



# LC4105V

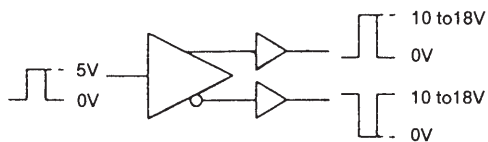
## Level Shifter

### Overview

The LC4105V is a level shifter driver that converts 5-V signals into signals with amplitudes between 10 and 18 V.

### Features

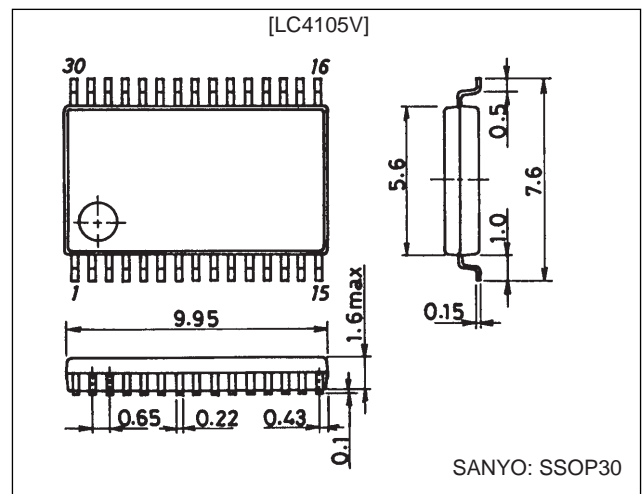
- Seven inputs and eleven outputs  
IN1 to IN3 produce only true outputs.  
IN4 to IN7 produce both true and inverted outputs.
- Slim SSOP-30 package



### Package Dimensions

unit: mm

#### 3191-SSOP30



### Specifications

**Absolute Maximum Ratings at  $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ , all voltages are relative to  $V_{SS}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply voltage	$V_{DD}$		-0.3		20	V
	$V_{DD1}$		-0.3		20	V
	$V_{CC}$		-0.3		7	V
	$V_{SS1}$		-0.3		+0.3	V
Input voltage	$V_{IN}$	IN1 to IN7	-0.5		$V_{CC} + 0.5$	V
Power dissipation	$P_d$	$T_a \leq 75^\circ\text{C}$			200	mW
Storage temperature	$T_{stg}$		-55		+125	$^\circ\text{C}$

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### Allowable Operating Ranges at voltages relative to $V_{SS}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply voltage	$V_{DD}$	*	10		18	V
	$V_{DD1}$	*		$V_{DD}$		V
	$V_{CC}$	*	3.0		5.5	V
	$V_{SS1}$	*		$V_{SS}$		V
High-level input voltage	$V_{IN-H}$	IN1 to IN7 ( $V_{CC} = 4.5$ to $5.5$ V) ( $V_{CC} = 3.0$ to $4.5$ V)	2.4		$V_{CC}$	V
			$0.7 V_{CC}$		$V_{CC}$	V
Low-level input voltage	$V_{IN-L}$	IN1 to IN7 ( $V_{CC} = 4.5$ to $5.5$ V) ( $V_{CC} = 3.0$ to $4.5$ V)	0		0.8	V
			0		$0.1 V_{CC}$	V
Operating temperature	$T_{opr}$		-10		+75	°C

Note: \* Applications must observe the directions in the note on page 5 at power on and at power off.

### Electrical Characteristics

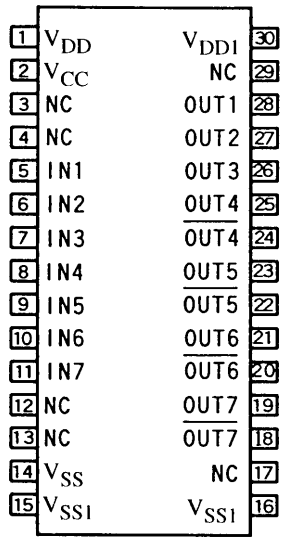
at  $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $V_{CC} = 5$  V, and  $V_{DD} = 16$  V, all voltages are relative to  $V_{SS}$ , unless otherwise specified

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
High-level input current	$I_{ih}$	$V_{in} = V_{CC}$ IN1 to IN7			1	$\mu\text{A}$
Low-level input current	$I_{il}$	$V_{in} = V_{SS}$ IN1 to IN7	-1			$\mu\text{A}$
High-level output voltage	$V_{oh}$	$I_o = 1$ mA	$V_{DD}-1$		$V_{DD}$	V
Low-level output voltage	$V_{ol}$	$I_o = -1$ mA	$V_{SS}$		$V_{SS}+1$	V
Output on resistance	$R_{out}$	$V_{DD} = V_{DD1} = 10$ V $I_o = \pm 1$ mA		60		$\Omega$
Current drain while idling	$I_{CCI}$	$V_{DD} = V_{DD1} = 18$ V, $V_{CC} = 5.5$ V		0.01	10	$\mu\text{A}$
	$I_{DDI}^*$	IN1 to IN7 = 0 V All outputs open.		0.10	10	$\mu\text{A}$
Current drain during operation	$I_{CCa}$	$V_{DD} = V_{DD1} = 15$ V, $V_{CC} = 5.5$ V		16		$\mu\text{A}$
	$I_{DDa}^*$	IN0 to IN6 = 0 V IN7 = 0 to 5.5 V/2 MHz Load 1		10		mA

Note: \*  $I_{DDI}$  and  $I_{DDa}$  are the total currents flowing into power supply pins  $V_{DD}$  and  $V_{DD1}$ .

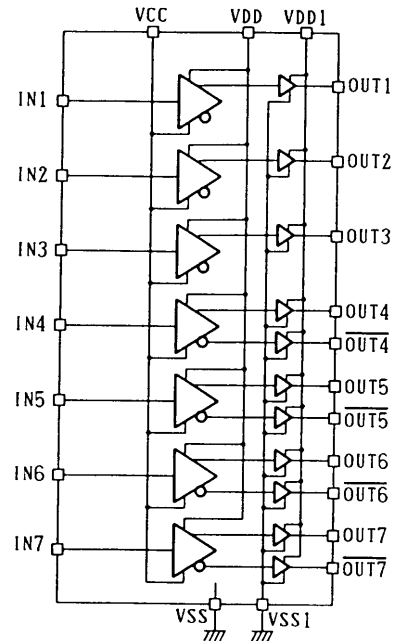
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## Pin Assignment



Top view

## Block Diagram



## Pin Descriptions

Pin Name	I/O	Pin Number	Function	
OUT1	O	28	Level shifter outputs	
OUT2		27		
OUT3		26		
OUT4		25		
OUT4*		24		
OUT5		23		
OUT5*		22		
OUT6		21		
OUT6*	20	Level shifter inputs		
OUT7	19			
OUT7*	18			
IN1	I		5	Level shifter inputs
IN2			6	
IN3			7	
IN4			8	
IN5			9	
IN6		10		
IN7		11		
V <sub>DD</sub>	—	1	Level shifter high-voltage power supply	
V <sub>DD1</sub>	—	30	Buffer high-voltage power supply	
V <sub>CC</sub>	—	2	Level shifter low-voltage power supply	
V <sub>SS1</sub>	—	15, 16	Buffer ground	
V <sub>SS</sub>	—	14	Level shifter ground	
NC		3, 4, 12, 13, 17, 29	Do not connect anything to these pins.	

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### Switching Characteristics at $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ , $V_{CC} = 5\text{ V} \pm 10\%$ , $V_{DD} = 10\text{ to }18\text{ V}$

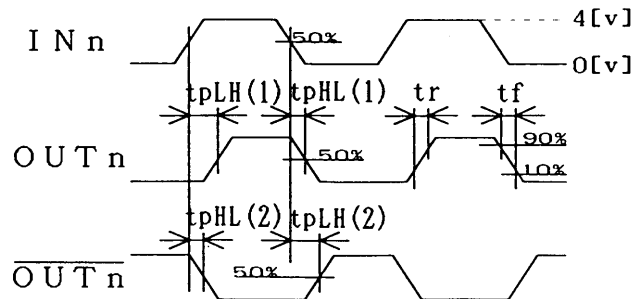
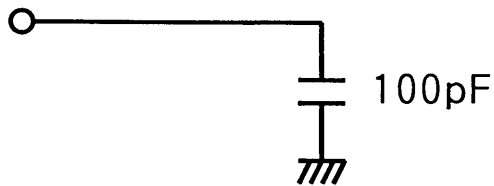
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Propagation delay	tpLH(1)	Load 1		33	60	ns
	tpHL(1)			35	60	ns
	tpLH(2)		tpHL(1)-10	36	tpHL(1)+20	ns
	tpHL(2)		tpLH(1)-20	20	tpLH(1)+10	ns
Rising time	tr	Load 1		24	50	ns
Falling time	tf	Load 1		24	50	ns

### at $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ , $V_{CC} = 3.0\text{ to }4.5\text{ V}$ , $V_{DD} = 10\text{ to }18\text{ V}$

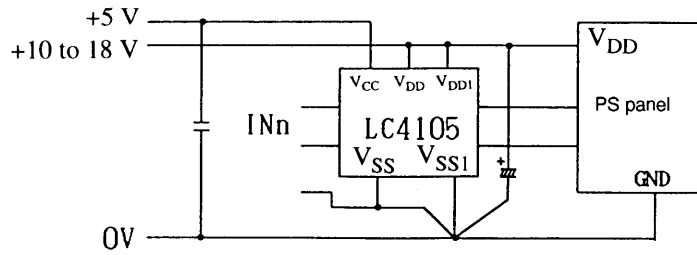
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Propagation delay	tpLH(1)	Load 1			100	ns
	tpHL(1)				120	ns
	tpLH(2)				120	ns
	tpHL(2)				100	ns
Rising time	tr	Load 1			50	ns
Falling time	tf	Load 1			50	ns

Note: The typical values are measured for OUT1 output with  $V_{CC} = 5.5\text{ V}$  and  $V_{DD} = 15\text{ V}$ .

Load 1



Power Supply Circuits

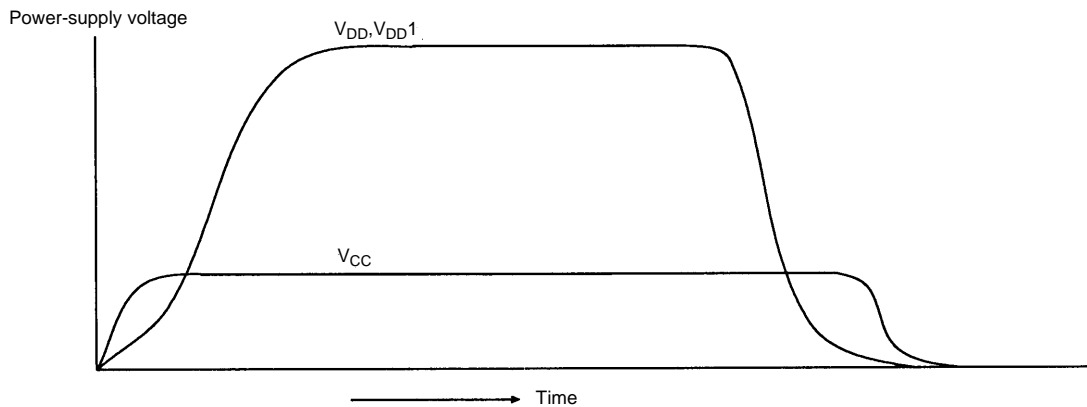


Keep the impedance of the  $V_{SS}$  and  $V_{SS1}$  lines as low as possible. Connect a large electrolytic capacitor across the  $V_{DD1}$  and  $V_{SS1}$  pins and close to the IC. Wherever possible, keep the grounds for the power supply circuits and the signal circuits separate and connect the two at a single point.

Notes on Power-Supply Voltage Application

This IC has two power supply systems:  $V_{DD}$  ( $V_{DD1}$ ) and  $V_{CC}$ , and requires that applications observe the notes provided here when applying or removing these voltages. In particular, if the  $V_{DD}$  ( $V_{DD1}$ ) system power-supply voltage becomes higher than the  $V_{CC}$  system voltage while the  $V_{CC}$  system voltage is not yet established (i.e. is less than  $V_{CCmin}$ ), excessive currents may flow and the IC may be destroyed. To prevent destruction of the IC due to this phenomenon, applications must, basically, follow the sequence described in item 1 below when turning the power supplies on or off.

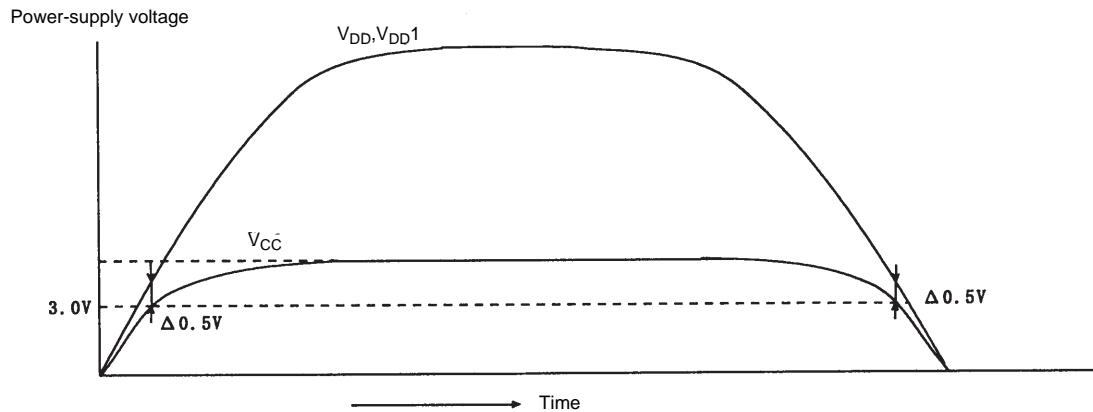
1. When turning the power on, first apply the  $V_{CC}$  voltage (bring this voltage to a value above  $V_{CCmin}$ ), and then apply the  $V_{DD}$  voltage. When turning the power off, first drop the  $V_{DD}$  voltage, and, after  $V_{DD}$  is below  $V_{CCmin}$ , then drop the  $V_{CC}$  voltage.



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However, there are many cases where it is not possible to control the power-supply voltage on/off sequence. This IC is actually capable of supporting the on/off sequence described in item 2 below.

2. If  $V_{DD}$  ( $V_{DD1}$ ) and  $V_{CC}$  are turned on and off at essentially the same time, the difference between  $V_{DD}$  and  $V_{CC}$  (e.g. the distance in the figure marked as  $\Delta 0.5\text{ V}$ ) must be held to be under  $0.5\text{ V}$  while  $V_{CC}$  is less than or equal to  $3.0\text{ V}$ .



Another point is that a certain amount of time is required to stabilize the  $V_{CC}$  system when  $V_{CC}$  is first applied and the IC is easily destroyed during this period. Inversely, when the power is removed, the  $V_{CC}$  system state is easily retained and as a result the device cannot be destroyed easily. In actual use, one can consider there to be a certain amount of margin for removing the  $V_{DD}$  ( $V_{DD1}$ ) voltage even after  $V_{CC}$  has already been dropped. However, this margin varies with sample-to-sample variations in the IC itself and with the details of the application circuit, and careful analysis and consideration of the actual usage conditions is required to assure that the IC will not be destroyed if the sequences in items 1 or 2 are not observed.

3. Note that when power is turned off and then immediately turned back on again, many circuit designs may fail to meet the conditions for the sequences described in items 1 and 2 above. Be sure to take this into account when designing applications that use this IC.

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