LogiSwitch

The Switch Debounce Company

# LS30 Rotary Encoder Switch Debounce/Noise-Rejection IC


## General Description

The LogiSwitch LS30 Rotary Encoder Switch Debounce IC utilizes LogiSwitch NoBounce™ Technology to debounce inherently noisy mechanical rotary encoders.

LogiSwitch LS30 integrated circuits (ICs) are intended for use with incremental rotary encoders. There are several underlaying implementation options for this class of encoder, including mechanical, optical, capacitive, and magnetic. The LS30 can be used with all types, but it is of special interest for mechanical encoders that can exhibit noisy signals featuring substantial amounts of switch bounce.

## Features

- Eliminates switch bounce.
- Utilizes LogiSwitch adaptive NoBounce Technology.
- Bounce-free P output indicates successful completion of a “click” cycle.
- Bounce-free D output reflects the rotational direction.
- Debounced pushbutton output
- LS30 + mechanical encoder less than half the cost of an equivalent optical encoder.
- No external components required (excluding optional decoupling capacitors).
- Low impedance 25mA totem pole outputs.
- PDIP or SOIP package options

The LS30 generates a clean Pulse (P) signal to indicate the end of a click cycle and the Direction (D) signal to indicate the rotation direction. There is also a Switch In (SI) and a corresponding debounced Switch Out (SO) in the case that the rotary encoder includes a pushbutton switch.

When using LogiSwitch LS30 integrated circuits (ICs), no pull-up resistors are required on the inputs or outputs because these elements are included inside the device. Also, no external components (like resistors and capacitors to implement RC filters) are required on the A, B, or SWI inputs.

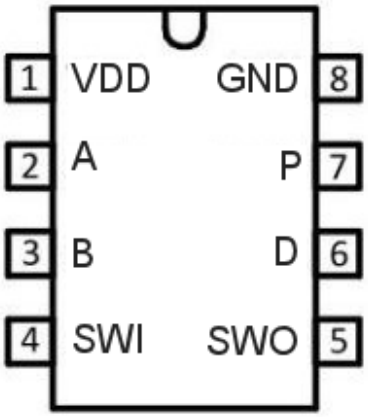
It is recommended (although not mandatory) that a 0.1µF capacitor is connected between the power and ground pins (as close to the pins as possible) to compensate for any problems in the power supply.

## Device Information

| Part Number | Package | Size Information |
|---|---|---|
| LS30-P | PDIP (8) | Plastic DIP 300 mil |
| LS30-S | SOIC (8) | Narrow SOIC 150 mil |

## Pin Description LS30

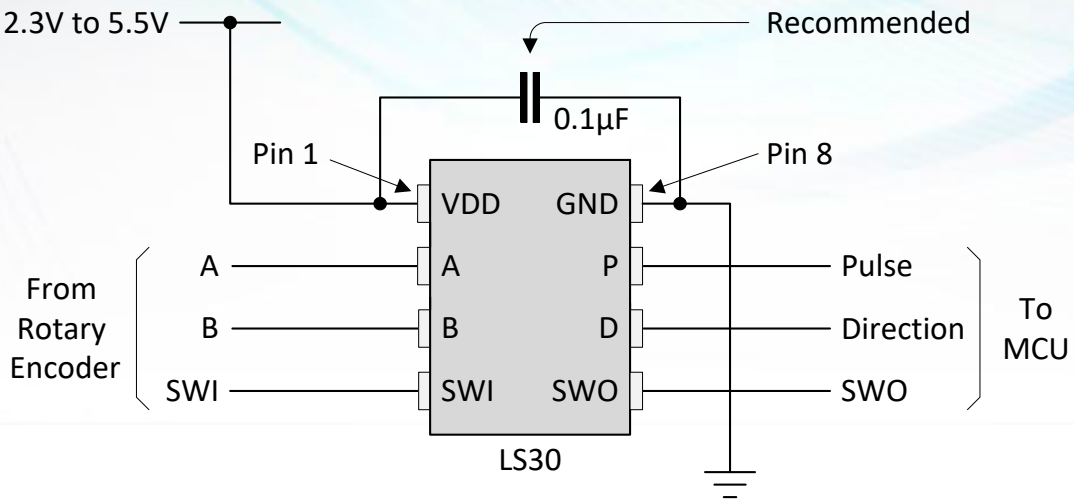
| Pin | Name | Function |
|---|---|---|
| 1 | VDD | +2.3 V to +5.5 V Supply Voltage |
| 2 | A | Normally Open Switch Input A |
| 3 | B | Normally Open Switch Input B |
| 4 | SWI | Normally Open Pushbutton Switch Input |
| 5 | SWO | Normally High Pushbutton Switch Output 2 |
| 6 | D | Direction Output (Powers Up Low) |
| 7 | P | Pulse Output (Powers Up Low) |
| 8 | VSS | Ground Reference (Switch Common) |

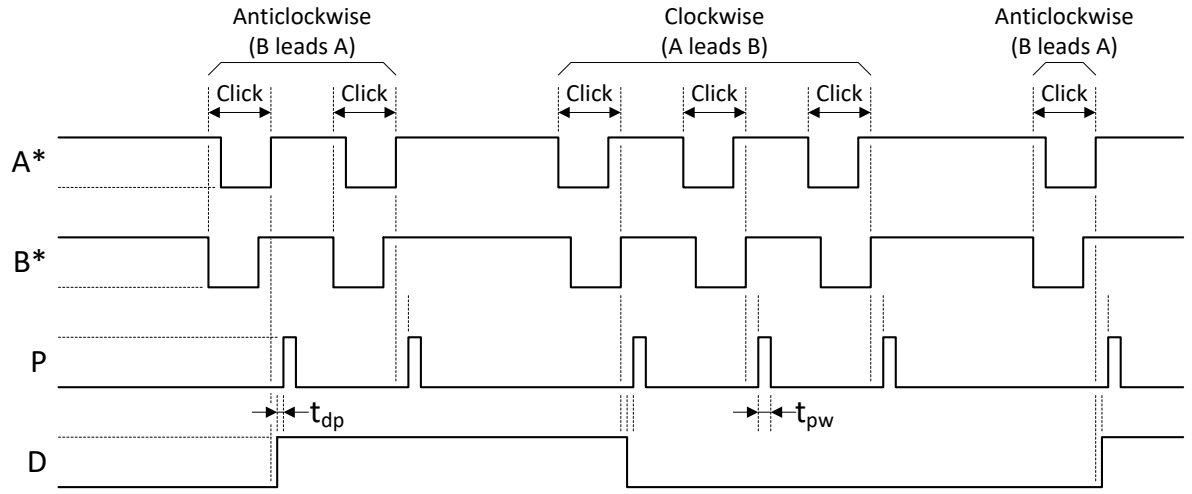


## CAD Models

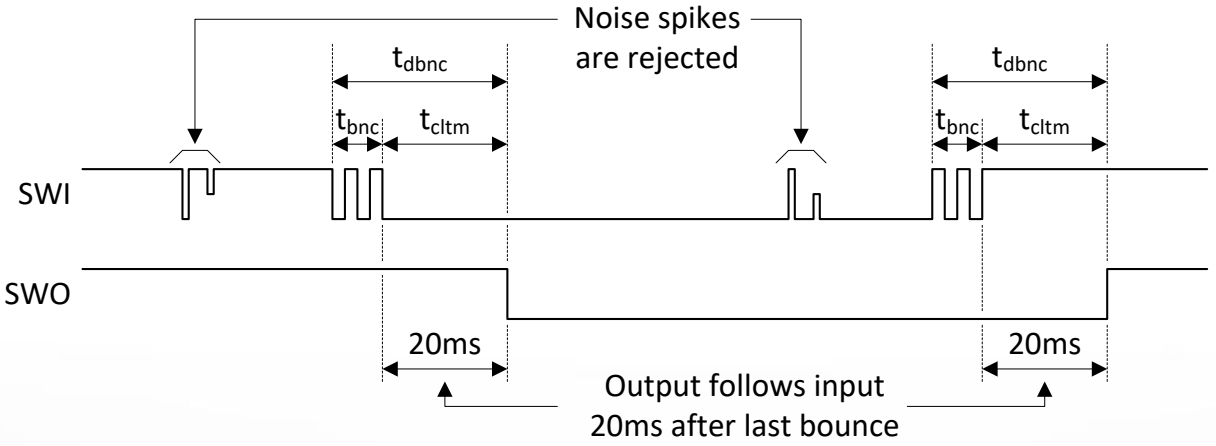
CAD models for the most popular CAD systems are available through SnapMagic as shown in the following table:

| SnapMagic | | | |
|---|---|---|---|
| **Part #** | **Function** | **Package** | **SnapMagic Link** |
| LS30-P | Rotary Encoder Debounce | 8-Pin PDIP | Link |
| LS30-S | Rotary Encoder Debounce | 8-Pin SOIC | Link |




*Switch bounce on the A and B inputs has been omitted from this diagram for reasons of clarity and simplicity.




Incremental encoders can be rotated without limit. It's up to the microcontroller (MCU) to determine what's happening and what to do. These encoders typically feature multiple detents

(24 detents for a full 360° rotation is a common number) that provide an inaudible tactile "clicking" sensation when the user rotates the knob.

In addition to their A and B outputs, many rotary encoders also feature a pushbutton switch action. This can be used by the program running of the microcontroller (MCU) for a wide variety of purposes, such as accepting the current rotational value, switching between rotational resolutions, cycling between different modes, etc.

The default states of the A and B inputs from the rotary encoder are high (11). A clockwise "click" of the encoder causes the A and B outputs to go through the sequence 11 (start), 01, 00, 10, 11 (end), with A leading B. An anticlockwise "click" of the encoder causes the A and B outputs to go through the sequence 11 (start), 10, 00, 01, 11 (end), with B leading A.

The LS30 powers up with the P (Pulse) output low and the D (Direction) output low (thereby indicating a default direction of clockwise). A high-going pulse on the P output indicates that a rotational "click" has occurred. A 0 on the D output indicates clockwise rotation; a 1 on the D output indicates anticlockwise rotation.

The P and D outputs respond at the end of a click cycle. Assuming the direction of rotation is changing, then the D (Direction) output changes first followed by the P (Pulse) output. Once the D output has been set to indicate clockwise or anticlockwise rotation, it will remain in this state until the user starts to rotate the encoder in the opposite direction.

A positive-going edge on the P signal can be used as an interrupt to the MCU. The corresponding interrupt service routine (ISR) can then check the state of the D signal. Alternatively, the program can simply poll the P signal waiting for it to change (the width of the pulses on the P signal are 5ms).

The A and B signals shown in the diagram above do not reflect any noise or switch bounce. In the case of mechanical rotary encoders, there can be a substantial amount of switch bounce on these signals. The amount of switch bounce can increase as a function of rotational speed and the age of the device. The LS30 addresses any switch bounce on the A and B inputs and generates clean signals on the P and D outputs.

The SWO (Switch Output) signal is a debounced version of the SWI (Switch Input) signal from the pushbutton switch on the encoder. The output follows the input 20ms after the final bounce (this signal behaves like one of the channels on an LS18 device; see the LS18 datasheet for more details).

## LS30 Operating Conditions

| Parameter | Min | Typ | Max | Units | Comments |
|---|---|---|---|---|---|
| Operating Temperature | -40 | | +85 | °C | |
| $t_{bnc}$ Bounce Time | 0 | ~1 | | ms | Dependent on the switch |
| $t_{cltm}$ Clean Time | 18.2 | 20.0 | 21.0 | ms | -40°C -+85°C<br>Vdd 2.5V – 5.5V |
| $t_{dbnc}$ Debounce Time | $t_{bnc}$ + $t_{cltm}$ | | | | |
| $t_{dp}$ | | 2µs | | | time from change on D to change on P |
| $t_{pw}$ | | 5ms | | | high-going pulse width on P |

## Electrical Specifications

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Operating Voltage Range | Vcc | | 2.5 | | 5.5 | V |
| Supply Current | Icc | Vcc = 3.0 V, All Inputs Open | | 1.0 | 1.6 | mA |
| Input Pull-up Current per Pin | Ipu | | 25 | 100 | 200 | µA |

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Supply current | Icc | Vcc = 3.0V, All Inputs Open | | 1 | 1.6 | mA |
| Input Pull-up Current per Pin - Switch Closed | Ipu | | 25 | 100 | 200 | uA |
| Debounce Time | $t_{dbnc}$ | Vcc = 2.5V to 5.5V | | 21 | | ms |
| Output Pin Drive Current | Iout | Source or Sink | | | 25 | mA |