

# MAX16151

# High Voltage Pushbutton On/Off Controller

## General Description

The MAX16151 is a high voltage, pushbutton on/off controller with a switch debouncer and built-in latch. This device accepts a noisy input from a mechanical switch and produces a clean, latched output, as well as a one-shot interrupt output, in response to a switch closure exceeding the debounce period at  $\overline{\text{PB\_IN}}$ . A switch closure longer than the shutdown period at  $\overline{\text{PB\_IN}}$  results in a longer one-shot interrupt output. The MAX16151 family has two sets of devices: one in which a longer switch closure greater than the shutdown period deasserts the latched output, and another in which the latched output stays asserted. See Table 1 for more information.

The MAX16151 operates from a supply range of +5V to +36V and consumes less than 15 $\mu$ A of supply current to ensure minimal battery current in low-power applications. The robust switch input ( $\overline{\text{PB\_IN}}$ ) handles  $\pm 60$ V levels and is  $\pm 10$ kV electrostatic discharge (ESD) protected for use in harsh industrial environments. The 3V regulated latched output can serve as a logic signal to control a pass transistor or voltage regulator. A separate  $\overline{\text{INT}}$  output provides a system interrupt whenever a valid pushbutton signal is detected. An asynchronous  $\overline{\text{CLR}}$  input allows an external signal to force the latched output to the OFF state. The MAX16151 operates over the -40°C to +125°C temperature range and is available in a 1.23mm x 0.83mm, 6-bump wafer-level package (WLP), and a 6-pin thin SOT23 package.

## Applications

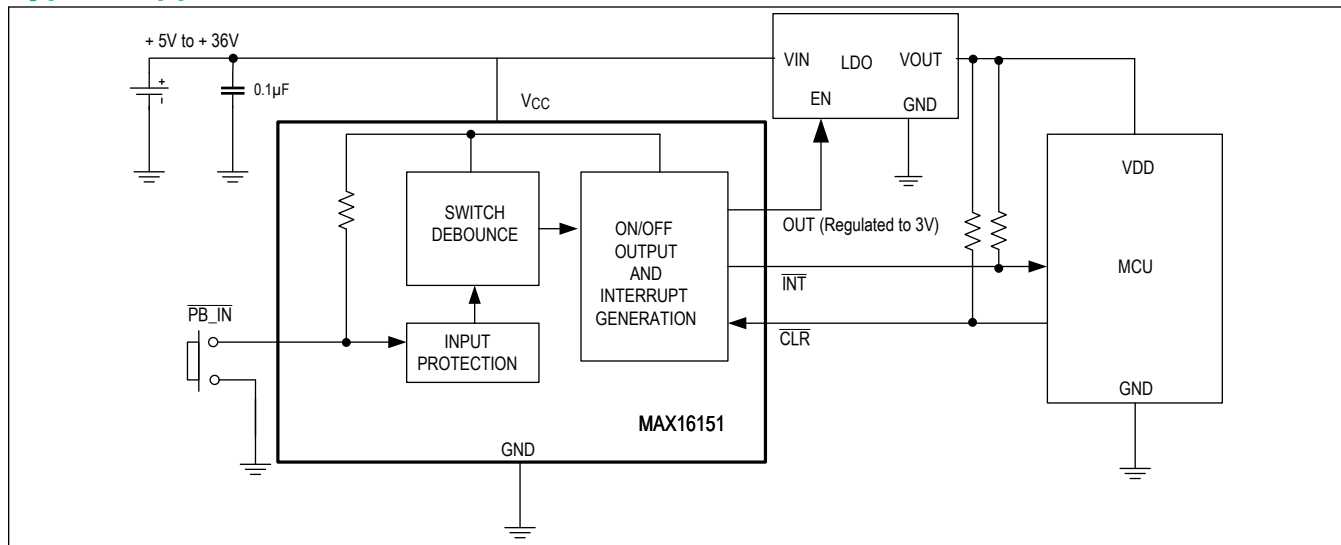
- Portable Instruments
- Industrial Equipment
- Desktop and Notebook Computers
- Telecommunication and Servers

## Benefits and Features

- Up to +36V Operating Range
- 3.0V Regulated Latched Output
- 10 $\mu$ A Standby Current (ISB)
- Debounces Noisy Switches
  - 50ms and 2s Debounce Timing Options
  - 8s and 16s Shutdown Periods
- One-shot  $\overline{\text{INT}}$  Output on Each Switch Closure
- 32ms  $\overline{\text{INT}}$  Duration
- Pushbutton Input Handle Up to  $\pm 60$ V
- $\pm 10$ kV HMB ESD Protection
- 6-pin SOT23 and 1.23mm x 0.83mm, 6-bump WLP
- -40°C to +125°C Operating Temperature Range

[Ordering Information](#) appears at end of data sheet.

Typical Application Circuit



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## Absolute Maximum Ratings

$V_{CC}$ to GND .....	-0.3V to +40V	Continuous Power Dissipation (6 WLP, Multilayer Board) ( $T_A = +70^\circ\text{C}$ , derate 10.50mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ .) .....	840mW
PB_IN to GND .....	-60V to +60V	Operating Temperature Range .....	$-40^\circ\text{C}$ to $+125^\circ\text{C}$
CLR, INT, OUT to GND .....	-0.3V to 6V	Junction Temperature .....	$+150^\circ\text{C}$
Continuous Power Dissipation (6 SOT23, Single Layer Board) ( $T_A = +70^\circ\text{C}$ , derate 8.70mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ .) .....	696mW	Storage Temperature Range .....	$-40^\circ\text{C}$ to $+150^\circ\text{C}$
		Soldering Temperature (reflow) .....	$+260^\circ\text{C}$

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## Package Information

### 6 SOT23

Package Code	U6+1
Outline Number	<a href="#">21-0058</a>
Land Pattern Number	<a href="#">90-0175</a>
<b>Thermal Resistance, Single Layer Board:</b>	
Junction to Ambient ( $\theta_{JA}$ )	N/A
Junction to Case Thermal Resistance ( $\theta_{JC}$ )	80 $^\circ\text{C}/\text{W}$
<b>Thermal Resistance, Four Layer Board:</b>	
Junction to Ambient ( $\theta_{JA}$ )	115 $^\circ\text{C}/\text{W}$
Junction to Case Thermal Resistance ( $\theta_{JC}$ )	80 $^\circ\text{C}/\text{W}$

### 6 WLP

Package Code	W60C1+2
Outline Number	<a href="#">21-100258</a>
Land Pattern Number	Refer to <a href="#">Application Note 1891</a>
<b>Thermal Resistance, Four-Layer Board:</b>	
Junction to Ambient ( $\theta_{JA}$ )	95.15 $^\circ\text{C}/\text{W}$
Junction to Case Thermal Resistance ( $\theta_{JC}$ )	N/A

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

## Electrical Characteristics

( $V_{CC} = V_{MIN}$  to  $V_{MAX}$ ,  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , Typical values are at  $T_A = +25^\circ\text{C}$  and  $V_{CC} = +24\text{V}$ . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design, test, and characterization.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Voltage Range	$V_{CC}$		5		36	V

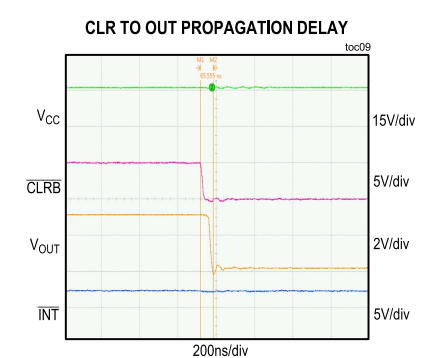
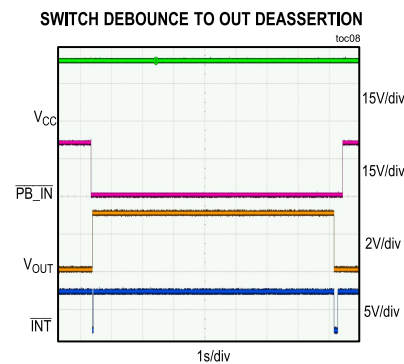
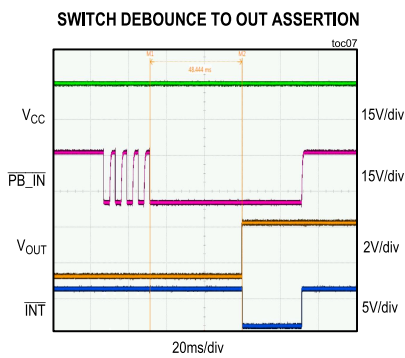
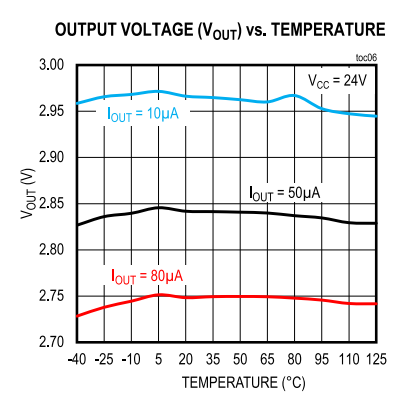
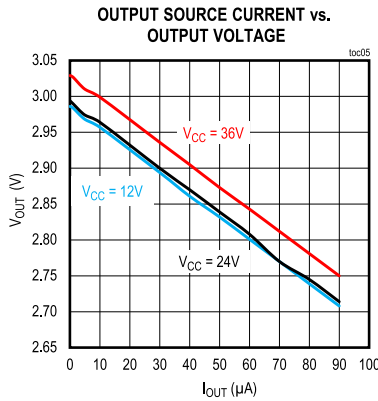
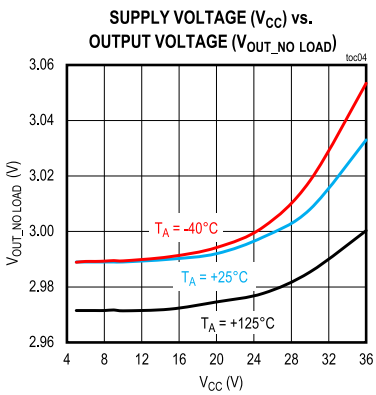
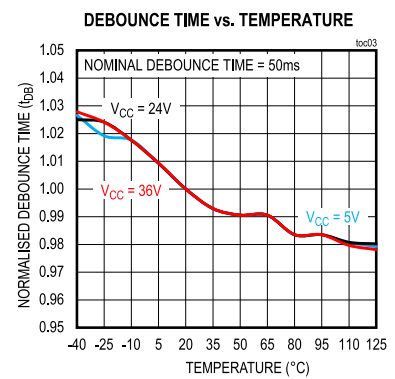
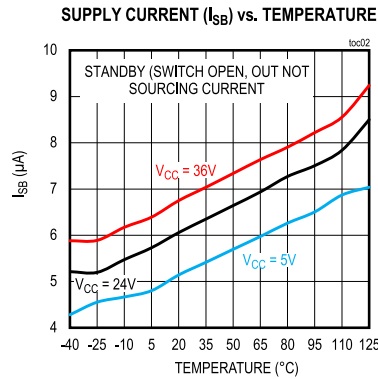
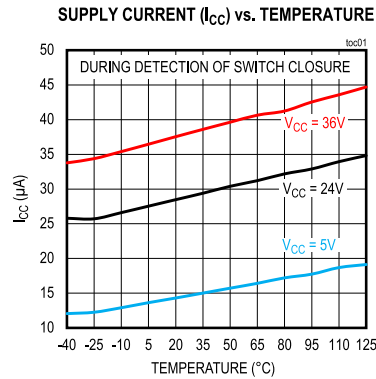
### Electrical Characteristics (continued)

( $V_{CC} = V_{MIN}$  to  $V_{MAX}$ ,  $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , Typical values are at  $T_A = +25^{\circ}\text{C}$  and  $V_{CC} = +24\text{V}$ . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design, test, and characterization.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply Current	$I_{SB}$	$V_{CC} = 36\text{V}$ , OUT not asserted, $\overline{\text{PB\_IN}}$ not connected. $-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$		10	15	$\mu\text{A}$
	$I_{CC}$	$V_{CC} = 36\text{V}$ , $I_{OUT} = 0$ ; During $\overline{\text{PB\_IN}}$ detection or INT assertion		40		$\mu\text{A}$
Timing Accuracy		Deviation from nominal value of debounce time ( $t_{DB}$ ), shutoff time ( $t_{SO}$ ), and interrupt time ( $t_{INT}$ )	-20	$\pm 5$	+20	%
Input High Voltage	$V_{IH}$	$\overline{\text{CLR}}$ and $\overline{\text{PB\_IN}}$	1.7			V
Input Low Voltage	$V_{IL}$	$\overline{\text{CLR}}$ and $\overline{\text{PB\_IN}}$			0.7	V
Minimum Input High Time Detected		$\overline{\text{PB\_IN}}$		600		$\mu\text{s}$
$\overline{\text{PB\_IN}}$ Hysteresis				100		mV
$\overline{\text{PB\_IN}}$ Pullup Resistance			500	1000	1500	$\text{k}\Omega$
$\overline{\text{PB\_IN}}$ Input Current	$I_{IN}$	$V_{\overline{\text{PB\_IN}}} = \pm 60\text{V}$	-170		+170	$\mu\text{A}$
$\overline{\text{PB\_IN}}$ Voltage Range		Continuous; $0\text{V} \leq V_{CC} \leq 36\text{V}$	-60		+60	V
		Transient; $0\text{V} \leq V_{CC} \leq 36\text{V}$	-60		+60	
$\overline{\text{CLR}}$ Input Current	$I_{CLR}$		-100		+100	nA
$\overline{\text{CLR}}$ Falling Edge to OUT Low Propagation Delay	$t_{CO}$	$R_L = 10\text{k}\Omega$ , $C_L = 100\text{pF}$			200	ns
$\overline{\text{CLR}}$ Lockout Time		Period following rising edge of OUT during which transitions on $\overline{\text{CLR}}$ are ignored.	$1.6 \times t_{INT}$	$2 \times t_{INT}$	$2.4 \times t_{INT}$	ms
OUT Output Voltage	$V_{OL}$	$I_{SINK} = 1.6\text{mA}$			0.4	V
	$V_{OH}$	$I_{SOURCE} = 50\mu\text{A}$	2.7			
OUT Output Voltage (DC)	$V_{OH}$	$+5 \leq V_{CC} \leq +36$ , $I_{OUT} = 0$		3		V
$\overline{\text{INT}}$ Output Voltage	$V_{OL\_INT}$	$I_{SINK} = 1\text{mA}$			0.2	V
$\overline{\text{INT}}$ Leakage Current			-100		+100	nA
Interrupt Pulse Duration	$t_{INT}$	Beginning at $t_{DB}$	25.6	32	38.4	ms
		Beginning at end of $t_{SO}$	102.4	128	153.6	
$\overline{\text{PB\_IN}}$ ESD Protection		Human Body Model		$\pm 10$		kV

Typical Operating Characteristics

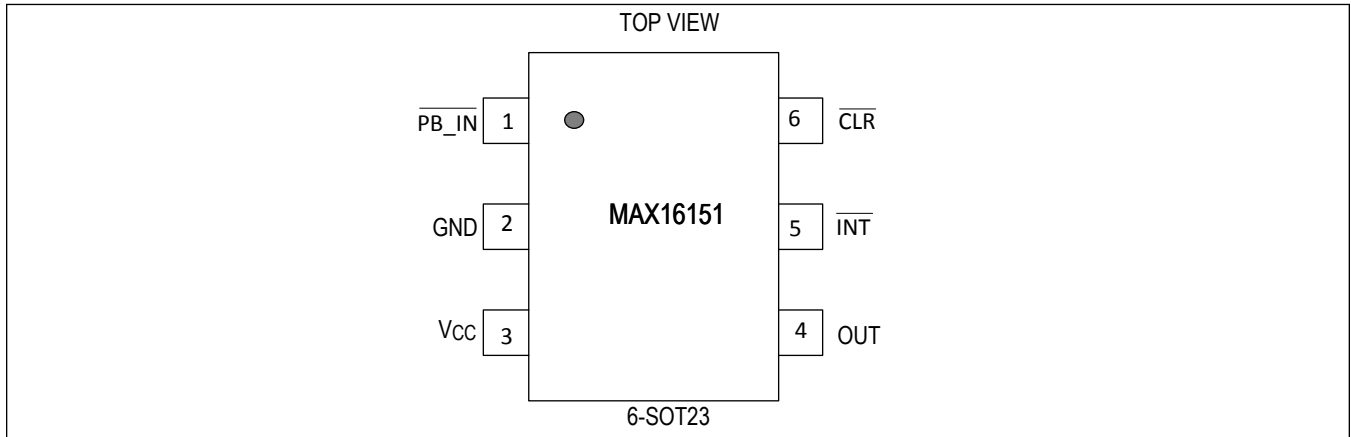
( $V_{CC} = +24V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.)



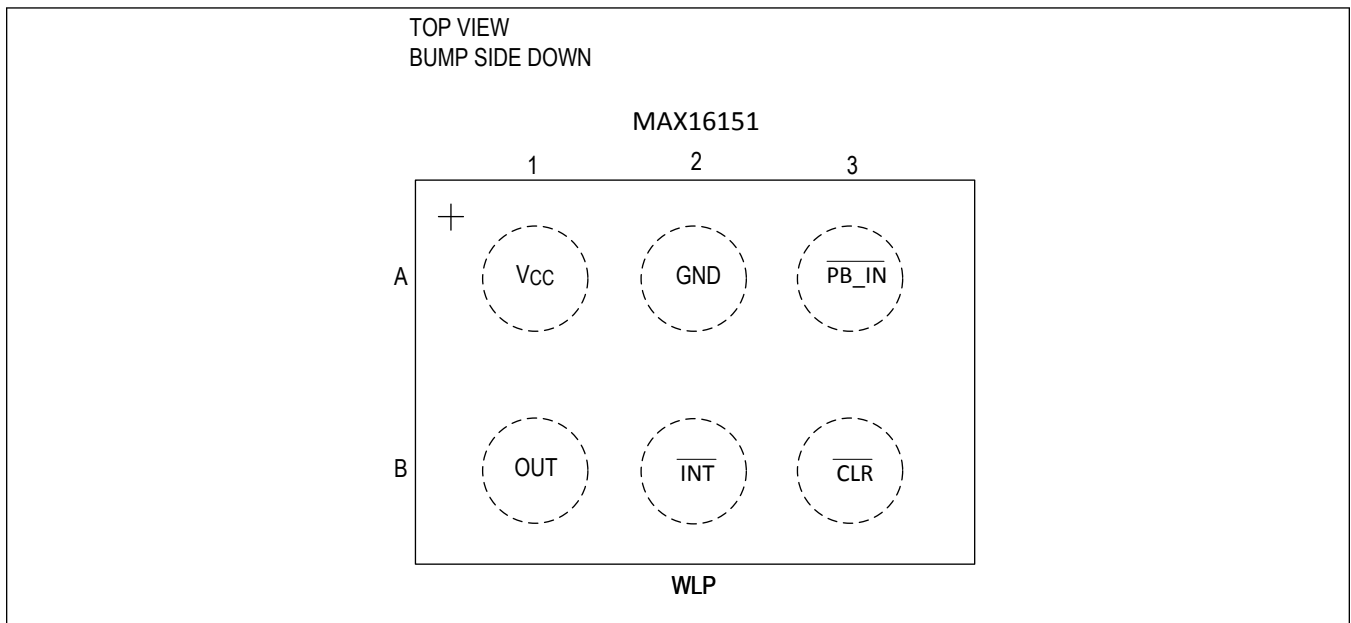


### Pin Configurations

#### SOT23-6



#### 6 WLP



### Pin Description

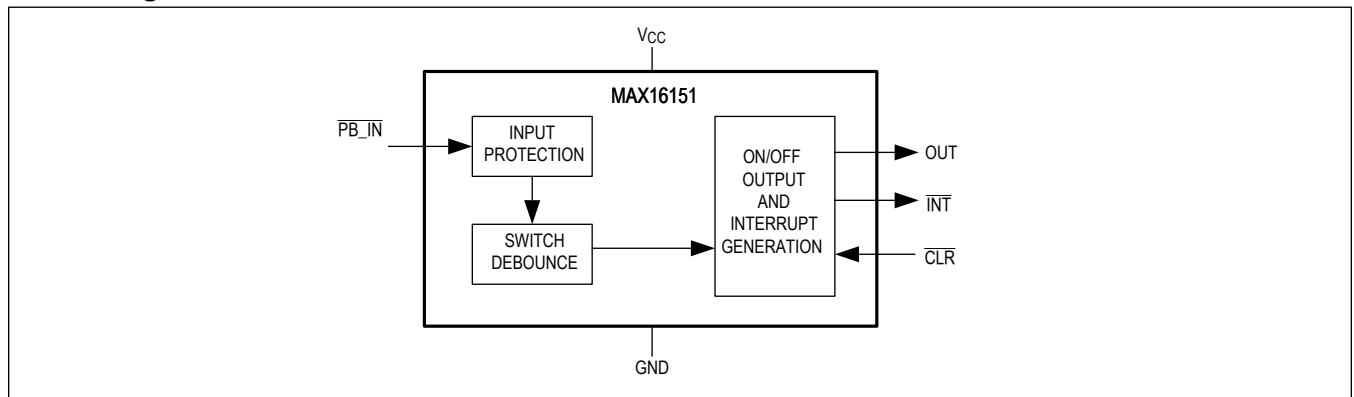
PIN		NAME	FUNCTION
SOT23-6	6 WLP		
3	A1	V <sub>CC</sub>	Power supply input. Bypass with a 0.1µF capacitor to ground.
2	A2	GND	Ground.

Pin Description (continued)

PIN		NAME	FUNCTION
SOT23-6	6 WLP		
1	A3	$\overline{\text{PB\_IN}}$	Pushbutton Input. $\overline{\text{PB\_IN}}$ is internally pulled up to $V_{\text{CC}}$ . Holding $\overline{\text{PB\_IN}}$ low for a period greater than the debounce time ( $t_{\text{DB}}$ ) forces $\text{OUT}$ to latch high and generate a one-shot pulse at $\overline{\text{INT}}$ . A MAX16151 $\overline{\text{PB\_IN}}$ switch closure longer than the shutdown period results in a longer one-shot pulse at $\overline{\text{INT}}$ . The MAX16151A deasserts the latched output when the switch closure period exceeds the shutdown period, while the MAX16151B does not deassert the latched output.
6	B3	$\overline{\text{CLR}}$	Clear input. Pulling $\overline{\text{CLR}}$ low deasserts the latched $\text{OUT}$ signal. If $\text{OUT}$ is deasserted, pulling $\overline{\text{CLR}}$ does not change $\text{OUT}$ 's state.
5	B2	$\overline{\text{INT}}$	Active-Low, Open-Drain Interrupt Output. $\overline{\text{INT}}$ is a one-shot output pulse. $\overline{\text{INT}}$ asserts for the interrupt timeout period when $\overline{\text{PB\_IN}}$ is held low for a period greater than the debounce time ( $t_{\text{DB}}$ ). $\overline{\text{INT}}$ is high impedance when deasserted, even when pulled up to external voltage.
4	B1	$\text{OUT}$	Active-High, Push-Pull Latch Output. The $\text{OUT}$ is internally connected to a 3V regulator.

Functional Diagrams

Block Diagram



### Detailed Description

The MAX16151 is a pushbutton on/off controller with a switch debouncer and latched output for controlling system power. A switch closure that pulls  $\overline{\text{PB\_IN}}$  low and is stable for a period greater than or equal to the debounce time ( $t_{\text{DB}}$ ) causes OUT to assert high. Driving  $\overline{\text{CLR}}$  low causes OUT to deassert. For the MAX16151A, a switch closure period greater than or equal to the shutdown period ( $t_{\text{SO}}$ ) causes OUT to deassert. Each debounced switch closure also initiates a one-shot  $\overline{\text{INT}}$  output. See Table 1 for details on the values of  $t_{\text{DB}}$ ,  $t_{\text{SO}}$ , and other timing intervals.

**Table 1. MAX16151 Input Timing Characteristics**

VERSION*	DEBOUNCE TIME ( $t_{\text{DB}}$ )	SHUTDOWN PERIOD ( $t_{\text{SO}}$ )	INTERRUPT PERIOD (SWITCH CLOSURE > $t_{\text{DB}}$ )	INTERRUPT PERIOD (SWITCH CLOSURE > $t_{\text{SO}}$ )	SWITCH CLOSURE > $t_{\text{SO}}$
MAX16151A	50ms	8s	32ms	128ms	OUT de-asserts
MAX16151B	2s	16s	32ms	128ms	OUT stays asserted

\*Versions with different combinations of timing parameters are available. Contact factory for availability.

### MAX16151 Operation

The MAX16151 operates from supply voltages between +5V and +36V. The pushbutton input is active-low. While awaiting a switch closure when OUT is deasserted, the power supply current is less than 15 $\mu\text{A}$ . After asserting OUT,  $\overline{\text{CLR}}$  continues to be ignored for  $\overline{\text{CLR}}$  lockout time (2x of the  $\overline{\text{INT}}$  period). If OUT is already deasserted when  $\overline{\text{CLR}}$  is pulled low the state of OUT is unchanged.  $\overline{\text{CLR}}$  input will not affect the  $\overline{\text{INT}}$ . Each debounced switch closure causes  $\overline{\text{INT}}$  to assert a switch closure longer than  $t_{\text{SO}}$  results in  $\overline{\text{INT}}$ , asserting for a period that is 4 times longer than the nominal  $\overline{\text{INT}}$  period. This longer  $\overline{\text{INT}}$  can be used to signal the system to perform a specific function or to initiate a shutdown process. Closing the switch longer than this extended  $\overline{\text{INT}}$  period does not cause further assertion of  $\overline{\text{INT}}$ .

The MAX16151A deasserts OUT when  $\overline{\text{PB\_IN}}$  is held low for a period equal to or greater than the shutdown time,  $t_{\text{SO}}$ . Holding  $\overline{\text{PB\_IN}}$  low for a duration less than  $t_{\text{SO}}$  does not deassert OUT. In the MAX16151B, holding  $\overline{\text{PB\_IN}}$  low for a period of equal to or greater than  $t_{\text{SO}}$  does not deassert OUT.

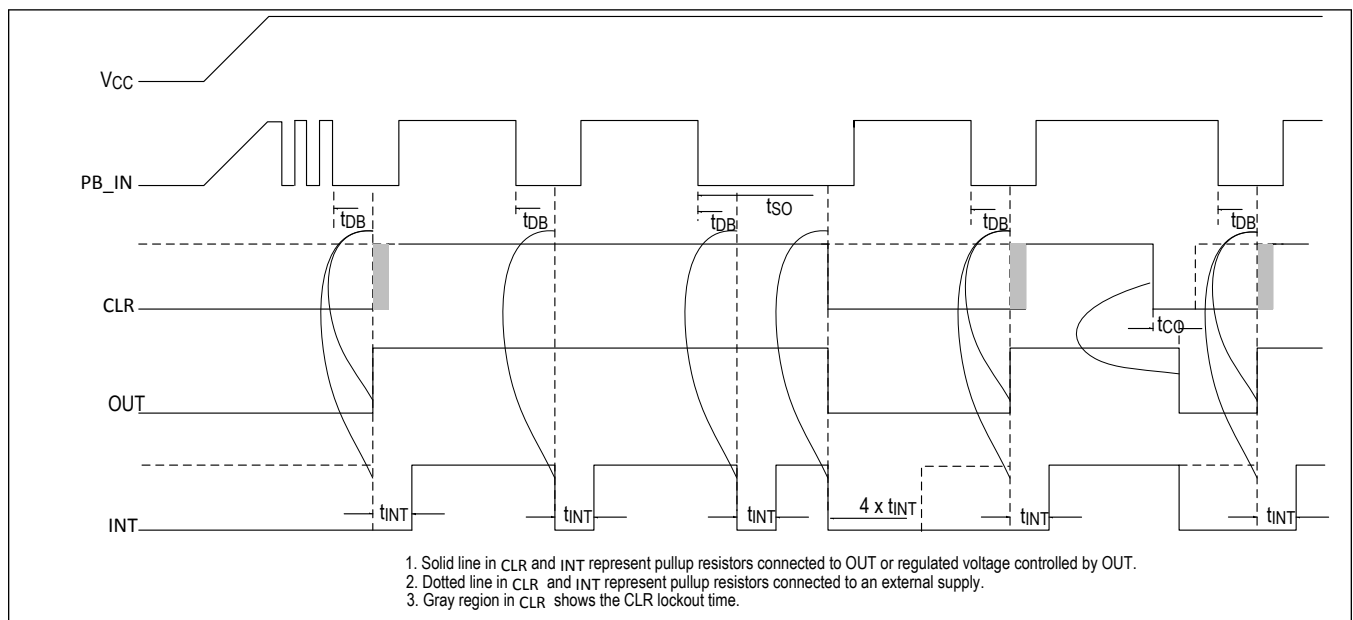


Figure 1. MAX16151A Timing Diagram with Long Pushbutton ( $t_{\text{SO}}$ ) Causes OUT to Deassert

In the MAX16151A diagram above (Figure 1), a switch closure of a duration greater than  $t_{\text{DB}}$  causes OUT to assert. A

switch closure of a duration greater than  $t_{SO}$  causes OUT to deassert. Typically,  $\overline{INT}$  and  $\overline{CLR}$  are pulled up either to OUT or to a regulated voltage controlled by OUT, as depicted in the MAX16151B diagram below (Figure 2). As such, INT and CLR are pulled low while OUT is deasserted. If INT and CLR are pulled up to a constant supply voltage, they behave as shown by the horizontal dashed lines while OUT is deasserted.

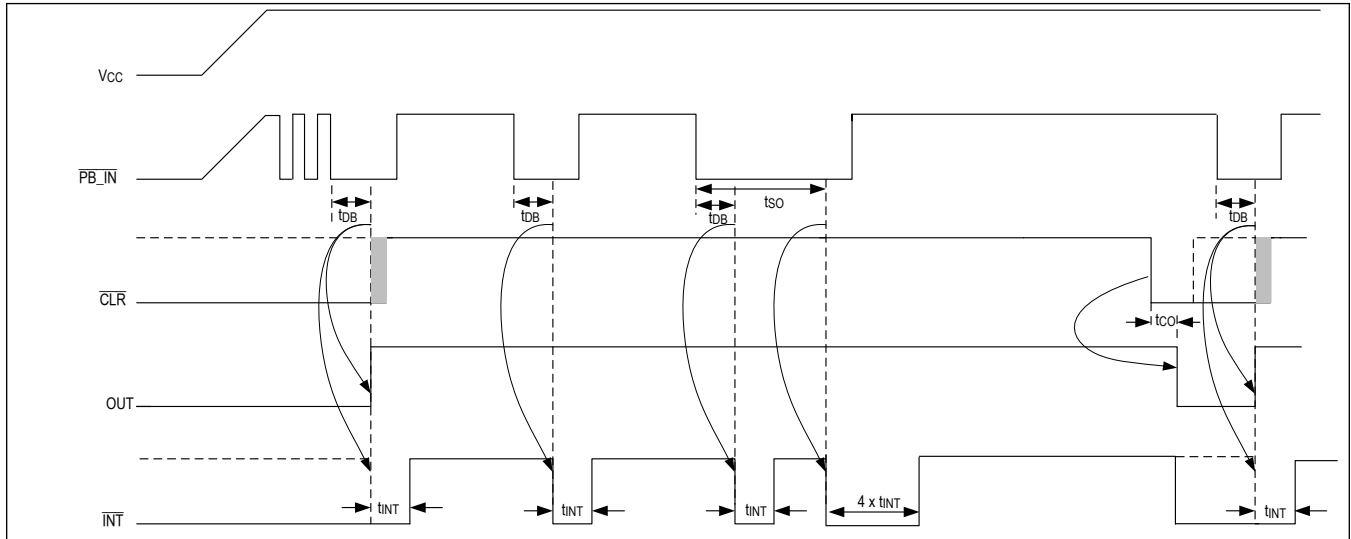


Figure 2. MAX16151B Timing Diagram with Long Pushbutton ( $t_{SO}$ ) Keeps OUT Asserted

In the MAX16151B diagram above (Figure 2), a switch closure of a duration greater than  $t_{DB}$  causes OUT to assert. A switch closure of a duration greater than  $t_{SO}$  does not cause OUT to deassert but does cause an extended interrupt.

### Robust Switch Input

The switch input ( $\overline{PB\_IN}$ ) includes overvoltage clamping diodes to protect against damaging fault conditions. Switch input voltages can safely swing  $\pm 60V$  relative to ground.

### $\pm 10kV$ ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The MAX16151 includes additional protection against static electricity to protect against ESD of  $\pm 10kV$  at the switch input. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. A design advantage of these devices is that they continue working without latchup after an ESD event, which eliminates the need to power-cycle the device. ESD protection can be tested in various ways; this product is characterized for protection of  $\pm 10kV$  using the Human Body Model.

### Human Body Model

Figure 3 shows the Human Body Model, while Figure 4 shows the current waveform it generates when discharged into a low-impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5k $\Omega$  resistor.

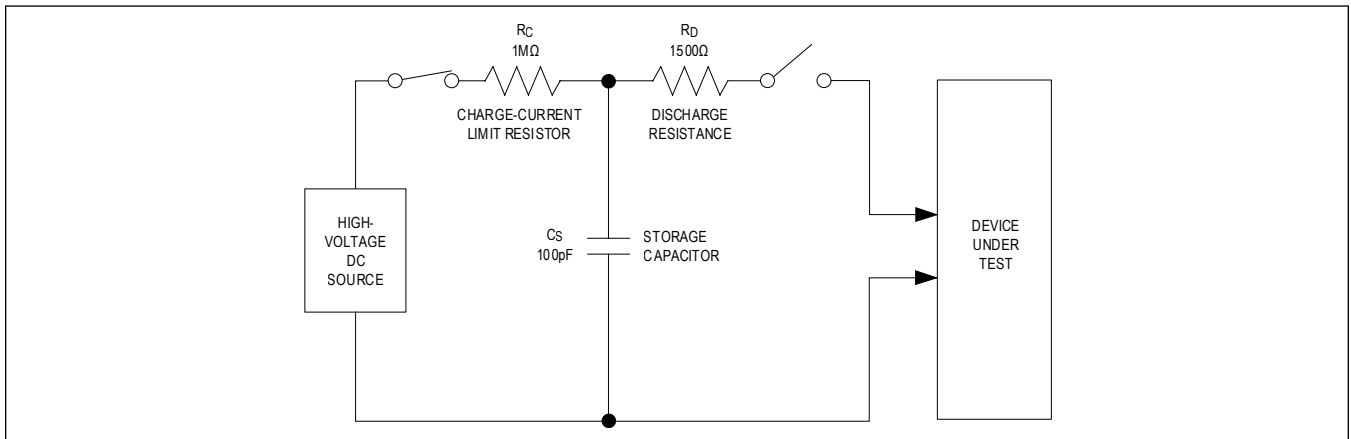


Figure 3. Human Body ESD Test Model

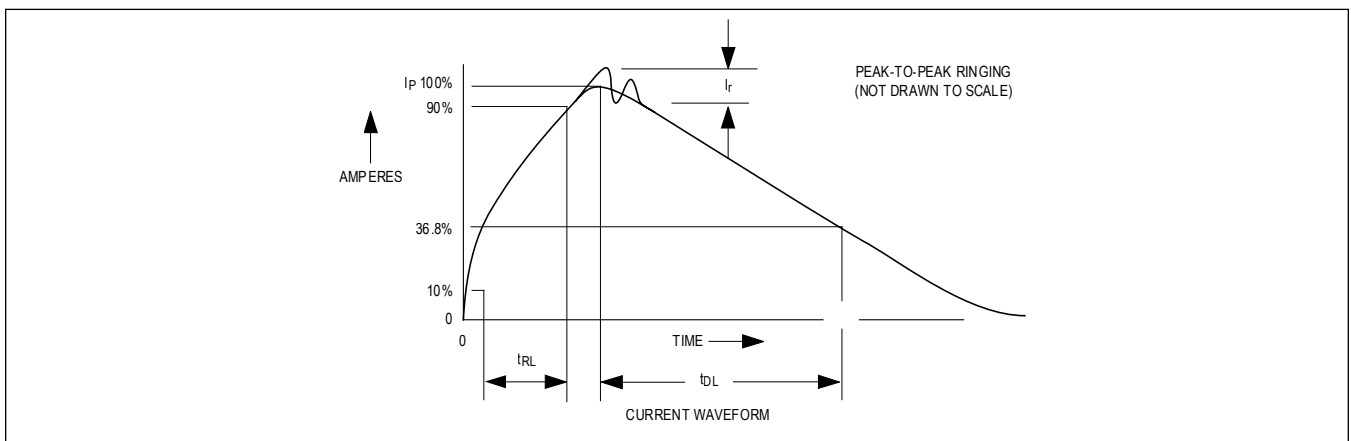


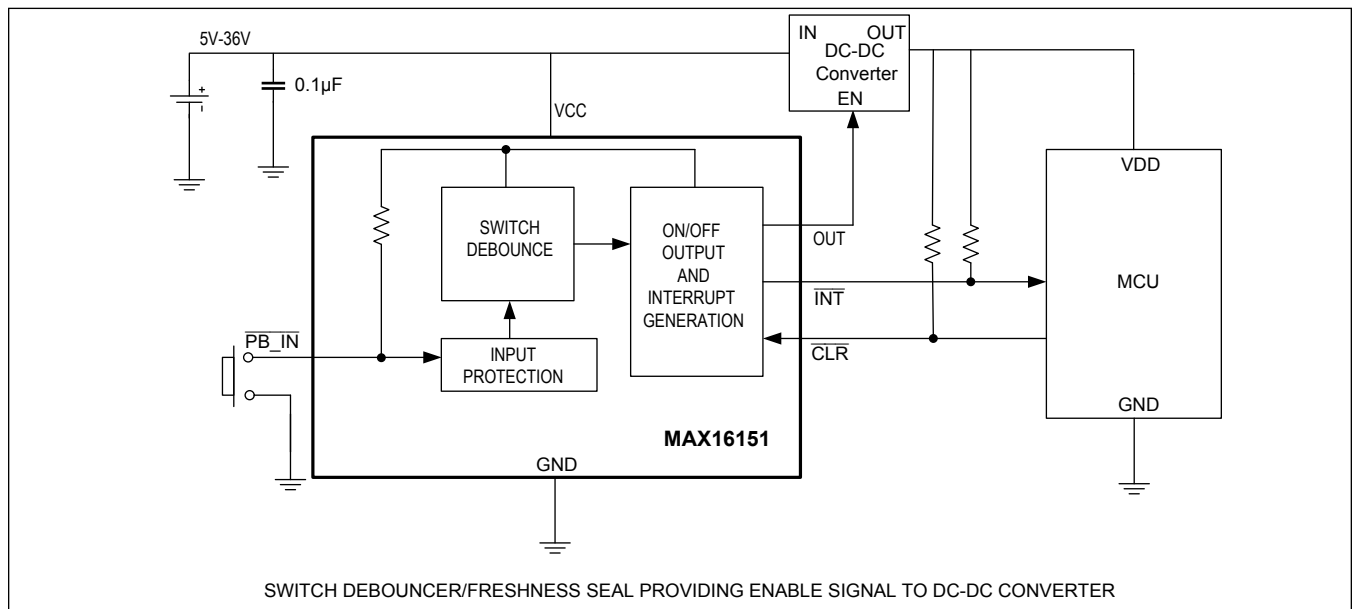
Figure 4. Human Body Current Waveform

### Applications Information

#### Powering the Load

The MAX16151 OUT has an internal 3V regulator that can be directly connected to a light load (typical 50uA). For a system requiring higher power, the output of the MAX16151 can be used as an enable signal for the voltage regulator powering the system. This Typical Application Circuit shows an LDO providing power to the load. The LDO's enable input is driven by OUT of the MAX16151. A debounced pushbutton at PB\_IN of the MAX16151 causes OUT to assert high, thereby enabling the LDO.

### Typical Application Circuits



### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PIN-PACKAGE
MAX16151AWT+T	-40°C to +125°C	6-WLP
MAX16151BWT+T*	-40°C to +125°C	6-WLP
MAX16151_WT+T*	-40°C to +125°C	6-WLP
MAX16151_UT+T*	-40°C to +125°C	6 SOT23

+ Denotes a lead(Pb)-free/RoHS-compliant package.

T Denotes tape-and-reel.

\* Denotes future products

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/21	Release for Market Intro.	—

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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