

## High-Speed 18V CMOS Comparators

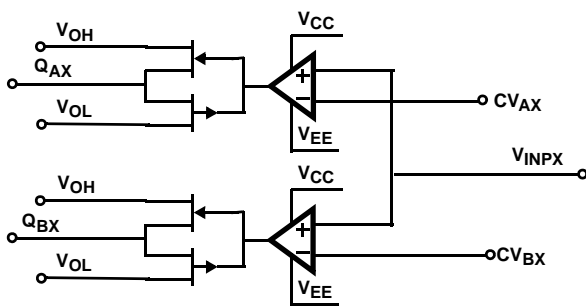
ISL55141, ISL55142, ISL55143 integrated circuits are high-speed, wide input common-mode range comparators. They provide three-state window comparators in a high voltage CMOS process (18V). Each comparator has dual receive thresholds,  $CV_A$  and  $CV_B$ , for establishing minimum  $1-V_{IH}$  and maximum  $0-V_{IL}$  voltage levels. These devices can accept inputs from a number of logic families, such as TTL, ECL, CMOS, LVCMOS, LVDS and CML. Two bits of output per comparator provide the test controller with qualification of a comparator input into three states. The two output bits work with a separate user supply to establish  $V_{OH}$ ,  $V_{OL}$  levels compatibility with the system's controller logic levels.

Fast propagation delay (9.5ns typical at  $\pm 50mV$  overdrive) makes this family compatible with high-speed digital test systems. The 18V range enables the comparator input to operate over a wide input range. Two references per input enable and three state digitization of input with voltage swings of up to 13V common mode. The operating frequency of these devices is typically 65MHz.

High voltage CMOS process makes these devices ideal for large voltage swing applications, such as special test voltages levels associated with Flash devices or power supervision applications and may avoid the need for test bus isolation relay(s).

## Functional Block Diagram

DUAL LEVEL COMPARATOR - RECEIVERS



x denotes 1, 2 or 4 channels for ISL55141, ISL55142 and ISL55143, respectively

## Features

- 18V I/O range
- 65MHz operation
- 9.5ns typical propagation delay
- Programmable input thresholds
- User defined comparator output levels
- Common-mode range includes negative rails
- Small footprints in QFN packages
- Power-down current  $<10\mu A$
- Pb-free plus anneal available (RoHS compliant)

## Applications

- Burn in ATE
- Low cost ATE
- Fast supervisory power control
- Instrumentation

## Ordering Information

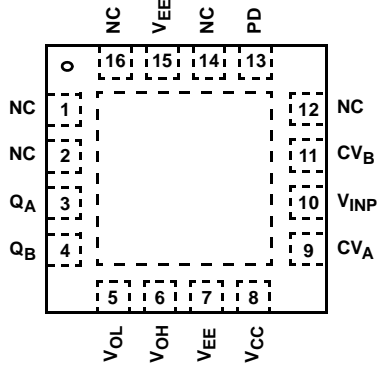
PART NUMBER	PART MARKING	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
ISL55141IRZ* (See Note)	55141IRZ	-40 to +85	16 Ld QFN (Pb-free)	L16.4X4A
ISL55141IVZ* (See Note)	55141IVZ	-40 to +85	14 Ld TSSOP (Pb-free)	M14.173
ISL55142IRZ* (See Note)	55142IRZ	-40 to +85	20 Ld QFN (Pb-free)	L20.5x5
ISL55142IVZ* (See Note)	55142IVZ	-40 to +85	20 Ld TSSOP (Pb-free)	M20.173
ISL55143IRZ* (See Note)	55143IRZ	-40 to +85	36 Ld TQFN (Pb-free)	L36.6X6

\* Add "-T" suffix for tape and reel.

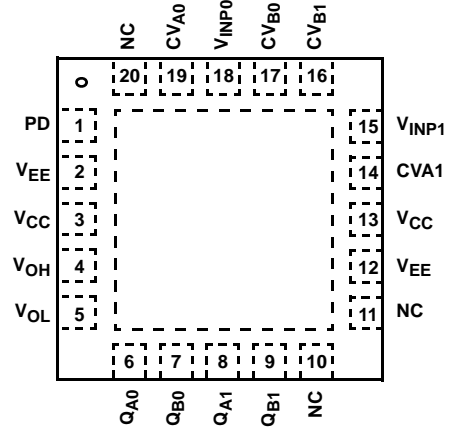
NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Pinouts

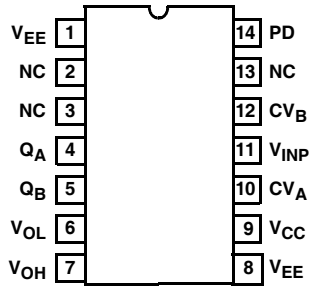
ISL55141 SINGLE DEVICE  
(4X4 QFN)  
TOP VIEW



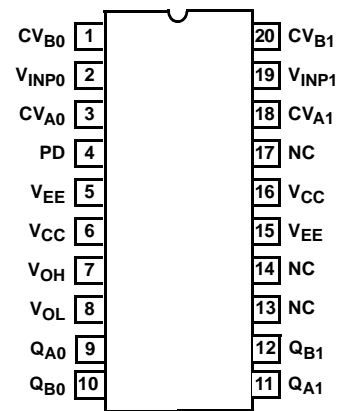
ISL55142 SINGLE DEVICE  
(5X5 QFN)  
TOP VIEW



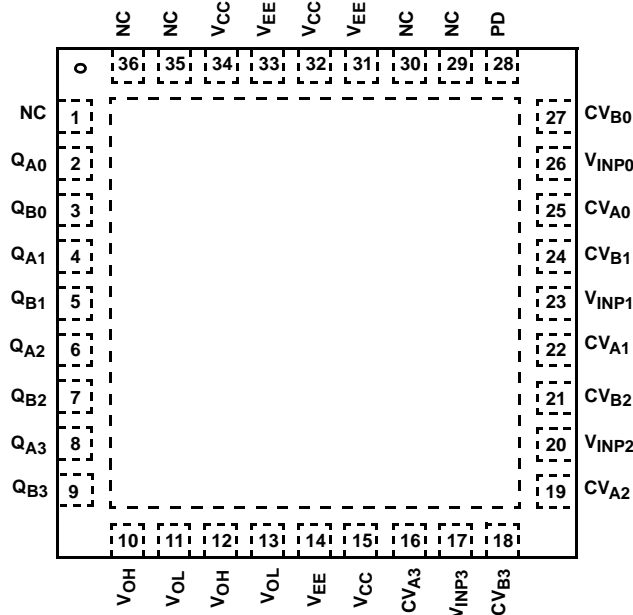
ISL55141 (TSSOP)  
TOP VIEW



ISL55142 (TSSOP)  
TOP VIEW



ISL55143 QUAD DEVICE  
(6X6 TQFN)  
TOP VIEW



**Pin Descriptions**

PIN	FUNCTION
V <sub>EE</sub>	Negative supply input
Q <sub>AX</sub>	Channel A, CV <sub>AX</sub> reference driven. Comparator output.
Q <sub>BX</sub>	Channel B, CV <sub>BX</sub> reference driven. Comparator output.
V <sub>OL</sub>	Comparator output logic low supply. Unbuffered analog input that sets all Q <sub>AX</sub> , Q <sub>BX</sub> "low" voltage level.
V <sub>OH</sub>	Comparator output logic high supply. Unbuffered analog input that sets all Q <sub>AX</sub> , Q <sub>BX</sub> "high" voltage level.
V <sub>CC</sub>	Positive supply input.
CV <sub>AX</sub>	Channel A comparator reference analog input.
V <sub>INPX</sub>	Window comparator input. Common to both channel Ax and channel Bx.
CV <sub>BX</sub>	Channel B comparator reference analog input.
PD	Power-down logic input (connect to V <sub>EE</sub> if not used for power-down).
NC	No internal connection.

**TABLE 1. CV<sub>A</sub>-Q<sub>A</sub> AND CV<sub>B</sub>-Q<sub>B</sub> BASIC COMPARATOR TRUTH TABLE**

INPUT		OUTPUTS*	
V <sub>INPX</sub>		Q <sub>AX</sub>	Q <sub>BX</sub>
<CV <sub>AX</sub>	<CV <sub>BX</sub>	0	0
<CV <sub>AX</sub>	>CV <sub>BX</sub>	0	1
>CV <sub>AX</sub>	<CV <sub>BX</sub>	1	0
>CV <sub>AX</sub>	>CV <sub>BX</sub>	1	1
* When Q <sub>AX</sub> /Q <sub>BX</sub> = 1, Output is connect to V <sub>OH</sub>			
* When Q <sub>AX</sub> /Q <sub>BX</sub> = 0, Output is connect to V <sub>OL</sub>			

# ISL55141, ISL55142, ISL55143

## Absolute Maximum Ratings

$V_{CC}$ to $V_{EE}$ .....	-0.5V to 19V
Input Voltages	
PD, $CV_{AX}$ , $CV_{BX}$ , $V_{INPX}$ , $V_{OH}$ , $V_{OL}$	
.....	( $V_{EE}$ -0.5V) to ( $V_{CC}$ +0.5V)
Output Voltage	
$Q_{AX}$ , $Q_{BX}$ .....	( $V_{OL}$ -0.5V) to ( $V_{OH}$ +0.5V)

## Thermal Information

Thermal Resistance (Typical, Note 1, 2)	$\theta_{JA}$ (°C/W)
16 Ld QFN Package .....	75
14 Ld TSSOP Package .....	90
20 Ld QFN Package .....	65
20 Ld TSSOP Package .....	80
36 Ld QFN Package .....	45
Maximum Junction Temperature (Plastic Package) .....	150°C
Maximum Storage Temperature Range .....	-65°C to 150°C
Maximum Lead Temperature (Soldering 10s) .....	300°C

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### NOTE:

- $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.
- Device temperature is closely tied to data-rates, driver loads and overall pin activity. Review Power Dissipation Considerations for more information.

## Recommended Operating Conditions

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Device Power	$V_{CC}$ - $V_{EE}$	10	15	18	V
Comparator Output High Rail	$V_{OH}$	$V_{EE}+1$		$V_{CC}-0.5$	V
Comparator Output Low Rail	$V_{OL}$	$V_{EE}+0.5$		$V_{EE}+6$	V
Common Mode Input Voltage Range	$V_{CM}$	$V_{EE}$		$V_{CC}-5$	V
Ambient Temperature	$T_A$	-40	27	+85	°C
Junction Temperature	$T_J$			+125	°C

**Electrical Specifications** Test Conditions:  $V_{CC} = 12V$ ,  $V_{EE} = -3V$ ,  $V_{OH} = 5V$ ,  $V_{OL} = 0V$ ,  $PD = V_{EE}$ ,  $C_{LOAD} = 15pF$ ,  $T_A = 25^\circ C$ , unless otherwise specified.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>DC CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$	$CV_{AX} = CV_{BX} = 1.5V$	-50		50	mV
Input Bias Current	$I_{BIAS}$	$V_{INPX} - CV_{(A/B)X} = \pm 5V$		10	25	nA
Power-down Current	$I_{PD}$	$PD = V_{CC}$		8	25	$\mu A$
Power-down Time (Note 5)	$t_{PD}$			10		$\mu s$
Power-up Time (Note 5)	$t_{PU}$			15		$\mu s$
<b>TIMING CHARACTERISTICS</b>						
Propagation Delay	$t_{pd}$		4.0	9.5	15	ns
Rise Time (Note 5)	$t_r$			1.4		ns
Fall Time (Note 5)	$t_f$			1.5		ns
Propagation Delay Mismatch	$\Delta t_{pd}$			0.5	2	ns
Maximum Operating Frequency	$F_{MAXR}$	Symmetry 50%		65		MHz
Min Pulse Width	$t_{WIDR}$			7.7		ns
<b>COMPARATOR INPUT</b>						
Input Current	$I_{IN}$	$V_{INPX} = V_{CC}$ or $V_{EE}$	-100	0	100	nA
Input Capacitance (Note 5)	$C_{IN}$			2.5		pF

# ISL55141, ISL55142, ISL55143

## Electrical Specifications

Test Conditions:  $V_{CC} = 12V$ ,  $V_{EE} = -3V$ ,  $V_{OH} = 5V$ ,  $V_{OL} = 0V$ ,  $P_D = V_{EE}$ ,  $C_{LOAD} = 15pF$ ,  $T_A = 25^\circ C$ , unless otherwise specified. (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>DIGITAL OUTPUTS <math>Q_{AX}</math>, <math>Q_{BX}</math></b>						
Output Resistance	$R_{outR}$		18	27	37	$\Omega$
Output Logic High Voltage	$V_{OH}$	$V_{OH} = 5V$ , $I_{SOURCE} = 1mA$	4.9	4.95	5.0	V
Output Logic Low Voltage	$V_{OL}$	$V_{OL} = 0V$ , $I_{SINK} = 1mA$	0.00	0.05	0.1	V
<b>POWER SUPPLIES, STATIC CONDITIONS</b>						
Positive Supply DC Current/Comparator	$I_{CC}$	No input data		+8.25	12.5	mA
Negative Supply Current/Comparator	$I_{EE}$	No input data	-12.5	-8.25		mA
Total Power Dissipation/Comparator	$P^\dagger$	Input data at 40MHz		670		mW

†Total Power dissipation per comparator can be approximately calculated from the following:

$$P = (V_{CC} - V_{EE}) * 8.25mW + 90pF * (V_{CC} - V_{EE})^2 * f + C_L * (V_{CC} - V_{EE})^2 * f$$

where  $f$  is the operating frequency and  $C_L$  is the load capacitance.

Because the ISL55142 has two comparators, the power dissipation would be twice of  $P$  calculated from the above equation. The ISL55143 would be four times  $P$ .

### NOTES:

3. Lab characterization, room temperature, timing parameters matched stimulus/loads, channel-to-channel skew < 500ps, 1ns maximum by design
4. Note about  $I_{CC}$  measurement input can approach 140mA (single comparator) at maximum pattern rates
5. Not 100% Tested

## Test Circuits and Waveforms

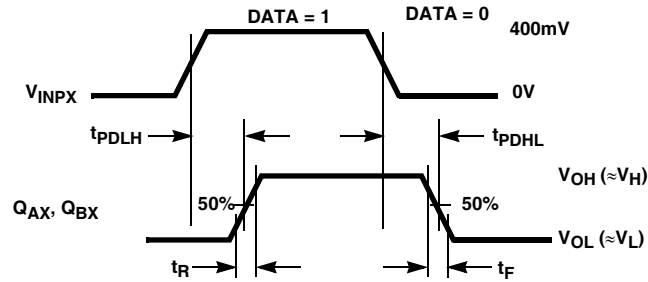


FIGURE 1. COMPARATOR PROPAGATION DELAY AND TRANSITION TIME MEASUREMENT POINTS

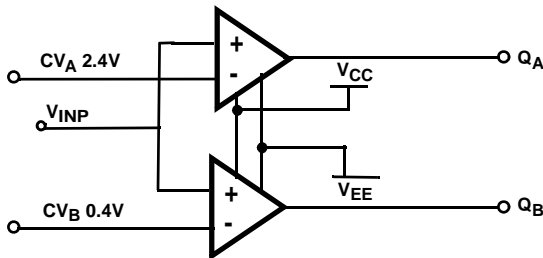


FIGURE 2. THREE-STATE WINDOW COMPARATOR FUNDAMENTALS

Although there is no electrical difference between the  $CV_A$  and  $CV_B$  Inputs, if one defines  $CV_A$  as being the high threshold and  $CV_B$  being the low threshold, it becomes easier to understand the utilization of a dual threshold comparator. Essentially this enables the qualification of an incoming signal into three states. In the case pictured, the three states are Valid Low < 0.4V, No-man's-land (between 0.4 and 2.4V), Valid High > 2.4V. Table 2 shows how the  $Q_A/Q_B$  truth table would be utilized in the real world.

TABLE 2.  $Q_A/Q_B$  TRUTH TABLE

$V_{INP}$	$Q_A$	$Q_B$	COMMENT
<0.4V	0	0	Valid 0
>0.4 and <2.4V	0	1	Invalid
>2.4V	1	1	Valid 1

Test Circuits and Waveforms (Continued)

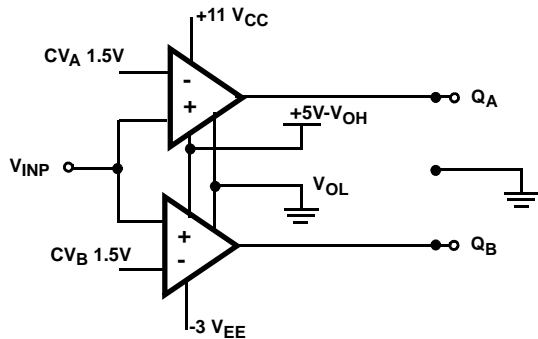


FIGURE 3.  $t_{pd}$  RECEIVER SWITCHING TEST CIRCUIT

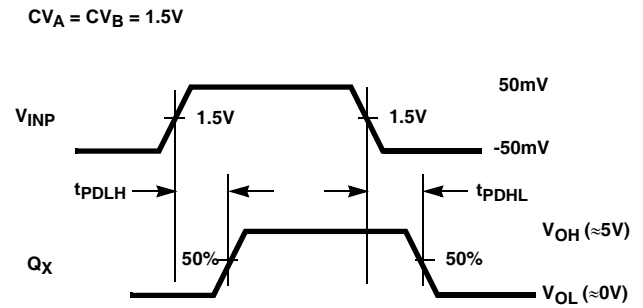


FIGURE 4.  $t_{pd}$  RECEIVER PROPAGATION DELAY MEASUREMENT POINTS

**Application Information**

The ISL55141, ISL55142, ISL55143 provide 1, 2 and 4 dual threshold, three-state window comparator(s) in TSSOP or QFN footprints. They offer a combination of speed (10ns  $T_{pd}$  and wide voltage range (18V). This product directly addresses the need for unique common-mode characteristics while supplying a power-down feature.

Figures 3 and 4 show the stimulus setup and measurement points for an example propagation delay measurement. Typical room temperature results are displayed in Figure 11.

Figure 4 shows a  $V_{INP}$  range of 50mV. In Figure 11 the offset is increased in the horizontal axis from 50mV above and below the reference (1.5V) up to 2.5V above and below the 1.5V reference.

Two lines are displayed in Figure 11. One represents the rising-to-rising delay ( $t_{PDLH}$ ) and the other the falling-to-falling delay ( $t_{PDHL}$ ).

**Comparator Features**

These three-state window comparators feature high output current capability, and user defined high and low output levels to interface with a wide variety of logic families. Each receiver comprises two comparators and each comparator has an independent threshold level input, making it easy to implement  $(Minimum\ 1 - V_{IH}) / (Maximum\ 0 - V_{IL})$  logic level comparator functions. The  $CV_{AX}$  and  $CV_{BX}$  pins set the threshold levels of the A and B comparators respectively.  $V_{OH}$  and  $V_{OL}$  set all the comparator output levels, and  $V_{OH}$  must be more positive than  $V_{OL}$ . These two inputs are unbuffered supply pins, so the sources driving these pins must provide adequate current for the expected load.  $V_{OH}$  and  $V_{OL}$  typically connect to the power supplies of the logic device driven by the comparator outputs.

The truth table for the receivers is given in Table 1. Receiver outputs are not tri-statable, and do not incorporate any on-chip short circuit current protection. Momentary short circuits to GND, or any supply voltage, will not cause permanent damage, but care must be taken to avoid longer duration short circuits. If tolerable to the application, current limiting resistors can be inserted in series with the  $Q_{AX}$  and  $Q_{BX}$  outputs to protect the receiver outputs from damage due to overcurrent conditions.

**Power-down Features**

The ISL55141, ISL55142, ISL55143 PD pin provides a means of reducing current consumption when the device is not in use. Supply currents falls from ~7mA to less than 10µA in the power-down mode. The device requires approximately 10µs to power-down and 15µs to power-up.

**Power Supply Bypassing and Printed Circuit Board Layout**

As with any high frequency device, good printed circuit board layout is necessary for optimum performance. Ground plane construction is highly recommended, lead lengths should be as short as possible, and the power supply pins must be well bypassed to reduce the risk of oscillation. For normal single supply operation, where the  $V_{EE}$  pin is connected to ground, one 0.1µF ceramic capacitor should be placed from the  $V_{CC}$  pin to ground. A 4.7µF tantalum capacitor should then be connected from the  $V_{CC}$  pin to ground. This same capacitor combination should be placed at each supply pin to ground if split supplies are to be used.

**Power Dissipation Considerations**

Specifying continuous data rates, driver loads and driver level amplitudes are key in determining power supply requirements as well as dissipation/cooling necessities. Driver output patterns also impact these needs. The faster the pin activity, the greater the need to supply current and remove heat.

The maximum power dissipation allowed in a package is determined according to:

$$P_{DMAX} = \frac{T_{JMAX} - T_{AMAX}}{\theta_{JA}}$$

where:

- $T_{JMAX}$  = Maximum junction temperature
- $T_{AMAX}$  = Maximum ambient temperature
- $\theta_{JA}$  = Thermal resistance of the package
- $P_{DMAX}$  = Maximum power dissipation in the package

**Approximate Power Dissipation**

$$(Typ) P = N * [(V_{CC} - V_{EE}) * 8.25mW + 90pF * (V_{CC} - V_{EE})^2 * f + CL * (V_{OH} - V_{OL})^2 * f]$$

where:

- N is the number of comparators in the chip (1 for ISL55141, 2 for ISL55142 and 4 for ISL55143).
- (f) is the operating frequency.
- CL is the load capacitor.

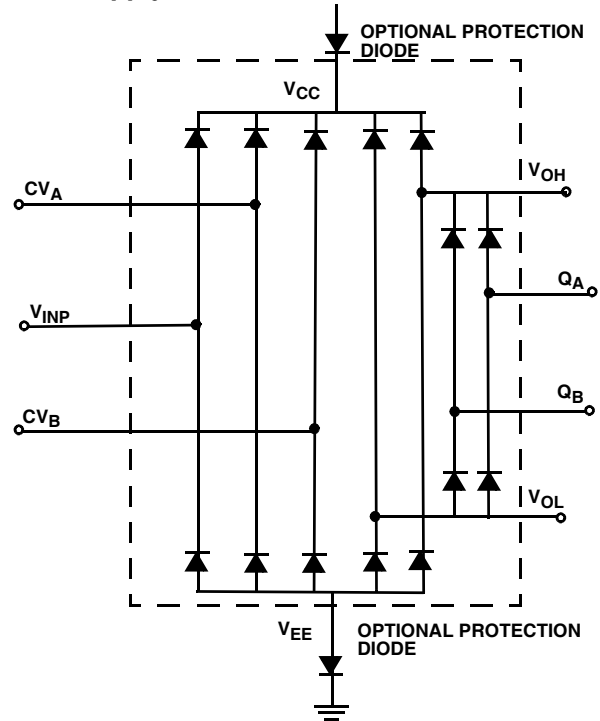
The power dissipation calculated from the above formula may have an error of ±20-25%.

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the loads. Power also depends on the number of channels changing state and frequency of operation. The extent of continuous active pattern generation/reception will greatly affect dissipation requirements.

The user should evaluate various heat sink/cooling options in order to control the ambient temperature part of the equation. This is especially true if the user's applications require continuous, high-speed operation.

*The reader is cautioned against assuming the same level of thermal performance in actual applications. A careful inspection of conditions in your application should be conducted.*

**Power Supply Information**



Circuit design must always take into account the internal EOS/ESD protection structure of the device.

**Important Note:** *The QFN package metal plane is used for heat sinking of the device. It is electrically connected to the negative supply potential (V<sub>EE</sub>). If V<sub>EE</sub> is tied to ground, the thermal pad can be connected to ground. Otherwise, the thermal pad (V<sub>EE</sub>) must be isolated from other power planes.*

**Power Supply Sequencing**

The ISL55141, ISL55142, ISL55143 reference every supply with respect to V<sub>EE</sub>. Therefore, apply V<sub>EE</sub>, V<sub>OL</sub> then V<sub>CC</sub> followed by the CV<sub>A</sub> and CV<sub>B</sub> supplies. The comparator V<sub>INP</sub> pin should not exceed V<sub>EE</sub> or V<sub>CC</sub> during power-up.

In cases where inputs may exceed voltage rails during power-up, series resistance should be employed to safeguard EOS to the ESD protection diodes.

**Typical Performance Curves** Device installed on Intersil ISL55141, ISL55142, ISL55143 Evaluation Boards.

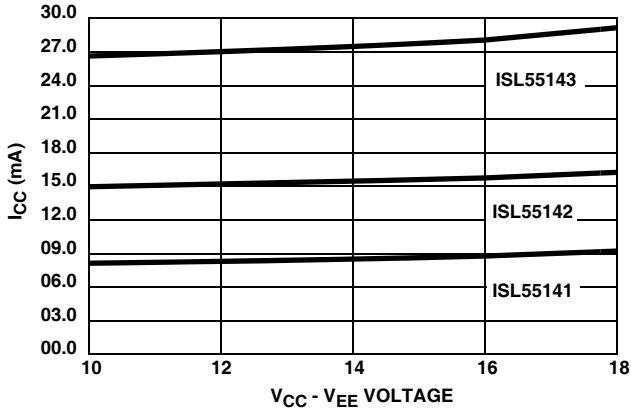


FIGURE 5. ISL55141, ISL55142, ISL55143 QUIESCENT CURRENT

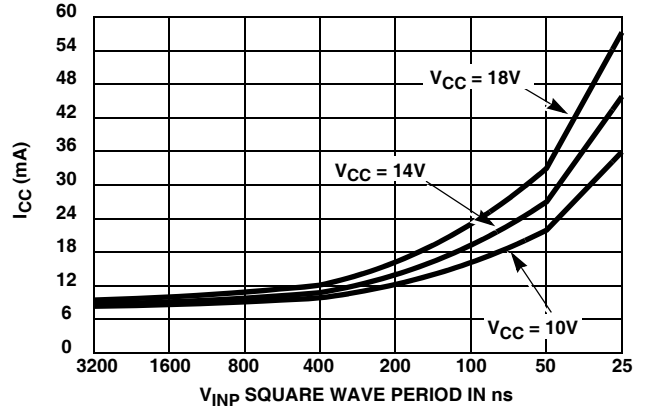


FIGURE 6. ISL55141  $I_{CC}$  vs FREQUENCY @ 10V, 14V, AND 18V

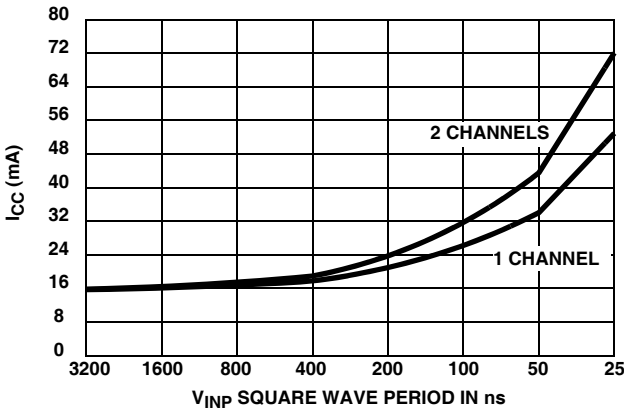


FIGURE 7. ISL55142  $I_{CC}$  1 AND 2 CHANNELS ACTIVE

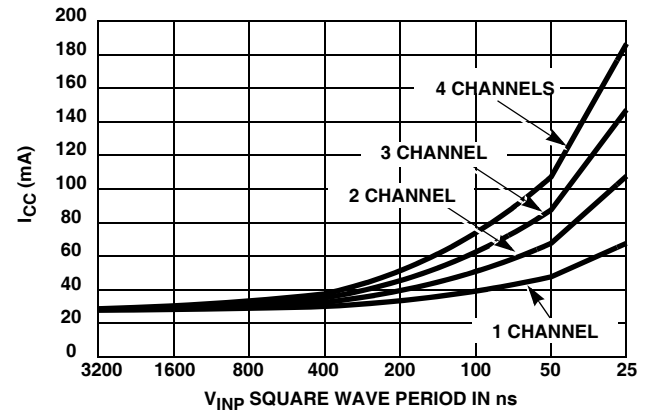


FIGURE 8. ISL55143  $I_{CC}$  1, 2, 3, 4 CHANNELS ACTIVE

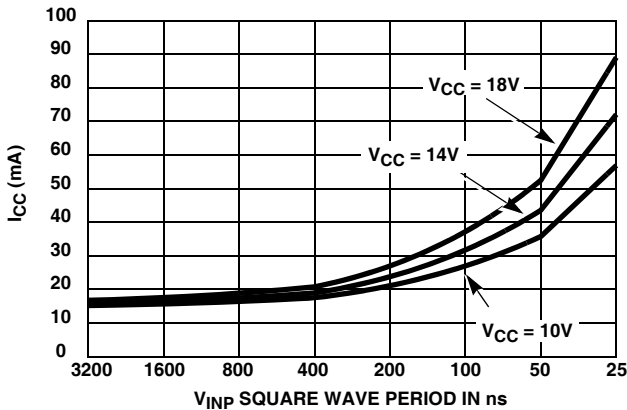


FIGURE 9. ISL55142 2-CHANNEL  $I_{CC}$  @ 10V, 14V, AND 18V

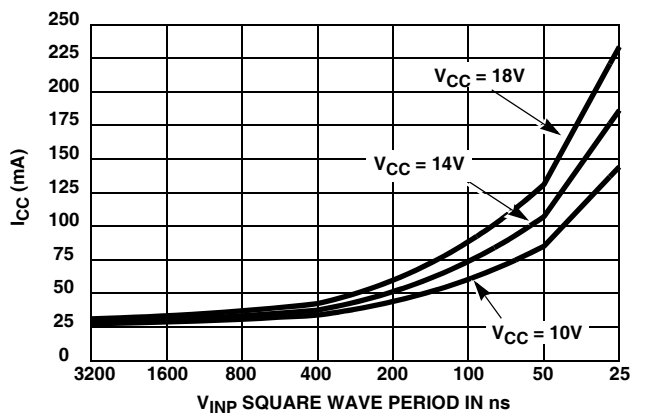


FIGURE 10. ISL55143 4-CHANNEL  $I_{CC}$  @ 10V, 14V, AND 18V



**Typical Performance Curves** Device installed on Intersil ISL55141, ISL55142, ISL55143 Evaluation Boards. (Continued)

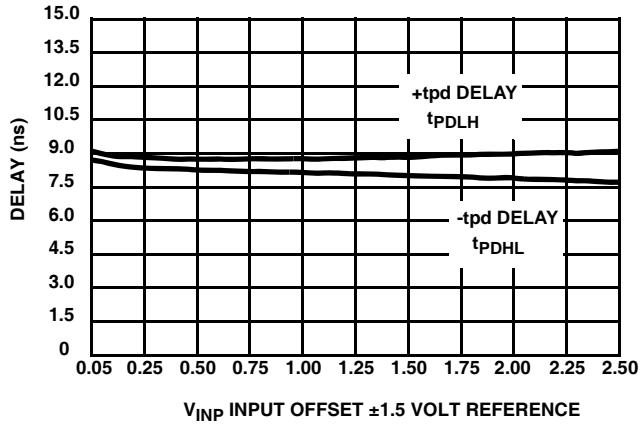


FIGURE 11. PROPAGATION DELAY @ 14V  $V_{CC}$ - $V_{EE}$

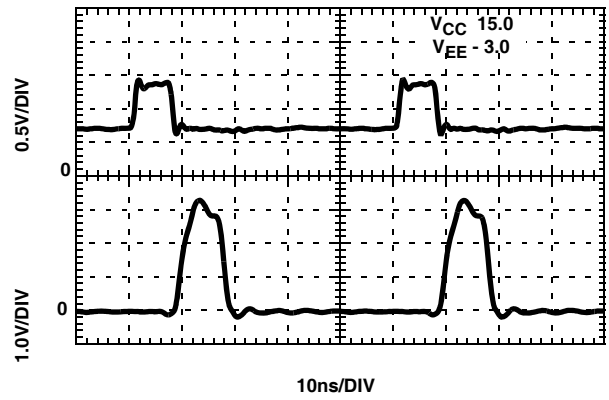
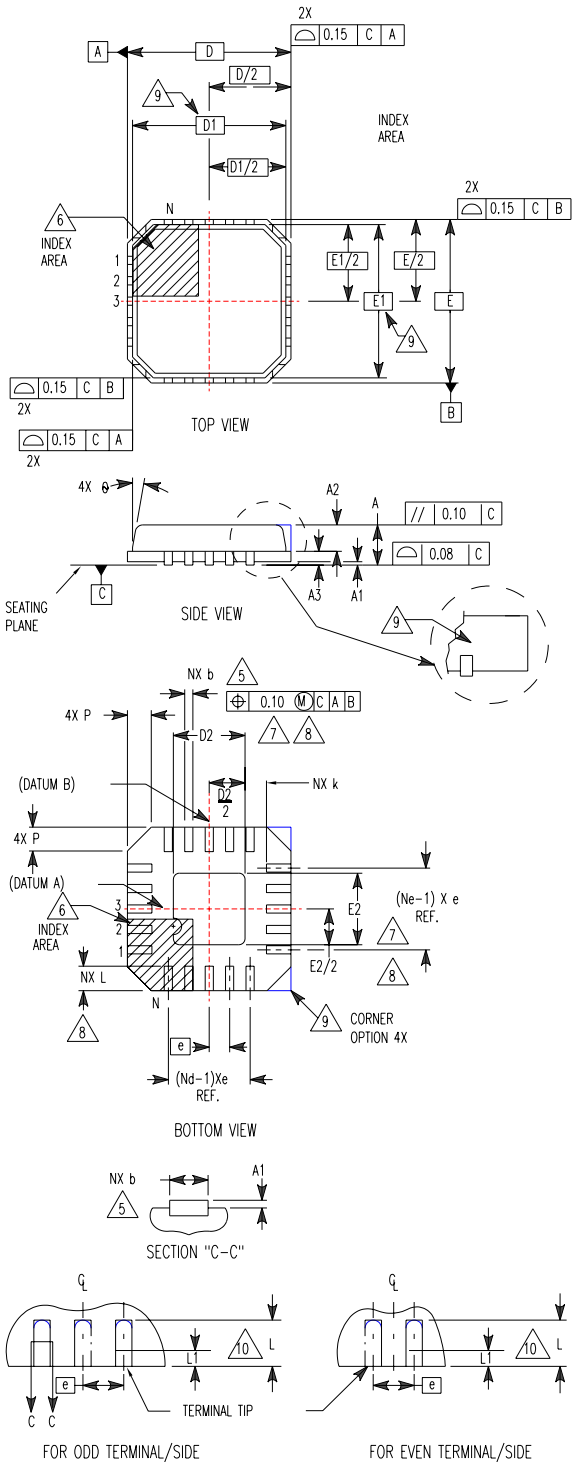


FIGURE 12. MINIMUM PULSE WIDTH RESPONSE

**Quad Flat No-Lead Plastic Package (QFN)  
Micro Lead Frame Plastic Package (MLFP)**

**L16.4x4A**

16 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE  
(COMPLIANT TO JEDEC MO-220-VGGD-10)



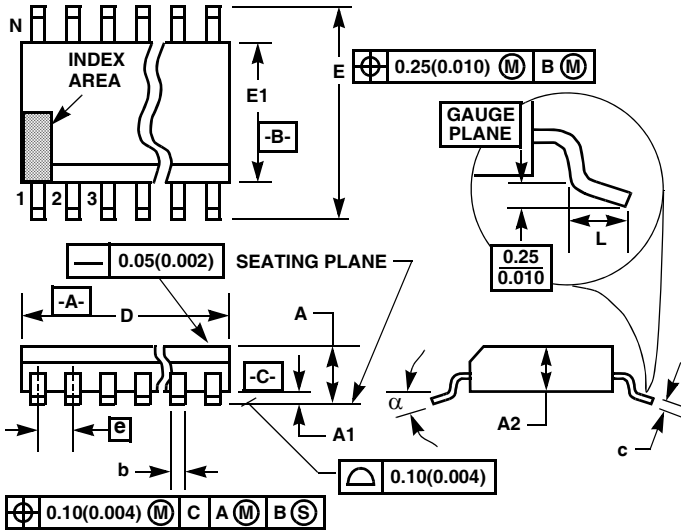
SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	0.80	0.90	1.00	-
A1	-	-	0.05	-
A2	-	-	1.00	9
A3	0.20 REF			9
b	0.18	0.25	0.30	5, 8
D	4.00 BSC			-
D1	3.75 BSC			9
D2	2.30	2.40	2.55	7, 8
E	4.00 BSC			-
E1	3.75 BSC			9
E2	2.30	2.40	2.55	7, 8
e	0.50 BSC			-
k	0.25	-	-	-
L	0.30	0.40	0.50	8
L1	-	-	0.15	10
N	16			2
Nd	4			3
Ne	4			3
P	-	-	0.60	9
θ	-	-	12	9

Rev. 2 3/06

**NOTES:**

1. Dimensioning and tolerancing conform to ASME Y14.5-1994.
2. N is the number of terminals.
3. Nd and Ne refer to the number of terminals on each D and E.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. Features and dimensions A2, A3, D1, E1, P & θ are present when Anvil singulation method is used and not present for saw singulation.
10. Depending on the method of lead termination at the edge of the package, a maximum 0.15mm pull back (L1) maybe present. L minus L1 to be equal to or greater than 0.3mm.

Thin Shrink Small Outline Plastic Packages (TSSOP)



M14.173  
14 LEAD THIN SHRINK SMALL OUTLINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.047	-	1.20	-
A1	0.002	0.006	0.05	0.15	-
A2	0.031	0.041	0.80	1.05	-
b	0.0075	0.0118	0.19	0.30	9
c	0.0035	0.0079	0.09	0.20	-
D	0.195	0.199	4.95	5.05	3
E1	0.169	0.177	4.30	4.50	4
e	0.026 BSC		0.65 BSC		-
E	0.246	0.256	6.25	6.50	-
L	0.0177	0.0295	0.45	0.75	6
N	14		14		7
α	0°	8°	0°	8°	-

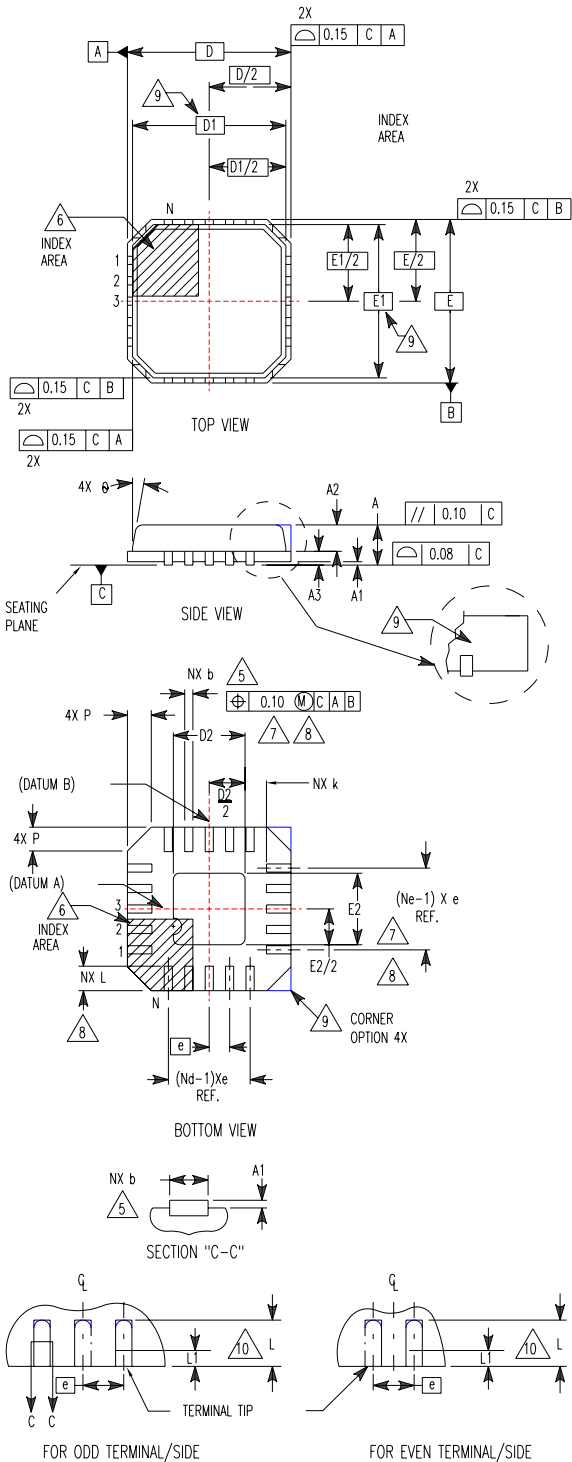
NOTES:

- These package dimensions are within allowable dimensions of JEDEC MO-153-AC, Issue E.
- Dimensioning and tolerancing per ANSI Y14.5M-1982.
- Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
- Dimension "E1" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.15mm (0.006 inch) per side.
- The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
- "L" is the length of terminal for soldering to a substrate.
- "N" is the number of terminal positions.
- Terminal numbers are shown for reference only.
- Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total in excess of "b" dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm (0.0027 inch).
- Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact. (Angles in degrees)

Rev. 2 4/06

**Quad Flat No-Lead Plastic Package (QFN)  
Micro Lead Frame Plastic Package (MLFP)**

**L20.5x5  
20 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE**



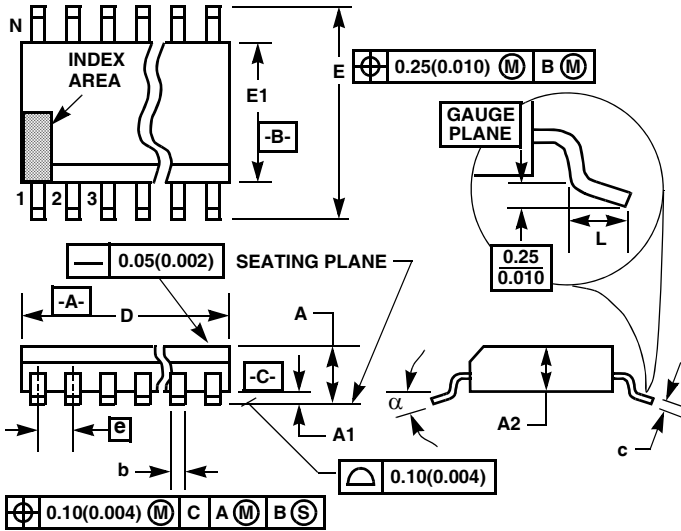
SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	0.80	0.90	1.00	-
A1	-	0.02	0.05	-
A2	-	0.65	1.00	9
A3	0.20 REF			9
b	0.23	0.30	0.38	5, 8
D	5.00 BSC			-
D1	4.75 BSC			9
D2	2.95	3.10	3.25	7, 8
E	5.00 BSC			-
E1	4.75 BSC			9
E2	2.95	3.10	3.25	7, 8
e	0.65 BSC			-
k	0.20	-	-	-
L	0.35	0.60	0.75	8
N	20			2
Nd	5			3
Ne	5			3
P	-	-	0.60	9
θ	-	-	12	9

Rev. 4 11/04

**NOTES:**

1. Dimensioning and tolerancing conform to ASME Y14.5-1994.
2. N is the number of terminals.
3. Nd and Ne refer to the number of terminals on each D and E.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.
9. Features and dimensions A2, A3, D1, E1, P & θ are present when Anvil singulation method is used and not present for saw singulation.
10. Compliant to JEDEC MO-220VHHC Issue I except for the "b" dimension.

Thin Shrink Small Outline Plastic Packages (TSSOP)



**M20.173**  
20 LEAD THIN SHRINK SMALL OUTLINE PLASTIC PACKAGE

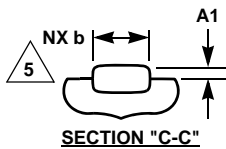
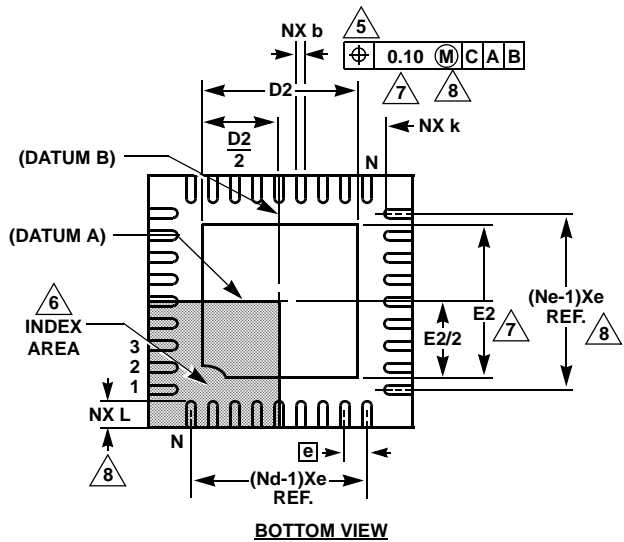
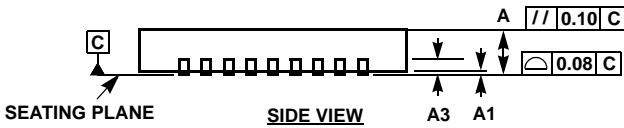
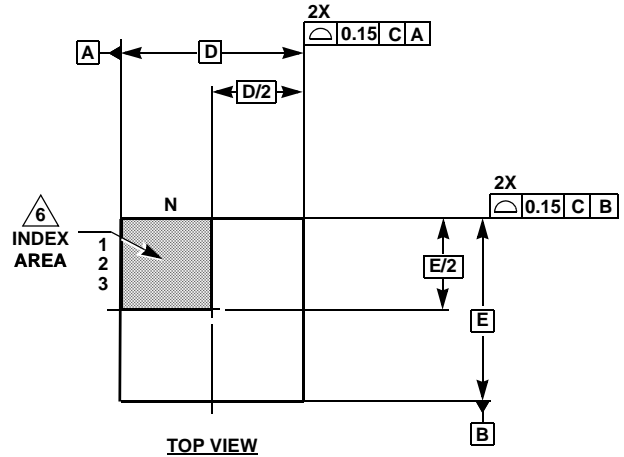
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.047	-	1.20	-
A1	0.002	0.006	0.05	0.15	-
A2	0.031	0.051	0.80	1.05	-
b	0.0075	0.0118	0.19	0.30	9
c	0.0035	0.0079	0.09	0.20	-
D	0.252	0.260	6.40	6.60	3
E1	0.169	0.177	4.30	4.50	4
e	0.026 BSC		0.65 BSC		-
E	0.246	0.256	6.25	6.50	-
L	0.0177	0.0295	0.45	0.75	6
N	20		20		7
$\alpha$	0°	8°	0°	8°	-

NOTES:

- These package dimensions are within allowable dimensions of JEDEC MO-153-AC, Issue E.
- Dimensioning and tolerancing per ANSI Y14.5M-1982.
- Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
- Dimension "E1" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.15mm (0.006 inch) per side.
- The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
- "L" is the length of terminal for soldering to a substrate.
- "N" is the number of terminal positions.
- Terminal numbers are shown for reference only.
- Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total in excess of "b" dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm (0.0027 inch).
- Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact. (Angles in degrees)

Rev. 1 6/98

Thin Quad Flat No-Lead Plastic Package (TQFN)



**L36.6x6**  
**36 LEAD THIN QUAD FLAT NO-LEAD PLASTIC PACKAGE**  
**(COMPLIANT TO JEDEC MO-220WJJD-1 ISSUE C)**

SYMBOL	MILLIMETERS			NOTES
	MIN	NOMINAL	MAX	
A	0.70	0.75	0.80	-
A1	-	-	0.05	-
A3	0.20 REF			-
b	0.18	0.25	0.30	5, 8
D	6.00 BSC			-
D2	3.80	3.95	4.05	7, 8
E	6.00 BSC			-
E2	3.80	3.95	4.05	7, 8
e	0.50 BSC			-
k	0.20	-	-	-
L	0.45	0.55	0.65	8
N	36			2
Nd	9			3
Ne	9			3

Rev. 2 04/06

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5m-1994.
2. N is the number of terminals.
3. Nd and Ne refer to the number of terminals on each D and E.
4. All dimensions are in millimeters. Angles are in degrees.
5. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
7. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
8. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts, see Intersil Technical Brief TB389.

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