

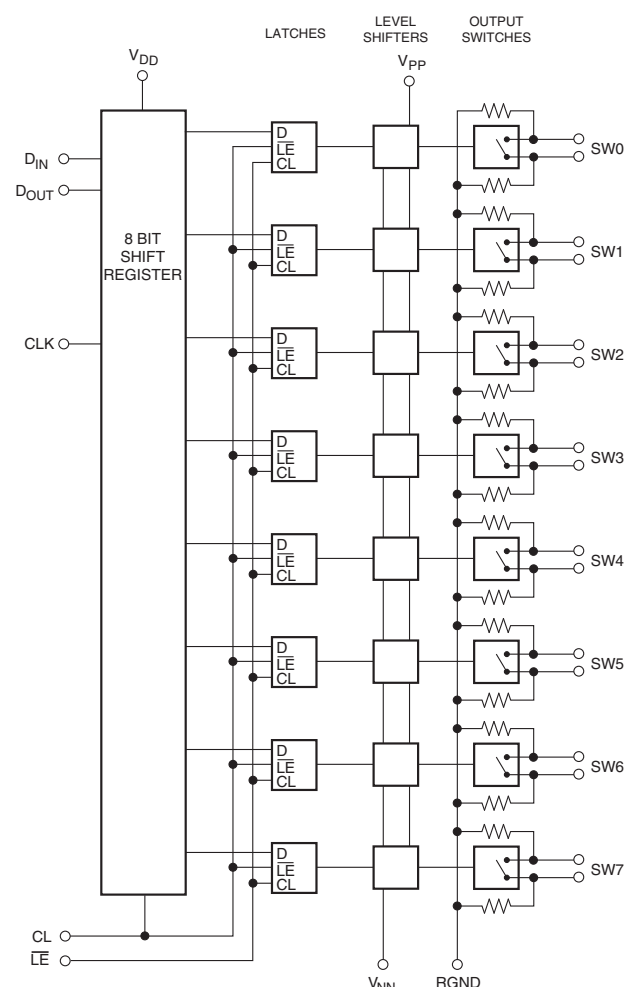
#### Features

- Processed with BCDMOS on SOI (Silicon on Insulator)
- Flexible High Voltage Supplies up to  $V_{PP}-V_{NN}+200V$
- Internal Output Bleeder Resistors
- DC to 10MHz Analog Signal Frequency
- -60dB Minimum Output-Off Isolation at 5MHz
- Low Quiescent Power Dissipation ( $< 1\mu A$  Typical)
- Output Switch On-Resistance Typically  $20\Omega$
- TTL I/Os for 3.3V Interface
- Surface Mount Package

#### Applications

- Ultrasound Imaging
- Printers
- Industrial Controls and Measurement
- Piezoelectric Transducer Drivers

Figure 1. Block Diagram



#### Description

The CPC7232 is a low charge injection 8-channel high-voltage analog switch integrated circuit (IC) for use in applications requiring high voltage switching. Bleeder resistors are incorporated into both terminals of each output switch. Control of the high voltage switching is via low voltage TTL logic level compatible inputs for direct connectivity to the system controller.

Switch manipulation is managed by an 8-bit serial to parallel shift register whose outputs are buffered and stored by an 8-bit transparent latch. Level shifters buffer the latch outputs and operate the high voltage switches.

Because the CPC7232 is capable of switching high load voltages and has a flexible load voltage range, e.g.  $V_{PP}/V_{NN}$ : +40V/160V or +100V/100V, it is well suited for many medical and industrial applications such as medical ultrasound imaging, printers, and industrial measurement equipment. The bleeder resistors enable the discharge of capacitive loads, such as piezoelectric transducers, connected to the output switches of the CPC7232.

Construction of the high voltage switches using Clare's reliable BCDMOS process technology on SOI (Silicon On Insulator) allow the switches to be organized as solid state switches with direct gate drive.

#### Ordering Information

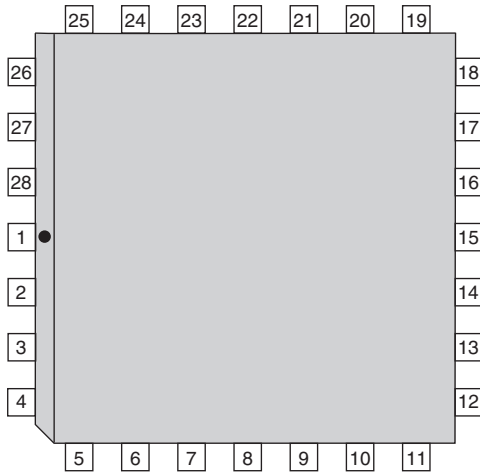
Part Number	Description
CPC7232W	28-Lead PLCC in Tubes (37/Tube)
CPC7232WTR	28-Lead PLCC Tape & Reel (500/Reel)
CPC7232K	48-Lead LQFP in Trays (250/Tray)
CPC7232KTR	48-Lead LQFP Tape & Reel (1000/Reel)



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## 1. Specifications

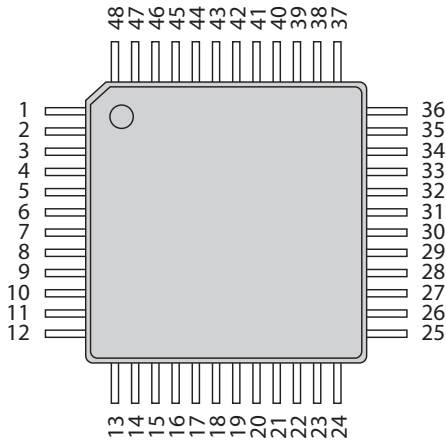
### 1.1 Package Pinout, PLCC-28



### 1.2 Pin Description

Pin	Name	Description
1	SW3	SW3 Output
2	SW3	SW3 Output
3	SW2	SW2 Output
4	SW2	SW2 Output
5	SW1	SW1 Output
6	SW1	SW1 Output
7	SW0	SW0 Output
8	SW0	SW0 Output
9	N/C	No connection
10	V <sub>PP</sub>	Switch positive high voltage supply
11	R <sub>GND</sub>	Ground for bleed resistors
12	V <sub>NN</sub>	Switch negative high voltage supply
13	GND	Ground
14	V <sub>DD</sub>	Logic positive voltage supply
15	N/C	No connection
16	D <sub>IN</sub>	Serial data input
17	CLK	Clock input, positive edge trigger
18	$\overline{LE}$	Latch enable, active low
19	CL	Latch clear, active high clears latches and opens switches
20	D <sub>OUT</sub>	Serial data output
21	SW7	SW7 Output
22	SW7	SW7 Output
23	SW6	SW6 Output
24	SW6	SW6 Output
25	SW5	SW5 Output
26	SW5	SW5 Output
27	SW4	SW4 Output
28	SW4	SW4 Output

### 1.3 Package Pinout, LQFP-48



### 1.4 Pin Description

Pin	Name	Description
1	SW5	SW5 Output
2	N/C	No connection
3	SW4	SW4 Output
4	N/C	No connection
5	SW4	SW4 Output
6	N/C	No connection
7	N/C	No connection
8	SW3	SW3 Output
9	N/C	No connection
10	SW3	SW3 Output
11	N/C	No connection
12	SW2	SW2 Output
13	N/C	No connection
14	SW2	SW2 Output
15	N/C	No connection
16	SW1	SW1 Output
17	N/C	No connection
18	SW1	SW1 Output
19	N/C	No connection
20	SW0	SW0 Output
21	N/C	No connection
22	SW0	SW0 Output
23	N/C	No connection
24	V <sub>PP</sub>	Switch positive high voltage supply
25	V <sub>NN</sub>	Switch negative high voltage supply
26	N/C	No connection
27	R <sub>GND</sub>	Ground for bleed resistors
28	GND	Ground
29	V <sub>DD</sub>	Logic positive supply voltage
30	N/C	No connection
31	N/C	No connection
32	N/C	No connection
33	D <sub>IN</sub>	Serial data input
34	CLK	Clock input, positive edge trigger
35	LE	Latch enable, active low
36	CL	Latch clear, active high clears latches and opens switches
37	D <sub>OUT</sub>	Serial data output
38	N/C	No connection
39	SW7	SW7 Output
40	N/C	No connection
41	SW7	SW7 Output
42	N/C	No connection
43	SW6	SW6 Output
44	N/C	No connection
45	SW6	SW6 Output
46	N/C	No connection
47	SW5	SW5 Output
48	N/C	No connection

## 1.5 Absolute Maximum Ratings

Parameter	Min	Max	Units
V <sub>DD</sub> Logic Power Supply Voltage	-0.5	6	V
V <sub>PP</sub> - V <sub>NN</sub> Supply Voltage	-	220	V
V <sub>PP</sub> Positive High Voltage Supply	-0.5	V <sub>NN</sub> +200	V
V <sub>NN</sub> Negative High Voltage Supply	-0.5	V <sub>PP</sub> -200	V
Logic input voltages	-0.5	V <sub>DD</sub> +0.3	V
Analog signal range	V <sub>NN</sub>	V <sub>PP</sub>	V
Peak analog signal current per channel	-	1	A
Power dissipation			W
28-Lead PLCC	-	2.5	
48-Lead LQFP	-	2.3	
Thermal Resistance, Junction to Ambient			°C/W
28-Lead PLCC	-	50	
48-Lead LQFP	-	53	
Storage temperature	-60	+150	°C

Absolute maximum electrical ratings are at 25°C.

*Absolute Maximum Ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Functional operation of the device at conditions beyond those indicated in the operational sections of this data sheet is not implied.*

## 1.6 Operating Conditions

Parameter	Symbol	Value
Logic power supply voltage <sup>1, 3</sup>	V <sub>DD</sub>	4.5V to 6V
Positive high voltage supply <sup>1, 3</sup>	V <sub>PP</sub>	40V to V <sub>NN</sub> + 200V
Negative high voltage supply <sup>1, 3</sup>	V <sub>NN</sub>	-40V to -160V
Analog signal voltage, peak-to-peak <sup>2</sup>	V <sub>SW</sub>	V <sub>NN</sub> +10V to V <sub>PP</sub> -10V
Operating temperature	T <sub>A</sub>	0°C to 70°C

<sup>1</sup> Power up/down sequence is arbitrary except that GND must be powered-up first and powered-down last.

<sup>2</sup> V<sub>SW</sub> must be V<sub>NN</sub> ≤ V<sub>SW</sub> ≤ V<sub>PP</sub> or floating during power up/down transition.

<sup>3</sup> Rise and fall times of power supplies, V<sub>DD</sub>, V<sub>PP</sub>, and V<sub>NN</sub>, should not be less than 1ms.

## 1.7 Electrical Characteristics

### 1.7.1 Switch Characteristics (over recommended operating conditions unless otherwise noted)

Parameter	Symbol	Test Conditions	0°C		+25°C			+70°C		Units
			min	max	min	typ	max	min	max	
Small signal switch on-resistance	R <sub>ONS</sub>	V <sub>PP</sub> =40V, V <sub>NN</sub> =-160V, I <sub>SW</sub> =5mA	-	30	-	21	38	-	48	Ω
		V <sub>PP</sub> =40V, V <sub>NN</sub> =-160V, I <sub>SW</sub> =200mA	-	25	-	-	27	-	32	
		V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V, I <sub>SW</sub> =5mA	-	25	-	21	27	-	30	
		V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V, I <sub>SW</sub> =200mA	-	18	-	16	24	-	27	
		V <sub>PP</sub> =160V, V <sub>NN</sub> =-40V, I <sub>SW</sub> =5mA	-	23	-	21	25	-	30	
		V <sub>PP</sub> =160V, V <sub>NN</sub> =-40V, I <sub>SW</sub> =200mA	-	22	-	-	25	-	27	
Small signal switch on-resistance matching	ΔR <sub>ONS</sub>	I <sub>SW</sub> =5mA, V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V	-	20	-	4	20	-	20	%
Large signal switch on-resistance	R <sub>ONL</sub>	V <sub>SW</sub> =V <sub>PP</sub> -10V, I <sub>SW</sub> =0.8A	-	-	-	16	-	-	-	Ω
Output bleed resistors	R <sub>INT</sub>	Output switch to R <sub>GND</sub> , I <sub>RINT</sub> =0.5mA	-	-	20	28	50	-	-	kΩ
Switch off leakage per switch	I <sub>SOL</sub>	V <sub>SW</sub> =V <sub>PP</sub> -10V and V <sub>NN</sub> +10V	-	5	-	0.4	10	-	15	μA
DC offset, switch off	-	R <sub>L</sub> =100kΩ	-	100	-	0.2	100	-	100	mV
DC offset, switch on	-	R <sub>L</sub> =100kΩ	-	100	-	0.2	100	-	100	
Switch output peak current	-	V <sub>SW</sub> duty cycle = 0.1%	-	-	-	-	0.8	-	-	A
Output switch frequency	f <sub>SW</sub>	Duty cycle = 50%	-	-	-	-	50	-	-	kHz
Maximum V <sub>SW</sub> slew rate	dV/dt	V <sub>PP</sub> =160V, V <sub>NN</sub> =-40V	-	20	-	-	20	-	20	V/ns
		V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V								
		V <sub>PP</sub> =40V, V <sub>NN</sub> =-160V								
Off isolation	K <sub>O</sub>	f=5MHz, 1kΩ/15pF load	-30	-	-30	-	-	-30	-	dB
		f=5MHz, 50Ω load	-58	-	-58	-	-	-58	-	
Switch crosstalk	K <sub>CR</sub>	f=5MHz, 50Ω load	-60	-	-60	-	-	-60	-	dB
Output switch isolation diode current	I <sub>ID</sub>	300ns pulse width, 2.0% duty cycle	-	300	-	-	300	-	300	mA
Off capacitance, SW to GND	C <sub>SG(OFF)</sub>	V <sub>SW</sub> =0V, 1MHz	5	17	5	-	25	5	20	pF
On capacitance, SW to GND	C <sub>SG(ON)</sub>	V <sub>SW</sub> =0V, 1MHz	25	40	20	-	40	25	50	
Output voltage spike	+V <sub>SPK</sub>	V <sub>PP</sub> =40V, V <sub>NN</sub> =-160V, R <sub>L</sub> =50Ω	-	-	-	37	150	-	-	mV
	-V <sub>SPK</sub>					93				
	+V <sub>SPK</sub>	V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V, R <sub>L</sub> =50Ω				35	150			
	-V <sub>SPK</sub>					80				
	+V <sub>SPK</sub>	V <sub>PP</sub> =160V, V <sub>NN</sub> =-40V, R <sub>L</sub> =50Ω				46	150			
	-V <sub>SPK</sub>					72				
Charge injection	Q	V <sub>PP</sub> =100V, V <sub>NN</sub> =-100V, V <sub>SW</sub> =0V			-	880	-		pC	

1.7.2 Logic DC Characteristics (over recommended operating conditions unless otherwise noted)

Parameter	Symbol	Test Conditions	0°C		+25°C			+70°C		Units
			min	max	min	typ	max	min	max	
D <sub>OUT</sub> source capability	V <sub>OH</sub>	I <sub>OUT</sub> = -400μA	-	-	V <sub>DD</sub> -0.7	V <sub>DD</sub> -0.1	-	-	-	V
D <sub>OUT</sub> sink capability	V <sub>OL</sub>	I <sub>OUT</sub> = +400μA	-	-	-	0.04	0.7	-	-	
Logic input capacitance	C <sub>IN</sub>	-	-	10	-	-	10	-	10	pF
Logic input high	V <sub>IH</sub>	4.75V < V <sub>DD</sub> < 5.25V	2	-	2	-	-	2	-	V
Logic input low	V <sub>IL</sub>	4.75V < V <sub>DD</sub> < 5.25V	-	0.8	-	-	0.8	-	0.8	

1.7.3 Logic Timing Characteristics (over recommended operating conditions unless otherwise noted)

Parameter	Symbol	Test Conditions	0°C		+25°C			70°C		Units
			min	max	min	typ	max	min	max	
Setup time before $\overline{LE}$ rises	t <sub>SD</sub>	-	150	-	150	-	-	150	-	ns
Time width of $\overline{LE}$	t <sub>WLE</sub>	-	150	-	150	-	-	150	-	
Clock delay time to Data Out	t <sub>DO</sub>	-	-	150	-	62	150	-	150	
Time width of CL	t <sub>WCL</sub>	-	150	-	150	-	-	150	-	
Setup time, data to clock	t <sub>SU</sub>	-	15	-	15	8	-	20	-	
Hold time, data from clock	t <sub>H</sub>	-	35	-	35	-	-	35	-	MHz
Clock frequency	f <sub>CLK</sub>	50% duty cycle, f <sub>DATA</sub> =f <sub>CLK</sub> /2	-	5	-	-	5	-	5	
Clock rise and fall times	t <sub>R</sub> , t <sub>F</sub>	-	-	50	-	-	50	-	50	ns
Turn-on time	t <sub>ON</sub>	V <sub>SW</sub> =V <sub>PP</sub> -10V, R <sub>L</sub> =10kΩ	-	5	-	2	5	-	5	μs
Turn-off time	t <sub>OFF</sub>					3				

## 1.7.4 Supply DC Characteristics (over recommended operating conditions unless otherwise noted)

Parameter	Symbol	Test Conditions	0°C		+25°C			+70°C		Units
			min	max	min	typ	max	min	max	
$V_{PP}$ quiescent supply current	$I_{PPQ}$	All switches off	-	-	-	0.1	10	-	-	$\mu A$
		All switches on, $I_{SW}=5mA$	-	-	-	-0.1	-10	-	-	
$V_{NN}$ quiescent supply current	$I_{NNQ}$	All switches off	-	-	-	-0.1	-10	-	-	$\mu A$
		All switches on, $I_{SW}=5mA$	-	-	-	-0.1	-10	-	-	
$V_{PP}$ operating supply current	$I_{PP}$	$V_{PP}=40V$ , $V_{NN}=-160V$	-	6.5	-	-	7	-	8	mA
		$V_{PP}=100V$ , $V_{NN}=-100V$	-	5	-	-	5.5	-	5.5	
		$V_{PP}=160V$ , $V_{NN}=-40V$	-	5	-	-	5	-	5.5	
$V_{NN}$ operating supply current	$I_{NN}$	$V_{PP}=40V$ , $V_{NN}=-160V$	-	6.5	-	-	7	-	8	mA
		$V_{PP}=100V$ , $V_{NN}=-100V$	-	5	-	-	5.5	-	5.5	
		$V_{PP}=160V$ , $V_{NN}=-40V$	-	5	-	-	5	-	5.5	
$V_{DD}$ average supply current	$I_{DD}$	$f_{CLK}=5MHz$ , $V_{DD}=5V$	-	4	-	-	4	-	4	mA
$V_{DD}$ quiescent supply current	$I_{DDQ}$	-	-	10	-	0.03	10	-	10	$\mu A$



## 2. Functional Description

The CPC7232 takes a serial stream of input data along with a synchronous clock signal. As the clock transits from low to high, the data at the input of each shift register is shifted through from SR(n) to SR(n+1). A high data bit, a "1," represents an ON switch; a low data bit, a "0," represents an OFF switch. Data is input and shifted through the internal shift register until all eight shift register positions, SR0 through SR7, are in the desired state.

**DIN:** The data-in line presents data bits to the CPC7232 to be shifted through the internal shift register.

**CLK:** The clock signal's rising edge is associated only with shifting data into and through the shift register.

**CL:** The clear line overrides all other inputs. When CL is high, the shift register is cleared to all 0s and all latches are set low, which causes all output switches to be turned OFF immediately. When CL is low, all output switches remain in whatever state they are in, ON or OFF, in response to CLK, latch inputs, and the LE signal.

**LE:** latch enable controls the state of the latches and thus the state of the eight switches. If LE is high, then the latches do not change states, but retain their most recent status: either ON or OFF. With LE high, input data and CLK have no effect on the state of the output switches. If LE is low, then all latch outputs and their switch states follow the inputs from the shift register. LE is overridden by CL: no matter what state LE is in, CL clears the latches. See **"Truth Table" on page 10**.

**DOUT:** The data-out pin is the output of SR7. After eight clock pulses, the first bit of eight input data bits is shifted to SR7 and appears on DOUT.

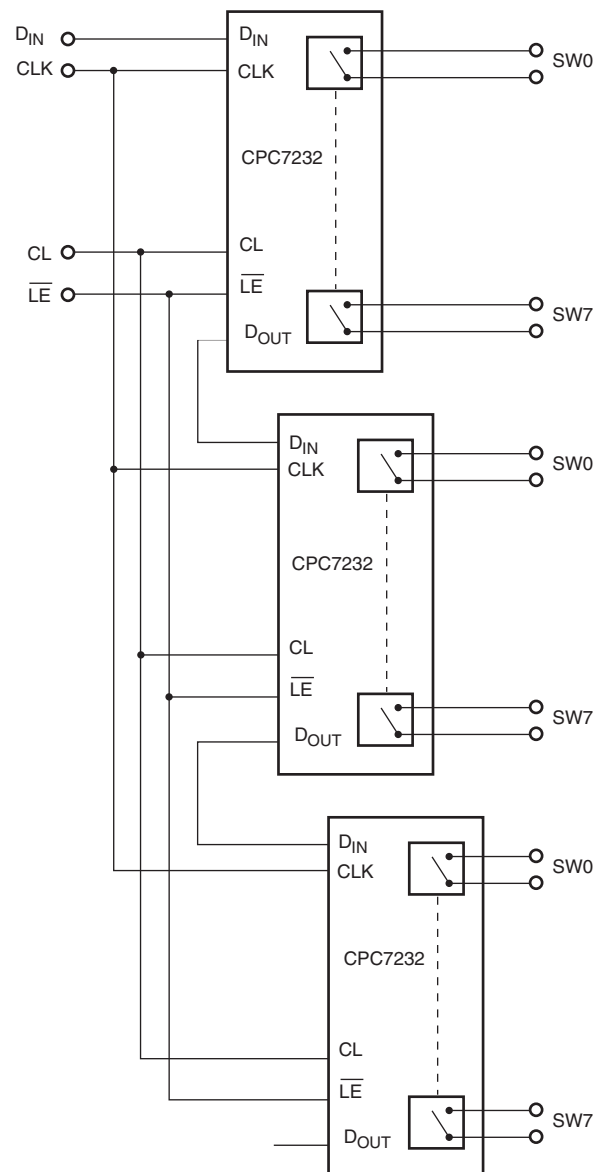
**SW0 - SW7:** The CPC7232 provides eight high-voltage SPST output switches with a typical on-resistance of 20Ω. The two connections of each switch are not polarity-sensitive.

**V<sub>PP</sub> and V<sub>NN</sub>:** Voltage inputs to the level shifters for each switch channel that translate the voltage level of the latch output signals to an appropriate level for the voltages being switched.

The high-voltage output switches are turned on and off in response to the data sent into the latches from the shift register: data 0 turns a switch OFF, data 1 turns a switch ON.

Two or more CPC7232 devices can be cascaded to form an n-switch arrangement. The DOUT pin of the first is connected to the DIN pin of the next in the series. All devices are connected to the same clock (CLK) signal. LE of all devices would normally be connected, as would CL, but this is not necessary.

The first data bit applied to DIN of the CPC7232, whether it's a single device or several cascaded devices, ripples through to the last switch output in line after the application of a full clocking sequence of 8 clock pulses per CPC7232. Setting the serial I/O device to output the most significant bit (MSB) first, results in the MSB appearing on SW7 of the last device in line after a full clocking sequence.



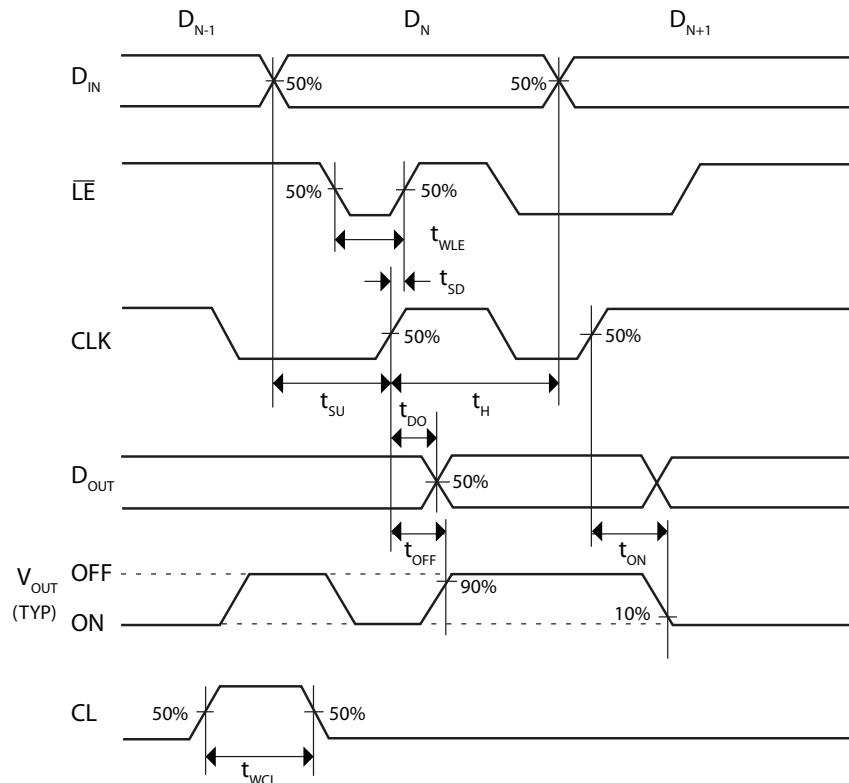
## 2.1 Truth Table

D0	D1	D2	D3	D4	D5	D6	D7	$\overline{LE}$	CL	SW0	SW1	SW2	SW3	SW4	SW5	SW6	SW7
L								L	L	OFF							
H								L	L	ON							
	L							L	L		OFF						
	H							L	L		ON						
		L						L	L			OFF					
		H						L	L			ON					
			L					L	L				OFF				
			H					L	L				ON				
				L				L	L					OFF			
				H				L	L					ON			
					L			L	L						OFF		
					H			L	L						ON		
						L		L	L							OFF	
						H		L	L							ON	
							L	L	L								OFF
							H	L	L								ON
X	X	X	X	X	X	X	X	H	L	HOLD PREVIOUS STATE							
X	X	X	X	X	X	X	X	X	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

**Notes:**

1. The eight switches operate independently.
2. Serial data is clocked in on the L $\rightarrow$ H transition CLK.
3. The switches go to a state retaining their present condition at the rising edge of  $\overline{LE}$ . When  $\overline{LE}$  is low the shift register data flows through the latch.
4.  $D_{OUT}$  is high when switch 7 is on.
5. Shift register clocking has no effect on the switch states if  $\overline{LE}$  is H.
6. The clear input overrides all other inputs.

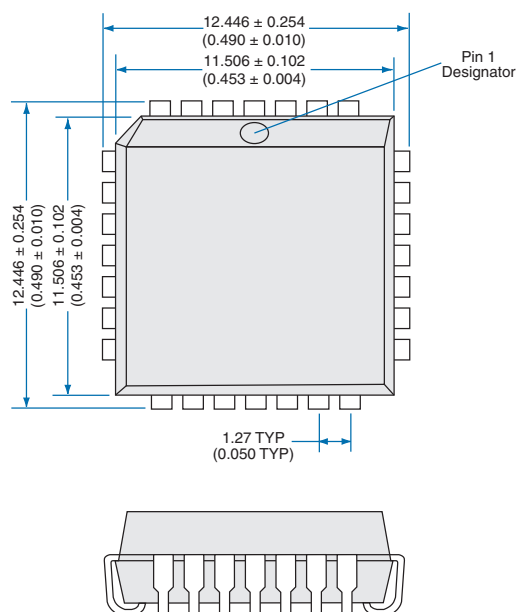
## 2.2 Logic Timing Waveforms



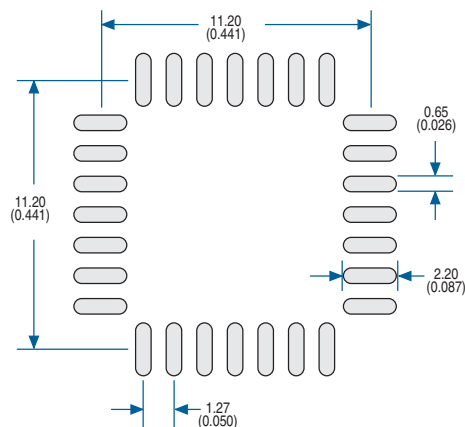
## 3. Manufacturing Information

### 3.1 Mechanical Dimensions

#### 3.1.1 28-Pin PLCC Package

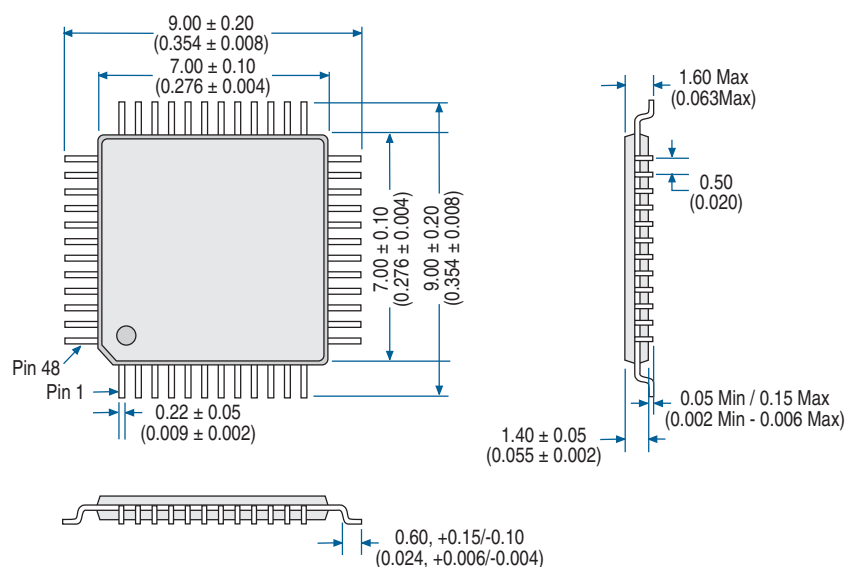


#### Recommended PCB Land Pattern

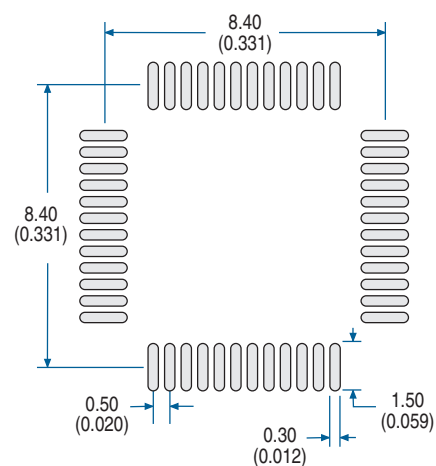


Dimensions  
mm  
(inches)

#### 3.1.2 48-Pin LQFP Package



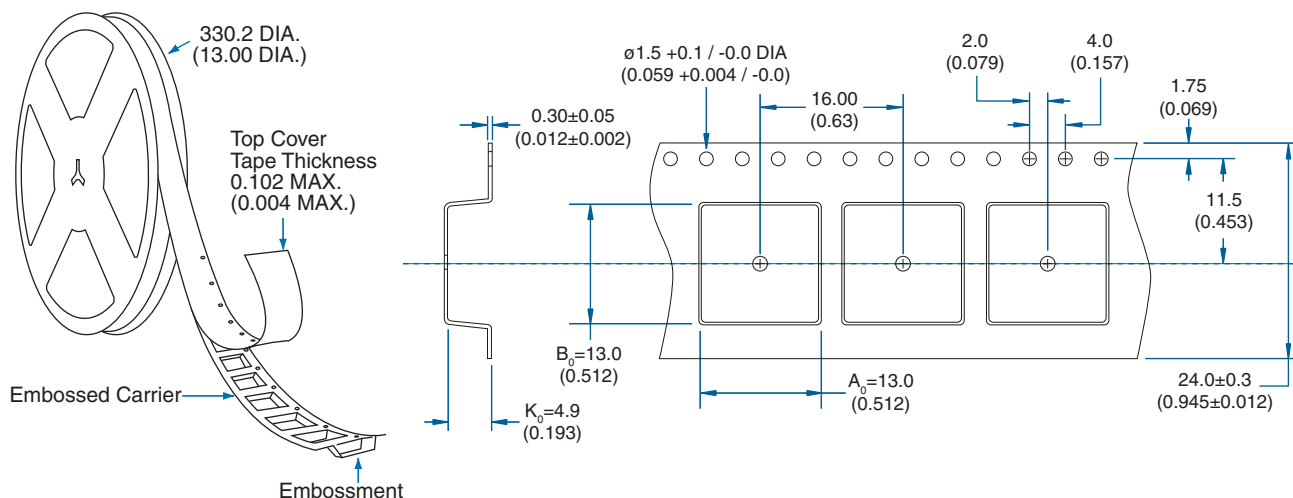
#### Recommended PCB Land Pattern



Dimensions  
mm  
(inches)

### 3.2 Tape and Reel Specifications

#### 3.2.1 PLCC-28

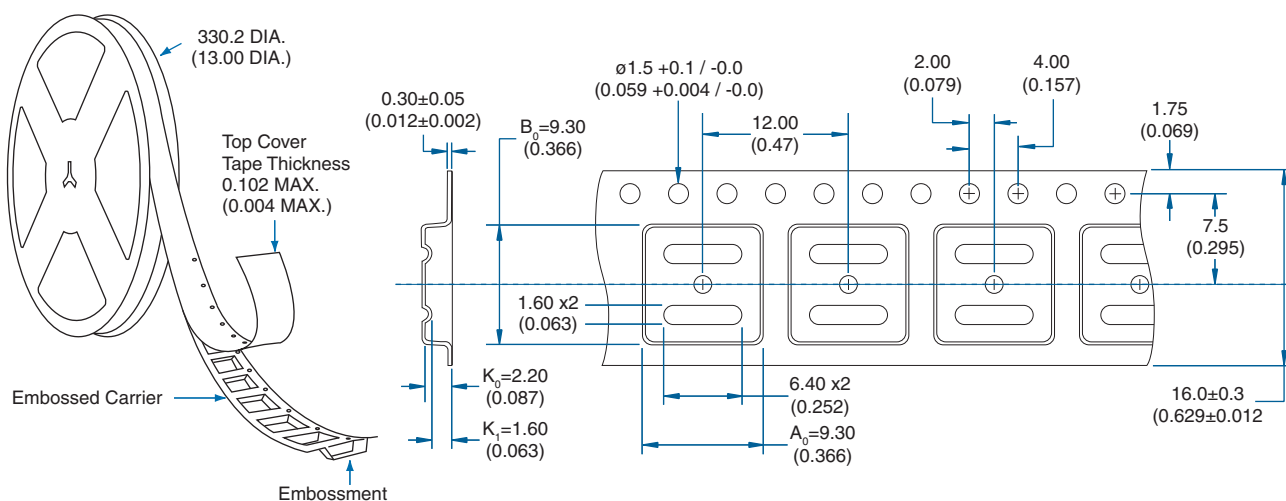


#### NOTES:

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$  (0.008)
2. Camber not to exceed 1mm in 100mm
3. Material: conductive black polystyrene
4.  $A_0$  and  $B_0$  measured on a plane 0.3mm above the bottom of the pocket
5.  $K_0$  measured from a plane on the inside bottom of the pocket to the top surface of the carrier
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
7. Unless otherwise noted, tolerance  $\pm 0.1$  (0.004)

Dimensions  
mm  
(inches)

#### 3.2.2 LQFP-48



#### NOTES:

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.2$
2. Camber in compliance with EIA 481
3. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
4. Unless otherwise specified, tolerance  $\pm 0.1$  (0.004)

Dimensions  
mm  
(inches)

### 3.3 Soldering

For proper assembly, the component must be processed in accordance with the current revision of IPC/JEDEC standard, J-STD-020. Failure to follow the recommended guidelines may cause permanent damage to the device resulting in impaired performance and/or a reduced lifetime expectancy.

### 3.4 Washing

Clare does not recommend ultrasonic cleaning of this part.



**For additional information please visit [www.clare.com](http://www.clare.com)**

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