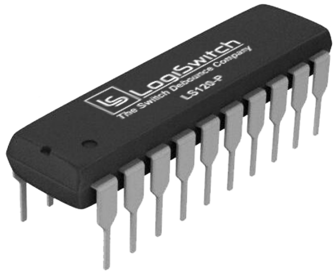
LS100 Series NoBounce ICs with Handshake



General Description

The LS100 line (LS118, LS119, and LS120) of Ultra-Fast Response Debounce ICs provides the circuit designer with the unique LogiSwitch NoBounce™ technology adaptive debounce logic and powerful handshake protocol for carefree, bounce-free, delay-free, poll-free, and external component-free operation.

Features

- Eliminates switch bounce.
- Utilizes adaptive NoBounce technology.
- Requires no external components
- Handshake protocol for efficient switch service control.
- 3/6/9 channel options.

Adaptive debounce expands the debounce cycle to fix switch bounces of any duration without the use of external passive components, calculations, or user-provided timing components. It is implemented using ultra-fast internal clocking and advanced bounce monitoring.

A feature of the LS100 Series exclusive to LogiSwitch is immediate output change with no delay on both actuation and release of the switch. The active high output mirrors the switch input in non-handshake cycles with the bounce/noise removed.

The LogiSwitch Handshake Protocol is a technique designed to transfer switch service control to the program, where it is perfectly relevant. All LogiSwitch LS100 series devices include NL/HS (Normally Low/Handshake) pins that incorporate the LogiSwitch request/acknowledge-based handshake protocol. Note that the NL/HS pins act as ordinary active-high outputs when the handshake is not utilized.

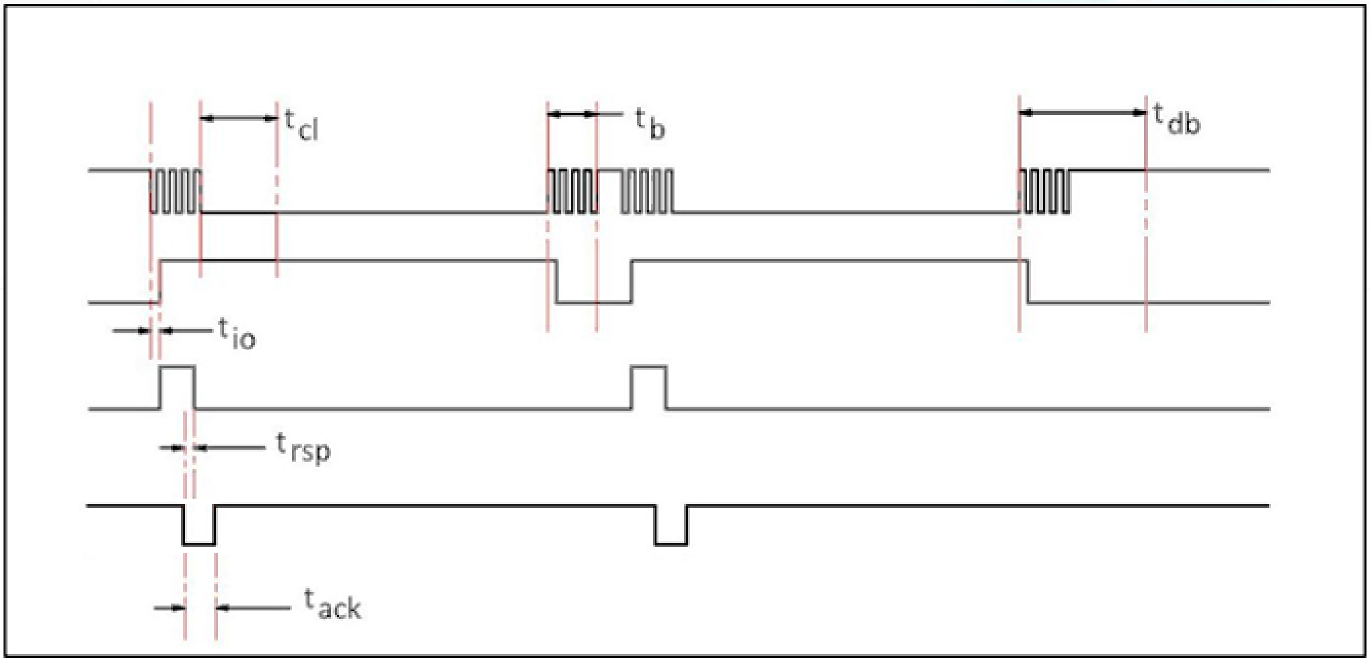
Device Information

Part Number	Channels	Package	Size Information
LS118-P	3	PDIP (8)	Plastic DIP 300 mil
LS118-S	3	SOIC (8)	Narrow SOIC 150 mil
LS119-P	6	PDIP (14)	Plastic DIP 300 mil
LS119-S	6	SOIC (14)	Narrow SOIC 150 mil
LS120-P	9	PDIP (20)	Plastic DIP 300 mil
LS120-S	9	SOIC (20)	Wide SOIC 300 mil

Pin Description

Pin			Name	Function
LS118	LS119	LS120		
1	1	1	Vdd	Supply Voltage +2.5 V to +5.5 V
8	14	20	Gnd	Ground Reference (Switch Common)
2-4	2-7	2-10	SWx	Switch Inputs - Normally Open
5-7	8-13	11-19	NL/HSx	Device Outputs - Normally Low / Handshake

Timing Waveforms



Operating Conditions

Parameter	Min	Typ	Max	Unit
Operating Temperature	-40		+85	°C
t_b Bounce time	0	1		ms
t_{db} Debounce time	$t_{db} + t_{cl}$			
t_{cl} Clean time	20	20	20	ms
t_{io} Time input to output	4	12	20	μs
t_{rsp} Response to ACK pulse	6	8	12	μs
t_{ack} ACK pulse time		5		μs

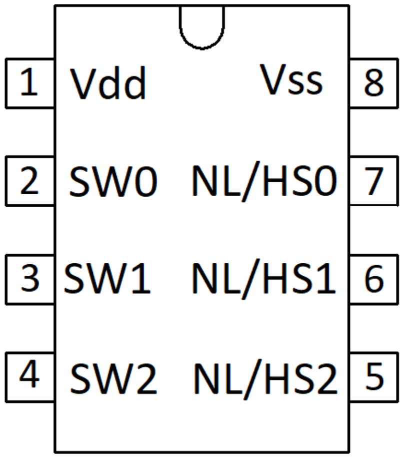
Electrical Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Operating Voltage Range	Vcc		2.5	5.5		V
Operating Temperature Range			-40		125	°C
Supply Current - LS118	Icc	Vcc = 3.0V, All Inputs Open	-	1.0	1.6	ma
Supply Current - LS119	Icc	Vcc = 3.0V, All Inputs Open		2.1	2.6	ma
Supply Current - LS120	Icc	Vcc = 3.0V, All Inputs Open		2.1	2.6	ma
Input Pull-up Current per Pin	Ipu	LS118	25	100	200	μa
Input Pull-up Current per Pin	Ipu	LS119, LS120	25	120	200	μa
Debounce Time (Internal)	tdb	Vcc = 2.5 V - 5.5 V		21		ms

Pin Description LS118

The LS118 is a three-channel IC offered in an 8-pin, 300 mil PDIP (LS118-P) or 150 mil narrow SOIC (LS118-S) package.

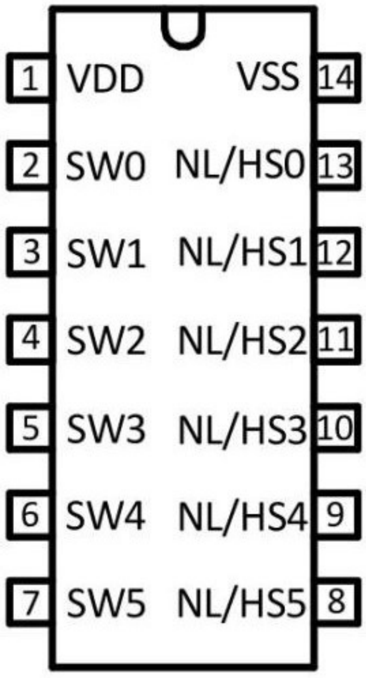
Pin	Name	Function
1	Vdd	+2.3 V to 5.5 V Supply
2	SW0	Switch Input 0
3	SW1	Switch Input 1
4	SW2	Switch Input 2
5	NL/HS2	Normally Low Output/Handshake Input 2
6	NL/HS1	Normally Low Output/Handshake Input 1
7	NL/HS0	Normally Low Output/Handshake Input 0
8	Vss	GND (Switch Common)



Pin Description LS119

The LS119 is a six-channel IC offered in a 14-pin, 300 mil PDIP (LS119-P) or 150 mil narrow SOIC (LS119-S) package.

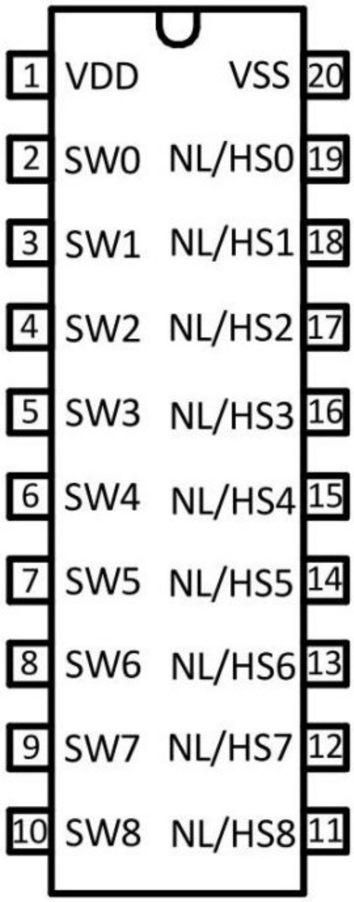
Pin	Name	Function
1	VDD	+2.3 V to +5.5 V Supply Voltage
2	SW0	Normally Open Switch Input 0
3	SW1	Normally Open Switch Input 1
4	SW2	Normally Open Switch Input 2
5	SW0	Normally Open Switch Input 3
6	SW0	Normally Open Switch Input 4
7	SW0	Normally Open Switch Input 5
8	NL/HS5	Normally Low Output/Handshake Input 5
9	NL/HS4	Normally Low Output/Handshake Input 4
10	NL/HS3	Normally Low Output/Handshake Input 3
11	NL/HS2	Normally Low Output/Handshake Input 2
12	NL/HS1	Normally Low Output/Handshake Input 1
13	NL/HS0	Normally Low Output/Handshake Input 0
14	VSS	Ground Reference (Switch Common)



Pin Description LS120

The LS120 is a nine-channel IC offered in a 20-pin, 300 mil PDIP (LS120-P) or 300 mil wide SOIC (LS120-S) package.

Pin	Name	Function
1	VDD	+2.3 V to +5.5 V Supply Voltage
2	SW0	Normally Open Switch Input 0
3	SW1	Normally Open Switch Input 1
4	SW2	Normally Open Switch Input 2
5	SW3	Normally Open Switch Input 3
6	SW4	Normally Open Switch Input 4
7	SW5	Normally Open Switch Input 5
8	SW6	Normally Open Switch Input 6
9	SW7	Normally Open Switch Input 7
10	SW8	Normally Open Switch Input 8
11	NL/HS8	Normally Low Output/Handshake Input 8
12	NL/HS7	Normally Low Output/Handshake Input 7
13	NL/HS6	Normally Low Output/Handshake Input 6
14	NL/HS5	Normally Low Output/Handshake Input 5
15	NL/HS4	Normally Low Output/Handshake Input 4
16	NL/HS3	Normally Low Output/Handshake Input 3
17	NL/HS2	Normally Low Output/Handshake Input 2
18	NL/HS1	Normally Low Output/Handshake Input 1
19	NL/HS0	Normally Low Output/Handshake Input 0
20	VSS	Ground Reference (Switch Common)



See the LS10 & LS100 Series applications note for help in locating pin 1.

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**
LS118-P	3-Channel Debounce w Handshake	8-Pin PDIP	Link
LS118-S	3-Channel Debounce w Handshake	8-Pin SOIC	Link
LS119-P	6-Channel Debounce w Handshake	14-Pin PDIP	Link
LS119-S	6-Channel Debounce w Handshake	14-Pin SOIC	Link
LS120-P	9-Channel Debounce w Handshake	20-Pin PDIP	Link
LS120-S	9-Channel Debounce w Handshake	20-Pin SOIC	Link

LS100 Series Theory of Operation

All mechanical switches are subject to a nasty little annoyance called "switch bounce". When a mechanical switch is actuated, the movable pole of the internal mechanism is forcefully snapped onto the fixed surface of a stationary throw.

The movable pole strictly adheres to the laws of physics and recoils numerous times upon each impact until it comes to rest in its new position. In nearly all cases switch bounce will cause problems in high-speed digital electronics that need to be dealt with one way or another. The LogiSwitch LS100 series provides a high output immediately upon sensing a switch closure and terminates the output immediately upon sensing the release. Switches exhibit contact bounce both when the switch is activated ("make" bounce) and when it is deactivated ("break" bounce). Debouncing eliminates all the extraneous transitions in both the make interval and the break interval that would otherwise be presented to the host computer. Note that the break debounce serves no other purpose than to assure the programmer that the current switch service routine is finished so the program will not see it as a continuation when a new switch cycle is initiated. LogiSwitch terminates NL/HS cycle immediately at the first sign of release. A new cycle is not permitted to be initiated until the break debounce interval has completed (20 milliseconds + bounce time) later. The non-handshake output of a LogiSwitch LS100 Series device is a mirror image of the raw switch input with the contact bounce removed.

Using the LogiSwitch Handshake

The NL/HS (Normally Low/HandShake) output pin for each channel is actually an I/O pin that allows bidirectional communication to/from the host computer to which it is interfaced. A request/acknowledge handshake between the LogiSwitch device and the target processor will eliminate the time wasted in polled routines and will insure against extraneous interrupts when used in interrupt service routines.

This feature transfers control of the termination of the cycle to the program rather than waiting for the switch to be released. A short 5 μs low-level acknowledgement (ACK) pulse by the connected host computer over the wired-OR NL/HS line is seen by the LogiSwitch device. The LogiSwitch device answers the ACK by latching a low level on the line to terminate the cycle. The ACK pulse from the program tells the LogiSwitch device that it has received the input and no longer needs its presence on the line. Note that the device continues to monitor the input for release of the switch, and both make and break debouncing still takes place in the background as normal. The line will accept another input after the break debounce period is timed out and 20 contiguous milliseconds of a clean high-level signal indicates a valid switch release.

After the ACK has been issued to the LogiSwitch device, the host computer can go about its business executing program code and never look back. The handshake enhances the responsiveness of so-called "polled" routines by eliminating the need for polling and thereby allowing the host to execute code throughout all the time it would have been sitting in a continuous loop waiting for release of the switch. A polled routine in a typical pushbutton application may delay the program by 200-500 milliseconds or longer waiting for switch release, during which time as many as 800,000 to 2 million instructions would have been executed by a moderate speed 16 MHz 8-bit PIC processor. Numerous operational advantages are also gained when the handshake is utilized in interrupt-driven applications, some of which may be seen in the "LogiSwitch No Bounce IC Applications Examples."

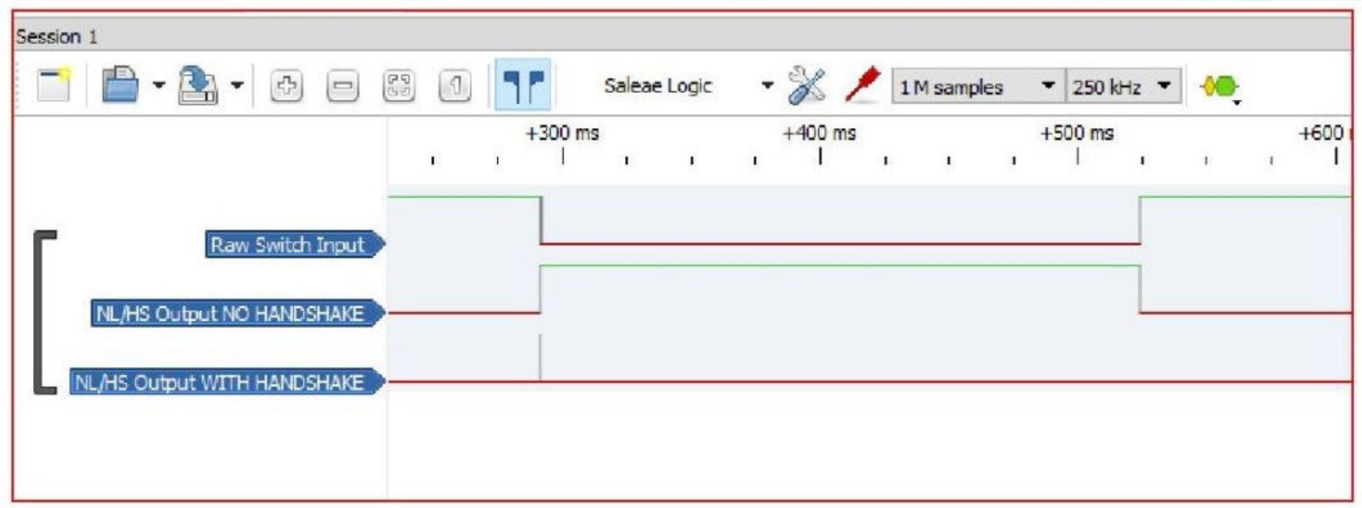


Figure 1. LS100 Series Logic Analyzer Capture of Switch Cycle With/Without Handshake

Figure 1 shows the input/output timing of an NL/HS output of a full switch cycle without the handshake vs. the 5 μs – 15 μs response of the LogiSwitch handshake feature. The device terminates the cycle within 20 μs of receipt of an ACK pulse.

Note the immediate response of the NL/HS pin in the "no handshake" cycle timing shown in this capture. A mirrored image follows the raw switch input on the NL/HS pin without the bounce.

Figure 2. Handshake timing with respect to 816 µs "Make" bounce.

This zoomed-in logic analyzer view shows the response of a cycle taking advantage of the powerful handshake feature of the LogiSwitch LS100 Series devices compared to a bounce duration of 816 µs. Typical response time from LS100 series is 3 µs after the host computer responds to the active high signal from the device.

Test for switch a service request in the main loop. If the NL/HS line is high, the switch has become active. If not, continue with the main loop until the next time through.

Okay, it is active. To acknowledge that we have received the request, we will send a pulse back to the LogiSwitch device.

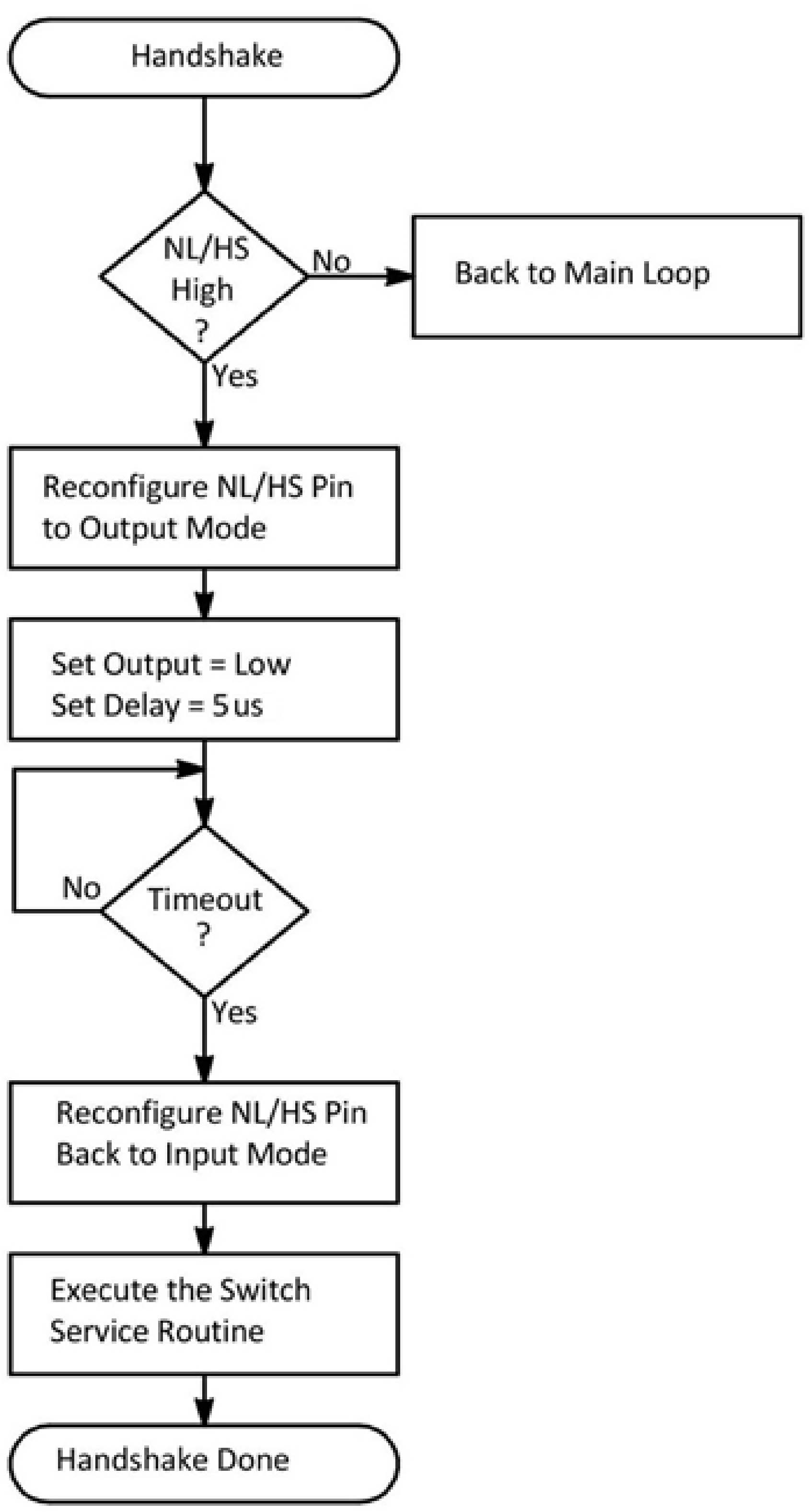
First, we set the NL/HS pin to output mode, then make it low.

Now we set a 5 µs delay to allow time for the LogiSwitch device to recognize our acknowledgement.

Has the delay timed out yet?

Timeout done. Now we want to go back to input mode. The LogiSwitch device has already seen the acknowledge pulse and has latched the line out low to end the cycle without the need for release of the switch. Note that another cycle will not be initialized until the switch has been released and its output debounced.

Now we are all done with this cycle. We can execute our switch service routine and go back to executing code in the main loop. The LogiSwitch device will determine when the switch has been released and debounced, so the next switch cycle may be initiated.



Software – Implementing the Handshake with an Arduino

The following few lines of code for an Arduino Uno demonstrate the simplicity of a host computer interface using the LogiSwitch handshake.

```
// *********************************************************************
// This code snippet for Arduino Uno demonstrates the single-pin handshake
// protocol of the LogiSwitch LS1xx-Series Switch Debouncer ICs
// *********************************************************************

int NL_HS = 8; // Define the pin(s)

void setup ()
{
    // Start with the NL_HS request-acknowledge pin configured as an input
    pinMode(NL_HS, INPUT);
}

void loop()
{
    // Place this code at the appropriate place in the main loop
    if (digitalRead(NL_HS) == HIGH) // Is switch active?
    {
        pinMode(NL_HS, OUTPUT);   // Yes, respond with handshake
        digitalWrite(NL_HS, LOW); // Acknowledge with a 5 µs low pulse
        delayMicroseconds(5);
        pinMode(NL_HS, INPUT);    // Return to input mode

        // The switch service routine or function call goes here
    }
}
```