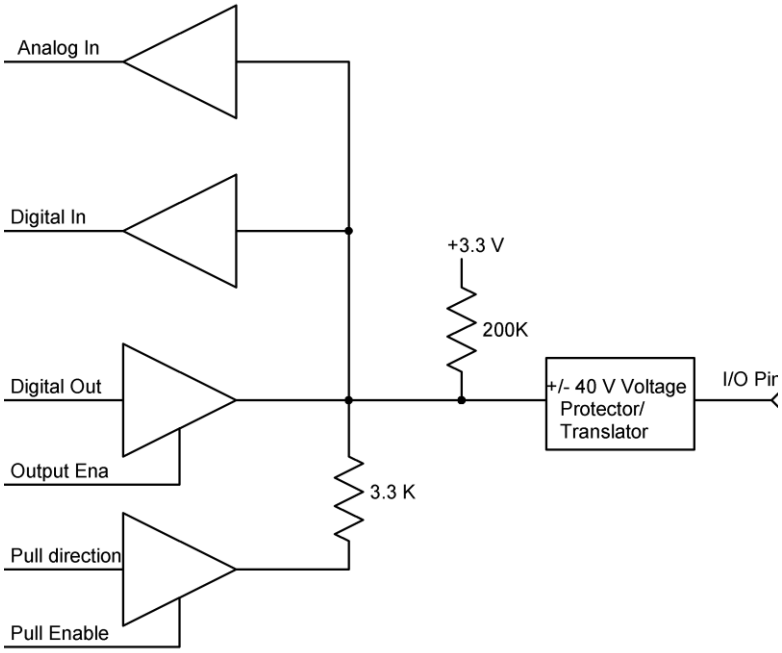
Using X-Series I/O

Description of I/O internal circuitry

Each of the seven I/O lines for the X-series SilverNugget and SilverMax controllers have software configurable functions.



The top block in this figure is the analog input which can read the voltage present even when the digital portion is in operation. More accurate analog readings normally turn off the pull-up and driver signals. For details on using analog inputs, please see Application Note AN023.

The second block is the LVTTL digital input. The input pin is shared with the output from the third block, and so this input will report the digital out level if the output is enabled.

The third block is a tri-state driver, allowing floating levels, high levels (3.3v) and low levels (0v) with 2mA capability. The digital out levels and the output enable are selected using the Configure I/O (CIO) command for the particular output pin, with state -1 being used for tristate (input mode), 1 being a high-level output, and 0 being a low-level output.

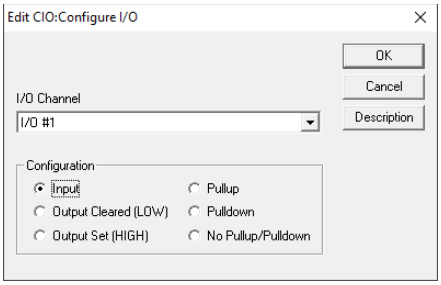
The fourth block is a second tri-state driver connected to the output pin via a 3.3k resistor. This provides the ability to have either a pull-up resistor, a pull-down resistor, or, when tristate, to disable the pull-x function, with only the ~ 200k internal light pull-up remaining. The pull-x operation is configured using the Configure I/O (CIO) command, with the added capability only present for the X-series controllers: SilverNugget X-series and SilverMax X-series.

The protector block serves several functions. For input signals, it clamps the internal voltages to approximately -0.2 and 3.5v for I/O pin voltages between -40v and +40v. This allows a 24v totem pole output from a PLC to directly interface without additional hardware. The protector also functions as a transistor in cascode connection acting as a voltage translator when in the output mode, allowing output to connect with both NPN and PNP 24v I/O up to 2mA. These connections will be covered in detail in the following pages.

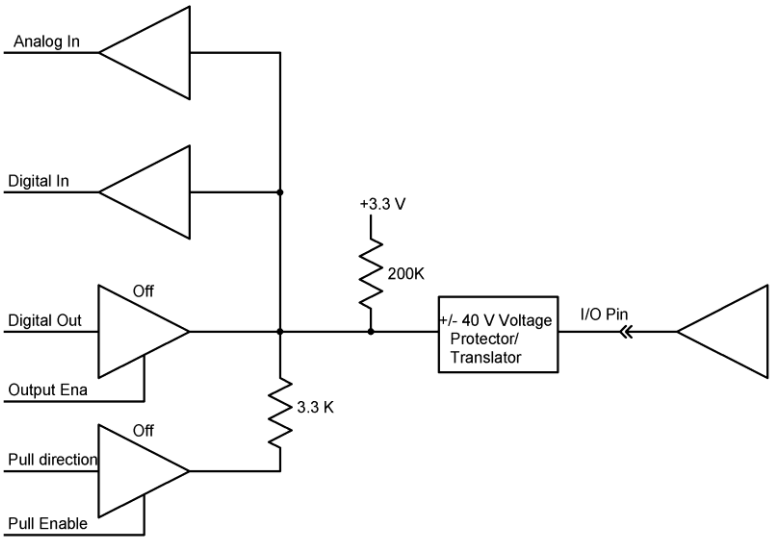
Simple Driven I/O

Simple driven input (to the controller) signals can connect directly with the I/O pins. This includes TTL, 0-12v and 0-24v inputs where the low level goes below 0.8v and both high and low directions are driven.

A Configure I/O (CIO) command may be used to set the I/O pin high or low, or to tristate for use as an input:



CIO x -1 (where x is 1 to 7) sets the main output to tristate for input mode.

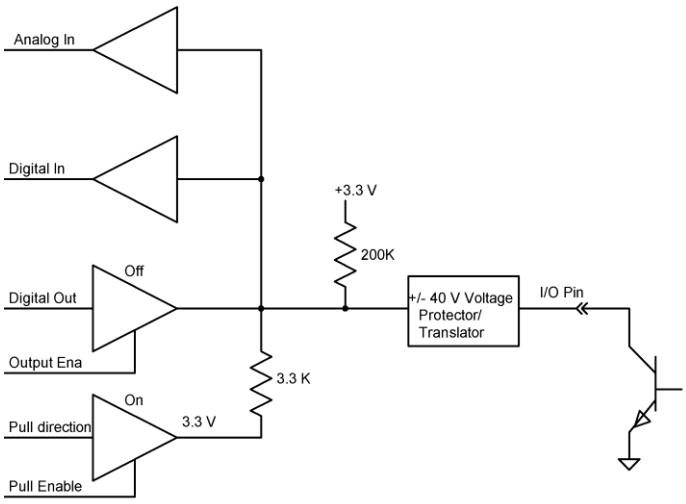


Open Collector / NPN inputs

Line# Oper	Label	Command
1:REM		Configure for Open Collector input
2:CIO		Configure "I/O #1" as Pullup
3:CIO		Configure "I/O #1" as Input

Open collector inputs to the controller require a pullup resistor. The 200k default pull-up may be a bit weak. It is suggested to use the 3.3k pull-up resistor function. This is selected by using the Configure I/O (CIO) command. The pull direction is set to high, and the pull enable is set to enable. The open collector output must pull to less than 0.8v for a reliable signal, so Darlington transistor outputs should be avoided, as their saturation voltage is near this level. If you are using Darlington optical switches, it is suggested that they be used in the PNP configuration (See next section).

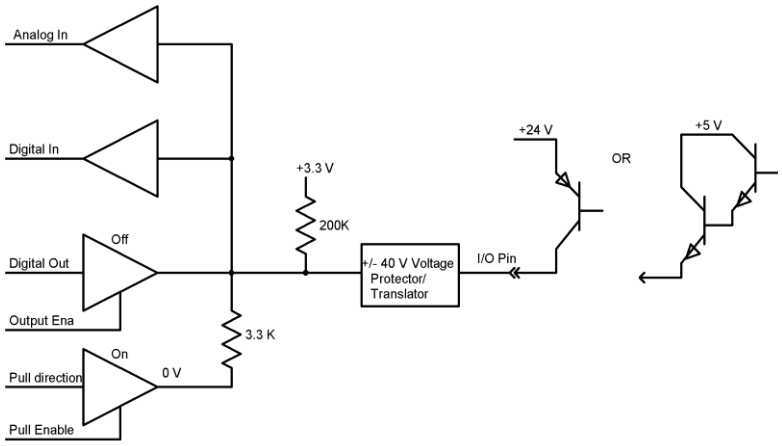
Switches and relays may also be connected using this configuration, connecting the I/O to logic ground via the switch or relay.



PNP Inputs / Pull high when active

Line# Oper	Label	Command
1:REM		Configure for Open Collector input
2:CIO		Configure "I/O #1" as Pulldown
3:CIO		Configure "I/O #1" as Input

Open emitter and PNP inputs only drive in the high direction. These signals need to have a pull-down resistor so that the internal logic level will drop to below 0.8v for a low level. The high level that drives to the input should be at least 2v to guarantee a high level is detected. The voltage protector will make the X-series tolerant of driving the inputs with up to 40v, so standard 24v PNP outputs from many PLC controllers can easily be accommodated.



Darlington style optical interrupter style switches have a saturation voltage of approximately 1.1v, which would not be adequate to generate an acceptable low voltage, but when connected to the supplied 5v power, they generate a 3.9v high level which has a nice noise margin against the 2v threshold. The voltage protector will keep the internal voltage to not more than 3.6v, while drawing 1 mA from the input when in the high driving state: between 3.3v and 40v. The pull-down resistor will keep the input pin low when the input is not being driven high.

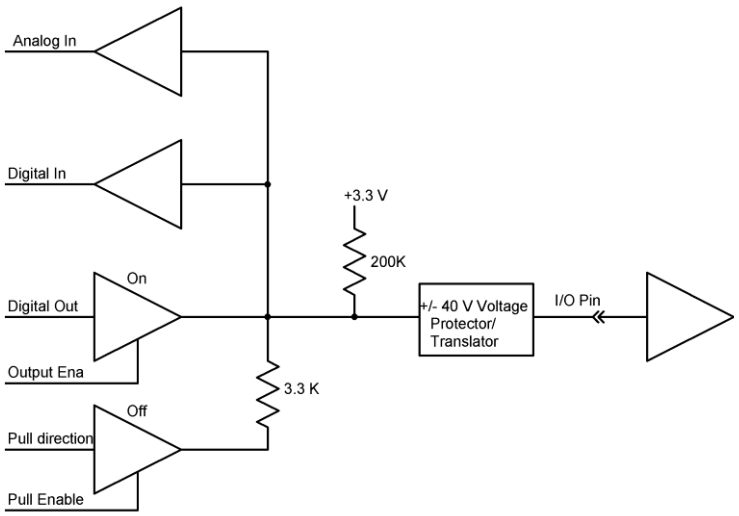
Driving 0-3.3v Outputs

Line# Oper	Label	Command
1:REM		Configure for Open Collector input
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Output and Clear(LOW)

Line# Oper	Label	Command
1:REM		Configure for Open Collector input
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Output and Set(HIGH)

The output can drive standard outputs high or low pulling in both directions. The pull-x channel normally defaults to off but is shown here explicitly as being turned off.

The CIO command can be used to drive this signal high or low. These can drive a standard TTL input.



Line# Oper	Label	Command
1:REM		Configure for Open Collector input
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Output and Clear(LOW)

Line# Oper	Label	Command
1:REM		Configure for Open Collector output
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Input

The output can be made to operate as an open collector output by turning off the pull-up/pull-down and switching between output mode and input mode (tristate).

Alternatively, you can turn the pull-up on (not shown) when operating in the open collector mode if you need a pull-up in your circuit. This can be used as an active low “OR” function where any of several modules can pull the output low, for example to signal a fault.

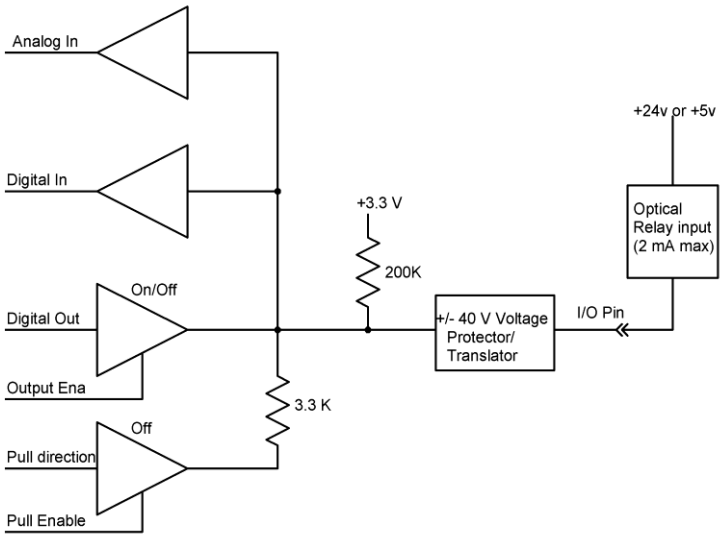
Driving higher voltage loads

Line# Oper	Label	Command
1:REM		Configure for Open Collector output
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Output and Clear(LOW)

Line# Oper	Label	Command
1:REM		Configure for Open Collector output
2:CIO		Configure "I/O #1" as No Pullup/Pulldown
3:CIO		Configure "I/O #1" as Input

Higher voltage loads, such as 24v NPN inputs or optical relays, can also be driven using the open collector modes. That is, turning off the pull-up/pull-down and driving the output either low or into tri-state by placing the I/O into input mode.

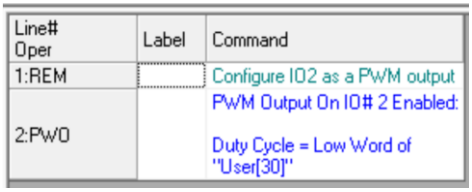
The voltage protector operates as a “cascode” transistor configuration. This configuration will keep the voltage at the internal I/O pin to between approximately 0 and 3.3v while allowing the 2mA current rating of the pin to control the output current seen at the external output pin, even if the voltage is higher, such as a 5v optical relay or a 24v input to a PLC.



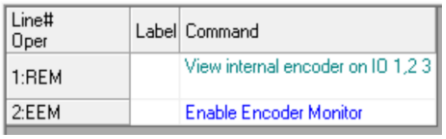
The output should be set to tri-state (input mode) so that the current on the internal side of the voltage protector drops to a low value so that the current at the output of the voltage protector will also be reduced to just leakage current.

Other Functions of the I/O

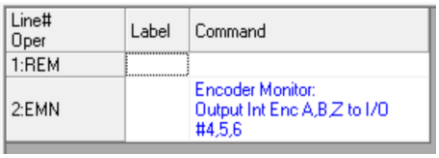
I/O #	CIO CMD	PWO CMD	EEM CMD	EMN CMD	EEM + EMN	Encoder input SEE CMD	PWM input AN067	I2C AN080	SPI TD080
1	Digital I/O		ENC A out		ENC A out				SOMI
2	Digital I/O	25 kHz PWM	ENC B out		ENC B out			SDA (Data)	CS*
3	Digital I/O		ENC Z out		ENC Z out			SLC (Clock	CLK
4	Digital I/O			ENC A out	ENC A* out	ENC A in			SIMO
5	Digital I/O			ENC B out	ENC B* out	ENC B in			
6	Digital I/O			ENC Z out	ENC Z* out	ENC Z in	PWM IN		
7	Digital I/O								



The Pulse Width Output (PWO) command configures I/O #2 as a 25kHz PWM with the duty cycle configured from either the upper or lower word of the selected register. This can be used with the analog output Breakout boards to control an analog output. The PWM dynamically varies with the register content.



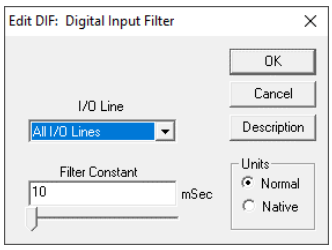
The Enable Encoder Monitor (EEM) command outputs the internal encoder signals to I/O 1, 2, and 3 for A, B, and Z signals.



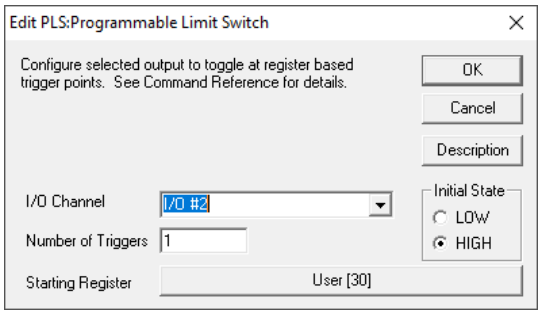
The Encoder Monitor (EMN) command outputs the internal encoder signals to I/O 4, 5, and 6. This allows you to select which set of IO you can use to monitor the internal encoder.

If both EEM and EMN are both active, then the signals to I/O 4, 5, and 6 are inverted to produce differential encoder output signals.

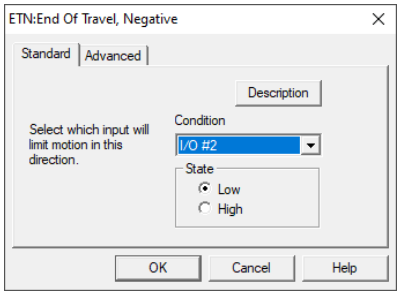
The Select External Encoder (SEE) command allows you to input an external encoder (or step and direction signal) which has the count stored to register 200 and the index stored to register 201. This may be used with the various step and direction commands or may be used for dual loop servo control in which a second encoder is placed closer to the load for higher performance.

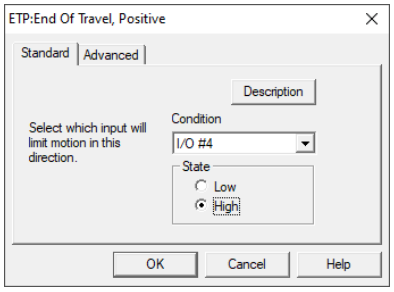


All the inputs are automatically filtered. The default is set in the initialization file, typically to 10 milliseconds to help eliminate issues with contact bounce. Each input can be separately configured to allow high speed registration to sample up to every 120µs without filtering. This filtering is not applied to PWM inputs, nor to encoder inputs which operate at much higher speeds.



The programmable limit switch can be used to automatically toggle the selected I/O by comparing the position to one or more trigger registers, with the output toggling as each threshold position is passed. The I/O toggles back when the motion is in the opposite direction. See AN050 for more details.





Any of the I/O can be used for end of travel limits, with either state being active. End of Travel Negative (ETN) sets the most negative limit, while End of Travel Positive (ETP) sets the most positive limit.

PWM inputs, compatible with the 1-2ms used for RC control are supported. See AN067 for more details.

The I/O also support I2C communications and SPI communications. See TD080 and AN080 for more information.