW	
%AQ30			Low Set-Point 8 HW	
%AQ31			High Set-Point 8 LW	
%AQ32			High Set-Point 8 HW	
%AQ33			Cnts per Revolution LW	
%AQ34			Cnts per Revolution HW	

*** PWM Cycle Time and On Time are in 100ns (0.1us) increments from 40us to 3,2767ms.**

**** Special use for 1 and 0: A value of 1 in %AQ5 or %AQ7 causes the PWM output to remain OFF. A value of 0 sets the cycle time to its maximum value of 6.5535ms.**

Key For Register Tables

Not Applicable to Option.	These tables serve as a general reference for the starting location of the registers. To determine the *actual* starting location of the various registers, it is necessary to consult the I/O Map screen in the Cscape Software *after* configuration.
LW	Low Word of DINT.
HW	High Word of DINT.
CNTR 1 / 2	Refers to Counter 1 / Counter 2.

How do I get started?

High Speed Counter Quick Start Examples

Example 1: Using the Diagnostic Tool (Option 6)

Note: This product has a detailed supplement (SUP0265). See ***Technical Support*** at the end of this document to locate and download the supplement from the web.

Initial Configuration - Selecting HSC Counter

1. For this example, physically install the HSC600 SmartStack module in the *first* I/O slot of the controller. (You can use the HSC601 instead.)

2. In Cscape, double-click on the first slot or click on the Config button to its right. A screen appears; click **Other** tab and then another screen appears. Select HE800HSC600 and click **OK**. The following screen appears showing the HSC in the first slot. Now click on the **Config** button to its right.

Figure 1 - Example 1 - HSC is Shown in First Slot

Note: Ensure that the proper controller is selected. If it is not selected, double-click on the controller and select the desired controller from the pull-down menu or press the **Config** button to its right. Press **OK**.

3. The following screen appears.

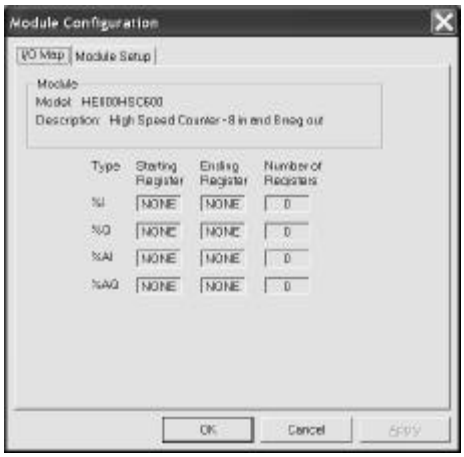


Figure 2 - Example 1 - Module Configuration Screen

You need to select an HSC option, so click the **Module Setup** tab.

Note: The I/O slot position that is selected affects the *actual* starting location of various registers. It is necessary to consult this **I/O Map** screen in the Cscape Software ***after*** configuration.

Configuring HSC using Option 6

4. The following screen appears.

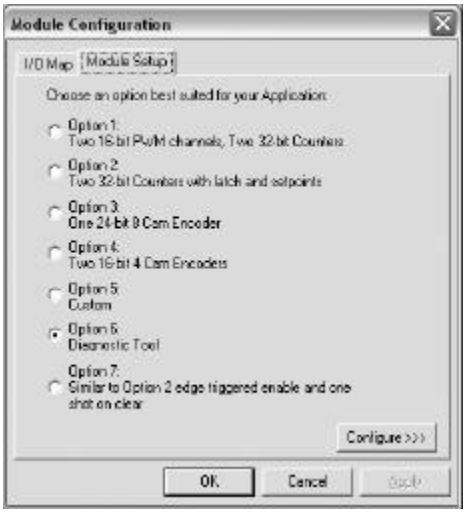


Figure 3 - Example 1 - Option 6 Selected

5. Click **Option 6**. Press **Configure** button. The following screen appears.

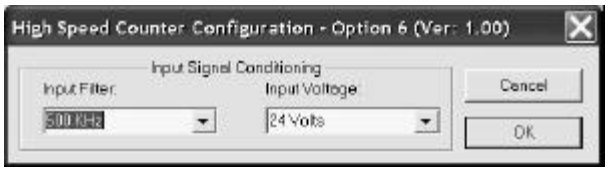


Figure 4 - Example 1 - Configuring Option 6

In this example, no configuration selections are needed. Simply press **OK**. The screen in Figure 3 appears again; press the **I/O Map** tab at the top of the screen.

Viewing I/O Map

6. The following screen appears.

Figure 5 - Example 1 - I/O Map for Option 6

The I/O Map shows the *actual* starting location of various registers for the configured HSC600 located in slot 1.

Click **OK** and then download the configuration to the OCS/RCS. No ladder program is needed for this example.

7. What if the HSC module had been placed in slot 2 instead of slot 1? How would it affect the I/O Map and the *actual* starting location of various registers?

Let us assume that there is a mixed digital I/O module in the *first* position and that the HSC is the *second* module on the stack. After configuration, you check the I/O Map for the HSC module (Figure 7).

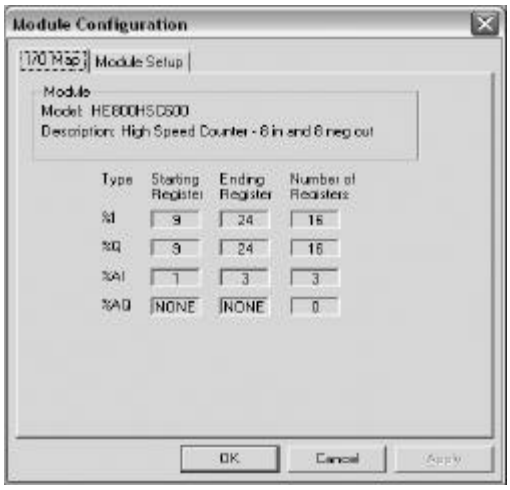


Figure 6 - Example 1 - I/O Map for HSC in Second Slot

Notice that the HSC digital I/O starts at register address 9, and the analog inputs start at 1. Any reference to the digital I/O on the High Speed Counter needs to be offset by the starting register address minus one. (e.g. %I1 on the HSC is located at %I9 in the Cscape register map [%I1 + {9-1} = %I9].)

Viewing Data Watch Window (HSC, Option 6)

8. Finally, go to the Data Watch Window and display %AI2 as an integer. You will see the free-running counter clocked by the 10MHz oscillator.

To show some control over the counter, turn on %Q23 (%Q15 + (9-1) = %Q23), which is the mask bit, and then turn on %Q21 (%Q13 + (9-1) = %Q21), which is the Aux1 bit. The counter stops counting (as a direct result of turning Q21 on) and is cleared to 0.

Turn off %Q21 and the counter resumes counting.

Figure 7 - Example 1 - Data Watch Window

Example 2: Using an Event Counter

When configuring an Event Counter, use Option 1 or 2 or 7 depending on your application. In Example 2, Option 1 is used.

Note: The HSC has a detailed supplement (SUP0265). See ***Technical Support*** at the end of this document to locate and download the supplement from the web.

Selecting Option 1

1. Install the HSC SmartStack module and start the initial configuration (page 11) and perform steps 1-3. **In this Example 2, it is assumed that the first slot contains a mixed digital module and the HSC is placed in the second I/O slot.**

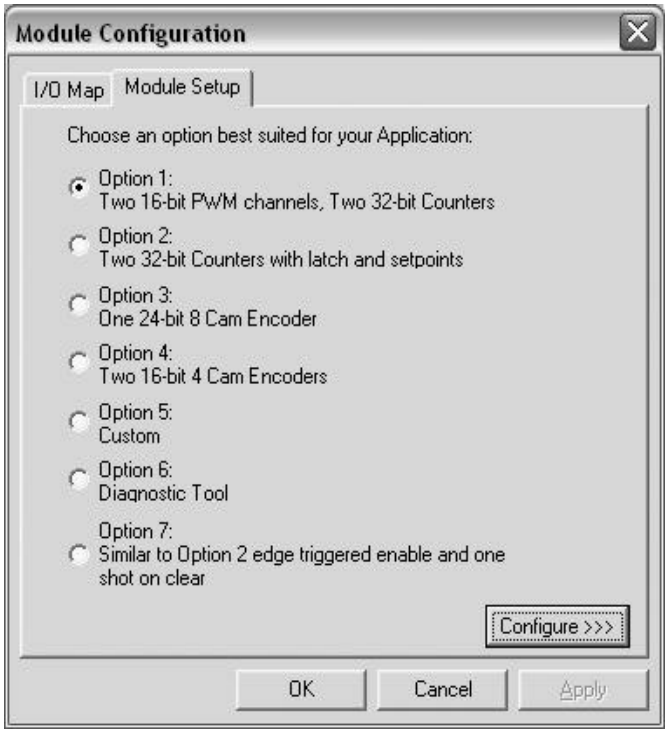


Figure 1 – Example 2 - Option 1 Selected

2. Select Option 1. Then, click the **Configure** button.

Configuring HSC Using Option 1

3. The HSC Configuration screen for Option 1 appears. Click the check boxes for:
1. Enable Counter 1
2. Under Mode, select 10 MHz Osc
3. Latch, Load, Clear and Enable from Ladder

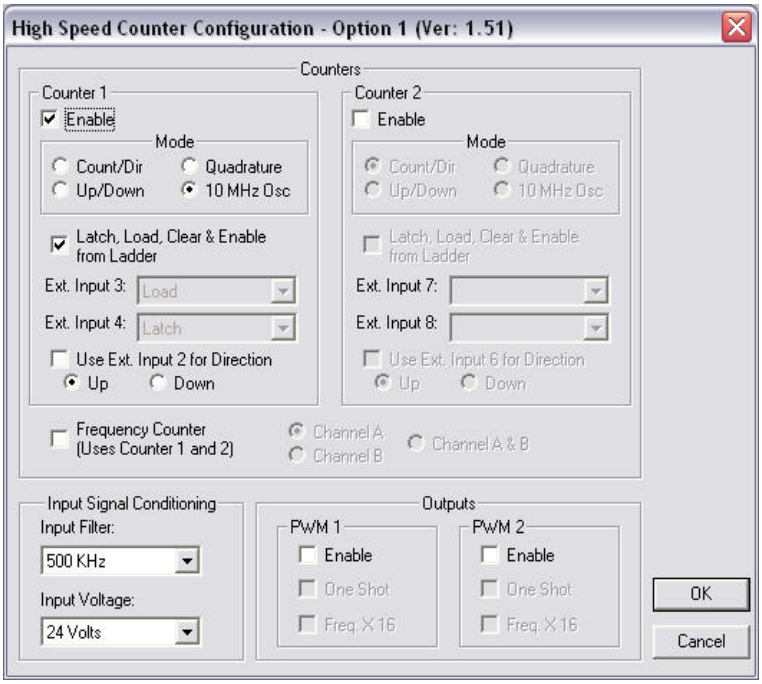


Figure 2 – Example 2 - Option 1 Configuration

You are now looking at your configuration choices on the screen as shown in **Figure 2**. To complete the configuration, press **OK**. You are now looking at the screen in **Figure 1**. Press the **I/O Map** tab at the top of the screen.

Viewing the I/O Map

4. The following screen appears.

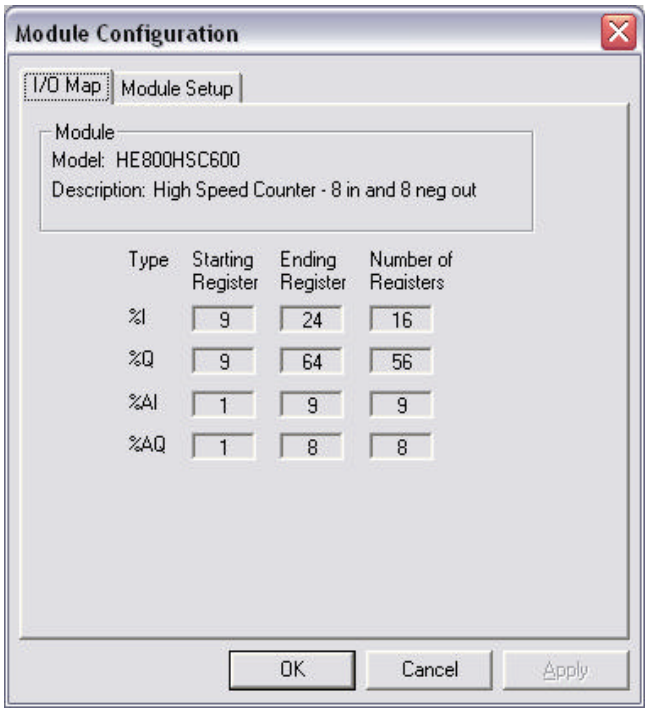


Figure 3 – Example 2 - High Speed Counter I/O Map with Option 1 Selected

Look at the I/O Map as shown in Figure 3. In this example, the High Speed Counter is the second module on the stack and there is a mixed digital I/O module in the first position. Therefore the HSC digital I/O starts at register address 9 and the analog I/O starts at 1. Any reference to the digital I/O on the HSC needs to be offset by the starting register address minus one. (e.g. %I1 on the HSC is located at %I9 in the Cscape register map [%I1 + {9-1} = %I9]).

Click **OK** and then download the configuration to the OCS/RCS. No ladder program is needed for this example.

Viewing Data Watch Window (HSC, Option 1)

5. Now go to the Data Watch Window. Select the Controller pull-down menu in Cscape and click Data Watch. Display %AI2 as a DINT (Double Integer). You will see 0 in the counter.

To allow the counter to count, turn on the enable bit located at %Q34, this is the 26th bit in the HSC register map. With the HSC starting at 9 as shown in the I/O Map of Figure 3, turn on %Q34 (%Q26 + (9-1) = %Q34). You will see the free-running counter clocked by the 10MHz oscillator.

Now, turn off %Q34 (%Q26 + (9-1) = %Q34) the Enable bit. The counter stops counting, and you can see the count value in %AI2/3.

Note: If Option 7 had been selected, the counter continues to count with the Enable bit turned off, because enable is latched. Turning on the Clear bit, the 27th bit in the HSC register map, turns off the Enable and clears the counter to 0.)

To clear the counter to 0, turn on the Clear bit at %Q35 (%Q27 + (9-1) = %Q35).

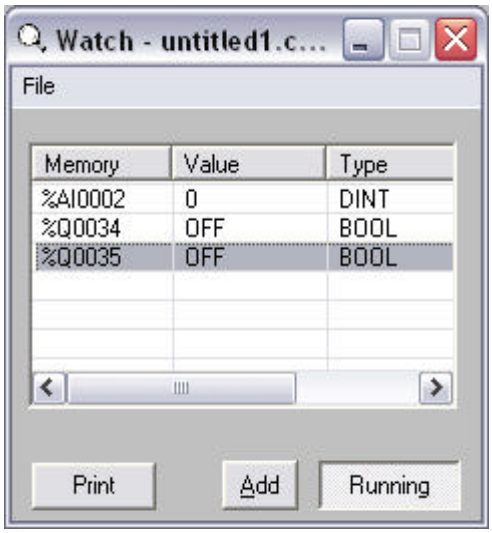


Figure 4 – Example 2 – Data Watch Window

What Additional Information Is Important To Know?

Data Consistency Issue During Counter Accumulator Register Access (Accumulator Register is not Latched)

Applications required to read the counter accumulator registers ***during counter operation*** need to employ the ***latched*** values. Latched values are not required for display purposes. (*Types of Control Signals* are discussed later in this section.)

Issue: The accumulator registers of option 1, 2, 3, and 7 counters contain Double Integer values. (That is, they are 24 or 32 bit registers.) If a count occurs coincident with the controller's access to the accumulator register, **erroneous data can result**. This is not an issue for the option 4 accumulator registers, because they are Integer values. (They are 16 bit registers.) The registers in question are as follows (assuming that the module's AI registers begin at AI1):

See %AI Register Table for more details on page 6 in this guide.

Option 1:
AI2/3 (Counter 1 count or frequency, use Latch and AI6/7)
AI4/5 (Counter 2 count or frequency, use Latch and AI8/9)
Option 2:
AI2/3 (Counter 1 count, use Latch and AI6/7)
AI4/5 (Counter 2 count, use Latch and AI8/9)
Option 3:
AI2/3 (Count value, no latch available, use CAM Image)
Option 4:
AI2 (Counter 1 count, no latch available, read accumulator directly)
AI3 (Counter 2 count, no latch available, read accumulator directly)
Option 7:
AI2/3 (Counter 1 count, use Latch and AI6/7)
AI4/5 (Counter 2 count, use Latch and AI8/9)

Types of Control Signals (Options 1, 2, and 7 only)

Note: The following definitions are taken from the HSC Supplement (SUP0265). See ***Technical Support*** at the end of this document to locate and download the supplement from the web.

Each counter (if enabled) is controlled by the following control signals.

LOAD: Setting the Load signal to Logic 1 forces the count to the Load Value. The Count remains at the Load value until the Load signal is reset to Logic 0. The count then starts from that value and increments or decrements depending on the direction of the count.

ENABLE: Setting the Enable signal to Logic 1 allows the Counter to count. When the Enable signal of an option 1 or 2 counter is set to Logic 0, counting is inhibited. When the Enable signal of an option 7 counter is set to Logic 0, counting continues. Use the Clear signal to stop counting.

CLEAR: Setting the Clear signal to Logic 1 clears the counter to zero, and the count remains at zero until the Clear signal is reset to Logic 0

LATCH: The current counter value is latched into the counter's Latch register on the rising edge of the Latch signal. The counting function is not disturbed by the latch. The register data is not reloaded until the following Latch signal's rising edge appears.

NOTES

Technical Support

For assistance and manual updates, contact Technical Support at the following locations:

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(317) 916-4274
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