

## Input Mode – Joystick

Included programs:

- Position Input Mode.qcp
- Velocity Input Mode.qcp
- Torque Input Mode.qcp

### Overview

Position, velocity and torque can be continuously controlled from a single, raw data source using the Input Mode commands:

- Position Input Mode (PIM)
- Velocity Input Mode (VIM)
- Torque Input Mode (TIM)

The raw data is called Input Source Data and can come from many sources including an analog input, a host, a CANOpen® register map, an internal calculations, etc...

The Input Mode commands allow the user to filter, clip and scale the Input Source Data to create a smooth, well behaved output. For example, let us say the user wants to use a joystick to command the servo to go from –2000 counts to +2000 counts. The PIM command will allow the user to:

- Filter Out High Frequency Analog Input Noise
- Choose Amount of Joystick Travel To Use
- Define a Dead Band Around the Joystick Center Position
- Define Number of Counts to Move
- Limit Move Velocity

This application note describes how to configure the Input Mode commands for the above mentioned options and in particular gives instructions on how to use a joystick to command position, velocity or torque.

### Edit Dialog Box

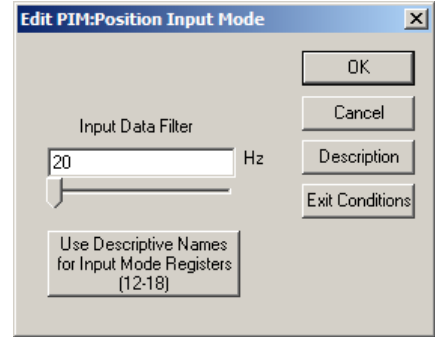
The Input Mode commands use registers 12-18 and command parameters to configure all of its options. They share a common edit dialog box (PIM shown below).

The Input Mode commands are modal. That is, once executed, they will continuously process the Input Source Data until a predefined exit condition is met or the Input Mode command is overridden.

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**Input Data Filter**

This is a low pass filter on the Input Source Data. Simply put, Input Source Data changing slower than the specified frequency is “passed”, while higher frequency data is considered noise and is ignored. The lower this number the slower the Input Mode command will respond.



**Use Descriptive Names**

Changes the a names of registers 12-18 to their defaults

**Exit Conditions**

Press this button to select which conditions will cause the Input Mode command to exit.

**Input Mode Registers 12-18**

Input Mode commands use registers 12-18, which must be initialized before executing the command. After the Input Mode command is executed, the registers are continuously read so changes to any register will affect the motion in real-time.

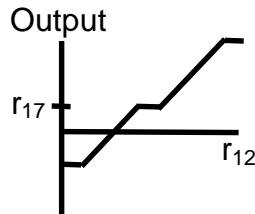
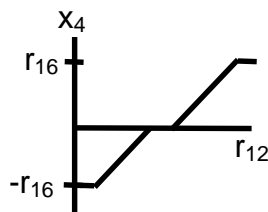
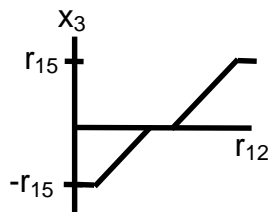
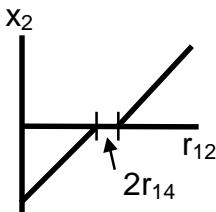
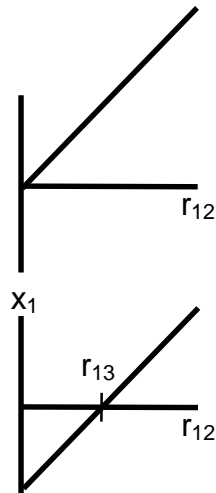
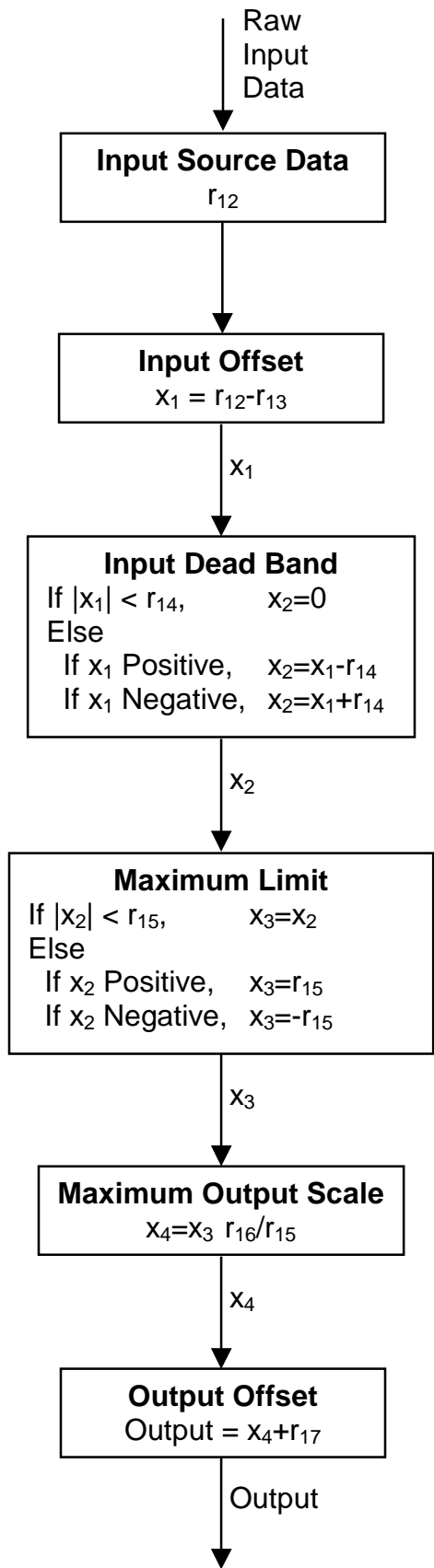
Registers 12-18 are defined as follows:

Register	Description	Range
12	Input Source Data	-2,147,483,648 to +2,147,483,647 <sup>(1)</sup>
13	Input Offset	-2,147,483,648 to +2,147,483,647 <sup>(1)</sup>
14	Input Dead Band	0 to 32767
15	Maximum Scale/Limit	0 to 32767
16	Maximum Output Scale	-2,147,483,648 to +2,147,483,647
17	Output Offset	-2,147,483,648 to +2,147,483,647
18	Output Rate of Change	0 to +2,147,483,647

- (1) Although register 12 and 13 may contain the indicated range, the Input Mode commands can at most process data in register 12 that ranges +/- 32767 from register 13.  
 $(Reg\ 13 - 32767) \leq Reg\ 12 \leq (Reg\ 13 + 32767)$ .

The Input Mode commands take the Input Source Data from register 12 and use registers 13-17 to sequentially process it through the steps shown in the Input Mode Flow Diagram (see following page).

Register 18 defines the outputs maximum rate of change. For example, the register 18 defines the maximum commanded velocity for the PIM command the maximum command acceleration for the VIM command.



**Legend**  
 $r_n$ : Register n  
 $x_n$ : Intermediate Term n

Register 13 establishes the "Zero Cross Over"

Register 14 defines a dead band around the Zero Cross Over. Changes within this area do not result in motion.

Register 15 defines the maximum allowed data above and below the Zero Cross Over.

Register 16 defines the maximum output that corresponds to the maximum input.

Register 17 is added as an offset to the output

### Position Input Mode.qcp

Assume a Joystick is wired to Analog Input #1. This example will demonstrate how to configure Position Input Mode (PIM) to make the servo move +/- 2000 counts as the joystick moves.

Line 3: Use Analog Continuous Read (ACR) to continuously read the joystick into register 12. Once executed, ACR continues in the background.

ACR takes the 10 bit analog input and scales it to a 15 bit number

- SilverNugget: 0 to 5V == 0 to 32767
- SilverDust: 0 to 3.3V == 0 to 32767

For details on analog inputs, see Application Note QCI-AN023 Analog Inputs.

Line 5: Assuming nobody is touching the joystick, read the joystick's center position into the Input Offset register (reg 13). The joystick center position will be used as the "Zero Cross Over". If the joystick is in the center it will read about 16000.

Line 7: A 2000 count dead band is established around the Zero Cross Over to give the joystick's center position a range of no motion.

Line 9: Setting the Maximum Input|Scale register (reg 15) to 14000 and assuming the Zero Cross Over is 16000, limits the input range between 2000 and 30000 thus clipping the joystick ends which are typically different from one joystick to another.

Line 11: Register 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output of +/- 2000 counts to correspond to the input range of +/- 14000 around Zero Cross Over.

Line 13: For this example we set the Output Offset to 0. If, instead, you wanted the output to range between -1000 and +3000, you would set this register to 1000.

Line 15: Register 18 is set to 8000cps (native value=32212255) to limit the commanded velocity.

Use Register Watch to monitor register 12 as the joystick moves back and forth. Note, the dead band and clipped end of travel. See the effects of registers 13-18 by changing them in Register Watch.

3:ACR	Analog Continuous Read: "User   Input Source Data[12]" = Analog Channel #1 Reg 13 = Offset
4:REM	Assuming nobody is touching the joystick, read the current position and store it into reg 13. The joystick center position will be used as the "Zero Cross Over".
5:ARI	Analog Read Input: "User   Input Offset[13]" = "Analog Channel #1"
6:REM	Reg 14 = Dead Band This will create a little dead band around the Zero Cross Over (joystick center).
7:WRP	Write 2000 to "User   Input Dead Band[14]" Register Reg 15 = Max Input & Scale
8:REM	Reg 15 defines the maximum allowed data above and below the Zero Cross Over. With the full range being 0-32767 and Zero Cross Over at about 16000, a reasonable input maximum is +/- 14000.
9:WRP	Write 14000 to "User   Maximum ScaleLimit[15]" Register Reg 16 = Max Output Scale
10:REM	Reg 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output to be +/- 2000 counts.
11:WRP	Write 2000 to "User   Maximum Output Scale[16]" Register Reg 17 = Output Offset
12:REM	Reg 17 is added as an offset to the final result. In this example we set this to zero.
13:WRP	Write 0 to "User   Output Offset[17]" Register Reg 18 = Rate
14:REM	Register 18 defines the maximum rate of change. For the PIM command this is the maximum velocity.
15:WRP	Write 8000 cps to "User   Output Rate of Change[18]" Register
16:REM	Enter Position Input Mode
17:PIM	Position Input Mode:

### Velocity Input Mode.qcp

Assume a Joystick is wired to Analog Input #1. This example will demonstrate how to configure Velocity Input Mode (VIM) to make the servo move +/- 20000cps as the joystick moves from left to right.

Line 3: Control Constants (CTC) are modified as shown to "loosen" up the servo loop. When using a joystick to command velocity, a smooth velocity is usually more important than aggressive position control.

2:REM	Use Control Constants (CTC) to "loosen" up the servo loop for a smoother velocity control.  Suggest: Kp = 1/2 default Kv1=0 Kv2= 1/2 default Kvff = 1/2 default Ka = 0 Kaff = 0 Ki = 0
3:CTC	Control Constants: Kp = 20 Kv1 = 0 Kv2 = 2 Kvff = 2 Ka = 0 Kaff = 0 Ki = 0

Lines 5-11: Registers 12-15 have the same setup as the above Position Input Mode.qcp example.

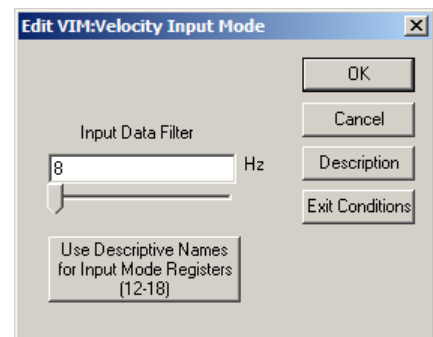
Line 13: Register 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output to be +/- 20,000cps (native value=80530637).

12:REM	Reg 16 = Max Output Scale  Reg 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output to be +/- 20000cps.
13:WRP	Write 20000 cps to "User   Maximum Output Scale[16]" Register
14:REM	Reg 17 = Output Offset  Reg 17 is added as an offset to the final result. In this example we set this to zero.
15:WRP	Write 0 to "User   Output Offset[17]" Register
16:REM	Reg 18 = Rate  Register 18 defines the maximum rate of change. For the VIM command this is the maximum acceleration.
17:WRP	Write 200000 cps/s to "User   Output Rate of Change[18]" Register
18:REM	Enter Velocity Input Mode
19:VIM	Velocity Input Mode:

Line 15: For this example we set the Output Offset to 0. If, instead, you wanted the joystick to modify a base speed, you would set register 17 to the base speed.

Line 17: Register 18 is set to limit the commanded acceleration.

Line 19: The Input Data Filter is set to 8Hz to filter out quick joystick movements, thus smoothing the input data.



### Torque Input Mode.qcp

Assume a Joystick is wired to Analog Input #1. This example will demonstrate how to configure Torque Input Mode (TIM) to make the servo move +/- as the joystick moves from left to right.

WARNING: The servo will go as fast as the commanded torque allows.

Lines 3-9: Registers 12-15 have the same setup as the above Position Input Mode example.

Line 11: Register 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output to be +/- 2000 (+/- 10% torque).

Line 13: Set the Output Offset to zero.

Line 15: Limit the maximum change in torque per second to 40000.

10:REM	Reg 16 = Max Output Scale Reg 16 defines the maximum output that corresponds to the maximum input. For our example we want the maximum output to be +/- 2000 (+/- 10% torque).
11:WRP	Write 2000 to "User   Maximum Output Scale[16]" Register
12:REM	Reg 17 = Output Offset Reg 17 is added as an offset to the final result. In this example we set this to zero.
13:WRP	Write 0 to "User   Output Offset[17]" Register
14:REM	Reg 18 = Rate Register 18 defines the maximum rate of change. For the TIM command this is the maximum change in torque per sec.
15:WRP	Write 40000 to "User   Output Rate of Change[18]" Register
16:REM	Enter Torque Input Mode
17:TIM	Torque Input Mode: