

# MC10E1651

## 5V, -5V Dual ECL Output Comparator with Latch

The MC10E1651 is fabricated using ON Semiconductor's advanced MOSAIC III™ process. The MC10E1651 incorporates a fixed level of input hysteresis as well as output compatibility with 10 KH logic devices. In addition, a latch is available allowing a sample and hold function to be performed. The device is available in both a 16-pin DIP and a 20-pin surface mount package.

The latch enable ( $\overline{\text{LEN}}_a$  and  $\overline{\text{LEN}}_b$ ) input pins operate from standard ECL 10 KH logic levels. When the latch enable is at a logic high level, the MC10E1651 acts as a comparator; hence, Q will be at a logic high level if  $V_1 > V_2$  ( $V_1$  is more positive than  $V_2$ ).  $\overline{Q}$  is the complement of Q. When the latch enable input goes to a low logic level, the outputs are latched in their present state providing the latch enable setup and hold time constraints are met.

### Features

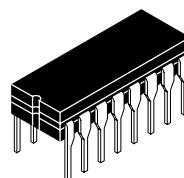
- Typical 3.0 dB Bandwidth > 1.0 GHz
- Typical V to Q Propagation Delay of 775 ps
- Typical Output Rise/Fall of 350 ps
- Common Mode Range -2.0 V to +3.0 V
- Individual Latch Enables
- Differential Outputs
- 28 mV Input Hysteresis
- Operating Mode:  $V_{CC} = 5.0 \text{ V}$ ,  $V_{EE} = -5.2 \text{ V}$ ,  $\text{GND} = 0 \text{ V}$
- No Internal Input Pulldown Resistors
- ESD Protection: > 2 kV Human Body Model, > 100 V Machine Model
- Meets or Exceeds JEDEC Spec EIA/JESD78 IC Latchup Test
- Moisture Sensitivity Level 1
- For Additional Information, see Application Note AND8003/D
- Flammability Rating: UL 94 V-0 @ 0.125 in, Oxygen Index: 28 to 34
- Transistor Count = 85 devices
- Pb-Free Packages are Available\*



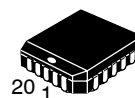
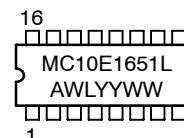
**ON Semiconductor®**

<http://onsemi.com>

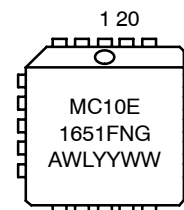
### MARKING DIAGRAMS



**CDIP-16  
L SUFFIX  
CASE 620A**



**PLCC-20  
FN SUFFIX  
CASE 775**



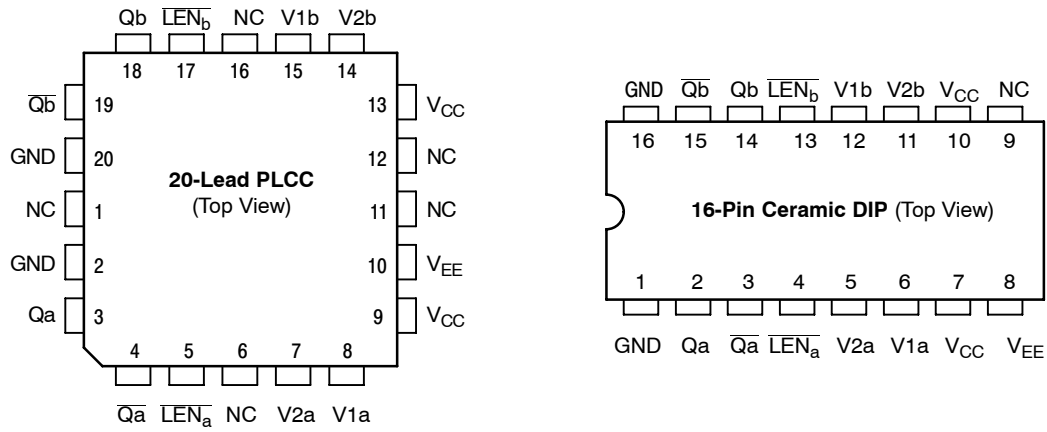
|    |                     |
|----|---------------------|
| A  | = Assembly Location |
| WL | = Wafer Lot         |
| YY | = Year              |
| WW | = Work Week         |
| G  | = Pb-Free Package   |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

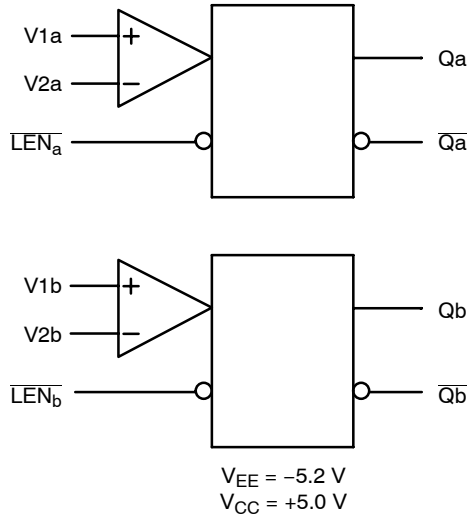
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\* All  $V_{CC}$  and  $V_{CCO}$  pins are NOT tied together on the die.

Warning: All  $V_{CC}$ , GND, and  $V_{EE}$  pins must be externally connected to Power Supply to guarantee proper operation.

**Figure 1. Logic Diagrams and Pinout Assignments**



**Figure 2. Logic Diagram**

**Table 1. PIN DESCRIPTION**

| PIN                                   | FUNCTION                     |
|---------------------------------------|------------------------------|
| Qa, $\overline{Qa}$                   | ECL Differential Outputs (a) |
| Qb, $\overline{Qb}$                   | ECL Differential Outputs (b) |
| $\overline{LENa}$ , $\overline{LENb}$ | ECL Latch Enable             |
| V1a, V1b                              | Input Comparator 1           |
| V2a, V2b                              | Input Comparator 2           |
| $V_{CC}$                              | Positive Supply              |
| $V_{EE}$                              | Negative Supply              |
| NC                                    | No Connect                   |
| GND                                   | Ground                       |

**Table 2. FUNCTION TABLE**

| $\overline{LEN}$ | V1, V2    | Function |
|------------------|-----------|----------|
| H                | $V1 > V2$ | H        |
| H                | $V1 < V2$ | L        |
| L                | X         | Latched  |

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**Table 3. MAXIMUM RATINGS**

| Symbol           | Parameter                                | Condition 1                          | Condition 2        | Rating                                             | Unit         |
|------------------|------------------------------------------|--------------------------------------|--------------------|----------------------------------------------------|--------------|
| V <sub>SUP</sub> | Total Supply Voltage                     | V <sub>EE</sub>   +  V <sub>CC</sub> |                    | 12.0                                               | V            |
| V <sub>PP</sub>  | Differential Input Voltage               | V <sub>1</sub> – V <sub>2</sub>      |                    | 3.7                                                | V            |
| V <sub>I</sub>   | Input Voltage                            |                                      |                    | V <sub>EE</sub> ≤ V <sub>I</sub> ≤ V <sub>CC</sub> | V            |
| I <sub>out</sub> | Output Current                           | Continuous Surge                     |                    | 50<br>100                                          | mA<br>mA     |
| T <sub>A</sub>   | Operating Temperature Range              |                                      |                    | 0 to +85                                           | °C           |
| T <sub>stg</sub> | Storage Temperature Range                |                                      |                    | –65 to +150                                        | °C           |
| θ <sub>JA</sub>  | Thermal Resistance (Junction–to–Ambient) | 0 lfpm<br>500 lfpm                   | 28 PLCC<br>28 PLCC | 63.5<br>43.5                                       | °C/W<br>°C/W |
| θ <sub>JC</sub>  | Thermal Resistance (Junction–to–Case)    | Standard Board                       | 28 PLCC            | 22 to 26                                           | °C/W         |
| V <sub>EE</sub>  | Operating Range                          | GND = 0 V                            |                    | –4.2 to –5.7                                       | V            |
| T <sub>sol</sub> | Wave Solder<br>Pb<br>Pb–Free             | ≤ 3 sec @ 248°C<br>≤ 3 sec @ 260°C   |                    | 265<br>265                                         | °C           |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

**Table 4. DC CHARACTERISTICS** V<sub>CC</sub> = +5.0 V ±5%; V<sub>EE</sub> = –5.2 V ±5%, V<sub>CC</sub> = 0 V (Note 1)

| Symbol                             | Characteristic                                                                                     | 0°C   |      |           | 25°C  |      |           | 85°C  |     |           | Unit |
|------------------------------------|----------------------------------------------------------------------------------------------------|-------|------|-----------|-------|------|-----------|-------|-----|-----------|------|
|                                    |                                                                                                    | Min   | Typ  | Max       | Min   | Typ  | Max       | Min   | Typ | Max       |      |
| V <sub>OH</sub>                    | Output HIGH Voltage (Note 1)                                                                       | –1020 |      | –840      | –980  |      | –810      | –920  |     | –735      | mV   |
| V <sub>OL</sub>                    | Output Low Voltage (Note 1)                                                                        | –1950 |      | –1630     | –1950 |      | –1630     | –1950 |     | –1600     | mV   |
| V <sub>IL</sub>                    | Input LOW Voltage ( $\overline{\text{LEN}}$ ) (Note 1)                                             | –1.95 |      | –1.48     | –1.95 |      | –1.48     | –1.95 |     | –1.45     | mV   |
| V <sub>IH</sub>                    | Input HIGH Voltage ( $\overline{\text{LEN}}$ ) (Note 1)                                            | –1.17 |      | –0.84     | –1.13 |      | –0.81     | –1.07 |     | –0.735    | mV   |
| I <sub>I</sub><br>I <sub>IH</sub>  | Input Current (V <sub>1</sub> , V <sub>2</sub> )<br>Input HIGH Current ( $\overline{\text{LEN}}$ ) |       |      | 65<br>150 |       |      | 65<br>150 |       |     | 65<br>150 | μA   |
| I <sub>CC</sub><br>I <sub>EE</sub> | Positive Supply Current<br>Negative Supply Current                                                 |       |      | 50<br>–55 |       |      | 50<br>–55 |       |     | 50<br>–55 | mA   |
| V <sub>CMR</sub>                   | Common Mode Range (Note 2)                                                                         | –2.0  |      | 3.0       | –2.0  |      | 3.0       | –2.0  |     | 3.0       | V    |
| Hys                                | Hysteresis                                                                                         |       | 27   |           |       | 27   |           |       | 30  |           | mV   |
| V <sub>skew</sub>                  | Hysteresis Skew (Note 3)                                                                           |       | –1.0 |           |       | –1.0 |           |       | 0   |           | mV   |
| C <sub>in</sub>                    | Input Capacitance<br>DIP<br>PLCC                                                                   |       |      | 3<br>2    |       |      | 3<br>2    |       |     | 3<br>2    | pF   |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

1. Input V<sub>IL</sub> and V<sub>IH</sub> parameters vary 1:1 with V<sub>CC</sub>. Output V<sub>OH</sub> and V<sub>OL</sub> parameters vary 1:1 with GND.
2. V<sub>CMR</sub> Min varies 1:1 with V<sub>EE</sub>; Max varies 1:1 with V<sub>CC</sub>.
3. Hysteresis skew (V<sub>skew</sub>) is provided to indicate the offset of the hysteresis window. For example, at 25°C the nominal hysteresis value is 27 mV and the V<sub>skew</sub> value indicates that the hysteresis was skewed from the reference level by 1mV in the negative direction. Hence the hysteresis window ranged from 14 mV below the reference level to 13 mV above the reference level. All hysteresis measurements were determined using a reference voltage of 0 mV.

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**Table 5. AC CHARACTERISTICS**  $V_{CC} = +5.0\text{ V} \pm 5\%$ ;  $V_{EE} = -5.2\text{ V} \pm 5\%$ ,  $V_{CC} = 0\text{ V}$  (Note 4)

| Symbol                 | Characteristic                                                          | 0°C        |            |             | 25°C       |            |             | 85°C       |             |              | Unit |
|------------------------|-------------------------------------------------------------------------|------------|------------|-------------|------------|------------|-------------|------------|-------------|--------------|------|
|                        |                                                                         | Min        | Typ        | Max         | Min        | Typ        | Max         | Min        | Typ         | Max          |      |
| $f_{MAX}$              | Maximum Toggle Frequency                                                |            | TBD        |             |            | > 1.0      |             |            | TBD         |              | GHz  |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay to Output (Note 4)<br>V to Q<br>$\overline{LEN}$ to Q | 750<br>550 | 900<br>725 | 1050<br>900 | 775<br>550 | 925<br>750 | 1075<br>900 | 850<br>650 | 1025<br>825 | 1200<br>1000 | ps   |
| $t_s$                  | Setup Time V                                                            | 450        | 300        |             | 450        | 300        |             | 550        | 350         |              | ps   |
| $t_h$                  | Enable Hold Time V                                                      | -50        | -250       |             | -50        | -250       |             | -100       | -250        |              | ps   |
| $t_{pw}$               | Minimum Pulse Width $\overline{LEN}$                                    | 400        |            |             | 400        |            |             | 400        |             |              | ps   |
| $t_{skew}$             | Within Device Skew (Note 5)                                             |            | 15         |             |            | 15         |             |            | 15          |              | ps   |
| $t_{JITTER}$           | Cycle-to-Cycle Jitter                                                   |            | TBD        |             |            | TBD        |             |            | TBD         |              | ps   |
| $T_{DE}$               | Delay Dispersion<br>(ECL Levels) (Notes 6, 7)<br>(Notes 6, 8)           |            |            |             |            | 100<br>60  |             |            |             |              | ps   |
| $T_{DL}$               | Delay Dispersion<br>(TTL Levels) (Notes 9, 10)<br>(Notes 8, 9)          |            |            |             |            | 350<br>100 |             |            |             |              | ps   |
| $t_r$<br>$t_f$         | Rise/Fall Times<br>(20-80%)                                             | 225        | 325        | 475         | 225        | 325        | 475         | 250        | 375         | 500          | ps   |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- Input  $V_{IL}$  and  $V_{IH}$  parameters vary 1:1 with  $V_{CC}$ , output  $V_{OH}$  and  $V_{OL}$  parameters vary 1:1 with GND.
- $t_{skew}$  is the propagation delay skew between comparator A and comparator B for a particular part under identical input conditions.
- Refer to figure 4 and note that the input is at 850mV ECL levels with the input threshold range between the 20% and 80% points. The delay is measured from the crosspoint of the input signal and the threshold value to the crosspoint of the Q and  $\overline{Q}$  output signals.
- The slew rate is 0.25 V/NS for input rising edges.
- The slew rate is 0.75 V/NS for input rising edges.
- Refer to Figure 5 and note that the input is at 2.5 V TTL levels with the input threshold range between the 20% and 80% points. The delay is measured from the crosspoint of the input signal and the threshold value to the crosspoint of the Q and  $\overline{Q}$  output signals.
- The slew rate is 0.3 V/NS for input rising edges.

## APPLICATIONS INFORMATION

The timing diagram (Figure 3.) is presented to illustrate the MC10E1651's compare and latch features. When the signal on the  $\overline{\text{LEN}}$  pin is at a logic high level, the device is operating in the "compare mode," and the signal on the input arrives at the output after a nominal propagation delay ( $t_{\text{PHL}}$ ,  $t_{\text{PLH}}$ ). The input signal must be asserted for a time,  $t_s$ , prior to the negative going transition on  $\overline{\text{LEN}}$  and held for a time,  $t_h$ , after the  $\overline{\text{LEN}}$  transition. After time  $t_h$ , the latch is operating in the "latch mode," thus transitions on the input do not appear at the output. The device continues to operate in the "latch mode" until the latch is asserted once again. Moreover, the  $\overline{\text{LEN}}$  pulse must meet the minimum pulse width ( $t_{\text{pw}}$ ) requirement to effect the correct input-output relationship. Note that the  $\overline{\text{LEN}}$  waveform in Figure 3. shows the  $\overline{\text{LEN}}$  signal swinging around a reference labeled  $\text{V}_{\text{BB\_INT}}$ ; this waveform emphasizes the requirement that  $\overline{\text{LEN}}$  follow typical ECL 10KH logic levels because

$\text{V}_{\text{BB\_INT}}$  is the internally generated reference level, hence is nominally at the ECL  $\text{V}_{\text{BB}}$  level.

Finally,  $\text{V}_{\text{OD}}$  is the input voltage overdrive and represents the voltage level beyond the threshold level ( $\text{V}_{\text{THR}}$ ) to which the input is driven. As an example, if the threshold level is set on one of the comparator inputs as 80 mV and the input signal swing on the complementary input is from zero to 100 mV, the positive going overdrive would be 20 mV and the negative going overdrive would be 80 mV. The result of differing overdrive levels is that the devices have shorter propagation delays with greater overdrive because the threshold level is crossed sooner than the case of lower overdrive levels. Typically, semiconductor manufactures refer to the threshold voltage as the input offset voltage (VOS) since the threshold voltage is the sum of the externally supplied reference voltage and inherent device offset voltage.

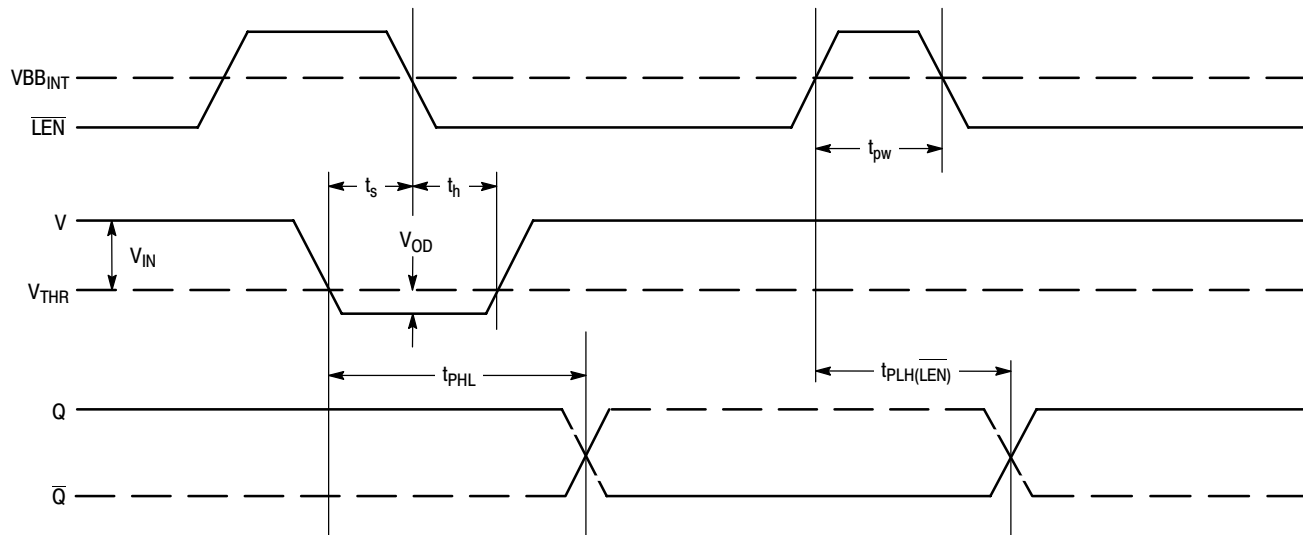


Figure 3. Input/Output Timing Diagram

## DELAY DISPERSION

Under a constant set of input conditions comparators have a specified nominal propagation delay. However, since propagation delay is a function of input slew rate and input voltage overdrive the delay dispersion parameters,  $T_{DE}$  and  $T_{DT}$ , are provided to allow the user to adjust for these variables (where  $T_{DE}$  and  $T_{DT}$  apply to inputs with standard ECL and TTL levels, respectively).

Figure 4 and Figure 5 define a range of input conditions which incorporate varying input slew rates and input voltage overdrive. For input parameters that adhere to these constraints the propagation delay can be described as:

$$T_{NOM} \pm T_{DE} \text{ (or } T_{DT})$$

where  $T_{NOM}$  is the nominal propagation delay.  $T_{NOM}$  accounts for nonuniformity introduced by temperature and voltage variability, whereas the delay dispersion parameter takes into consideration input slew rate and input voltage overdrive variability. Thus a modified propagation delay can be approximated to account for the effects of input conditions that differ from those under which the parts were tested. For example, an application may specify an ECL input with a slew rate of 0.25 V/NS, an overdrive of 17 mV and a temperature of 25°C, the delay dispersion parameter would be 100 ps. The modified propagation delay would be

$$775 \text{ ps} \pm 100 \text{ ps}$$

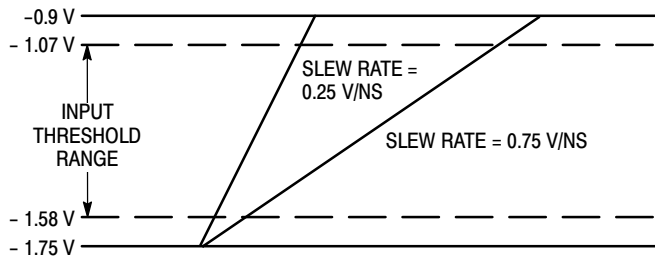


Figure 4. ECL Dispersion Test Input Conditions

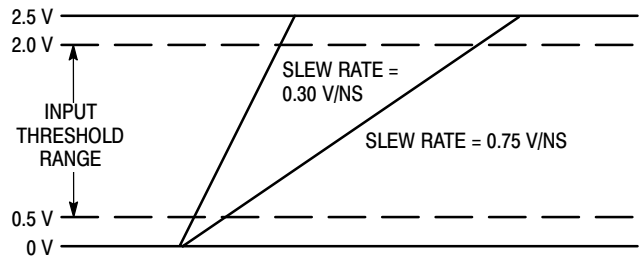
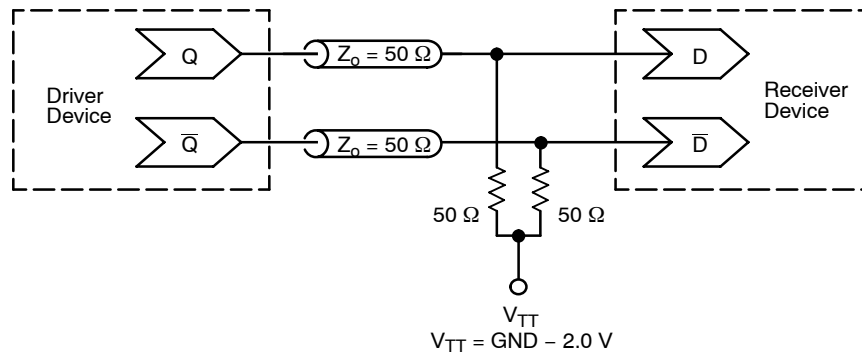


Figure 5. TTL Dispersion Test Input Conditions

## MC10E1651



**Figure 6. Typical Termination for Output Driver and Device Evaluation**  
(See Application Note AND8020/D – Termination of ECL Logic Devices.)

### ORDERING INFORMATION

| Device         | Package              | Shipping <sup>†</sup> |
|----------------|----------------------|-----------------------|
| MC10E1651L     | CDIP-16              | 25 Units / Rail       |
| MC10E1651FN    | PLCC-20              | 46 Units / Rail       |
| MC10E1651FNG   | PLCC-20<br>(Pb-Free) | 46 Units / Rail       |
| MC10E1651FNR2  | PLCC-20              | 500 / Tape & Reel     |
| MC10E1651FNR2G | PLCC-20<br>(Pb-Free) | 500 / Tape & Reel     |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

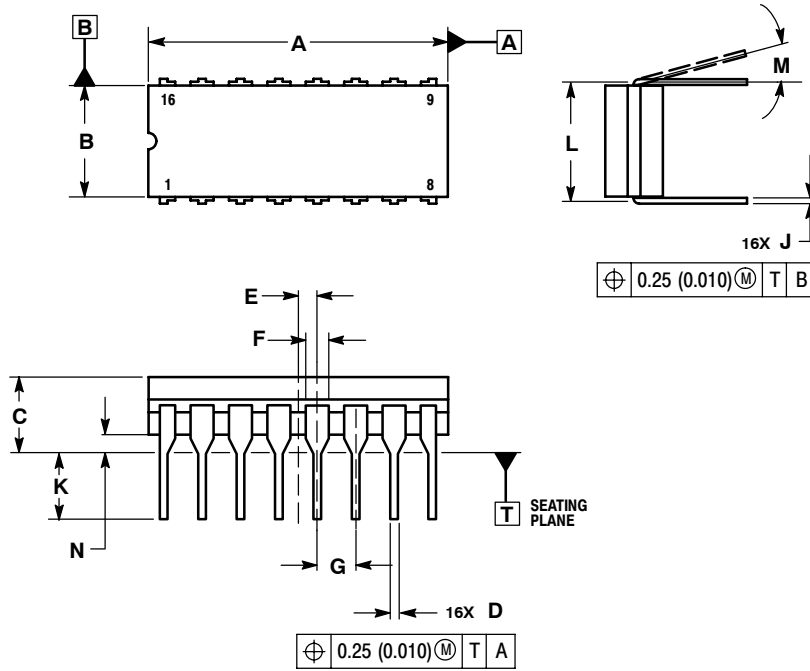
### Resource Reference of Application Notes

- AN1405/D** – ECL Clock Distribution Techniques
- AN1406/D** – Designing with PECL (ECL at +5.0 V)
- AN1503/D** – ECLinPS™ I/O SPICE Modeling Kit
- AN1504/D** – Metastability and the ECLinPS Family
- AN1568/D** – Interfacing Between LVDS and ECL
- AN1672/D** – The ECL Translator Guide
- AND8001/D** – Odd Number Counters Design
- AND8002/D** – Marking and Date Codes
- AND8020/D** – Termination of ECL Logic Devices
- AND8066/D** – Interfacing with ECLinPS
- AND8090/D** – AC Characteristics of ECL Devices

# MC10E1651

## PACKAGE DIMENSIONS

CDIP-16  
L SUFFIX  
CERAMIC DIP PACKAGE  
CASE 620A-01  
ISSUE O



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.
5. THIS DRAWING REPLACES OBSOLETE CASE OUTLINE 620-10.

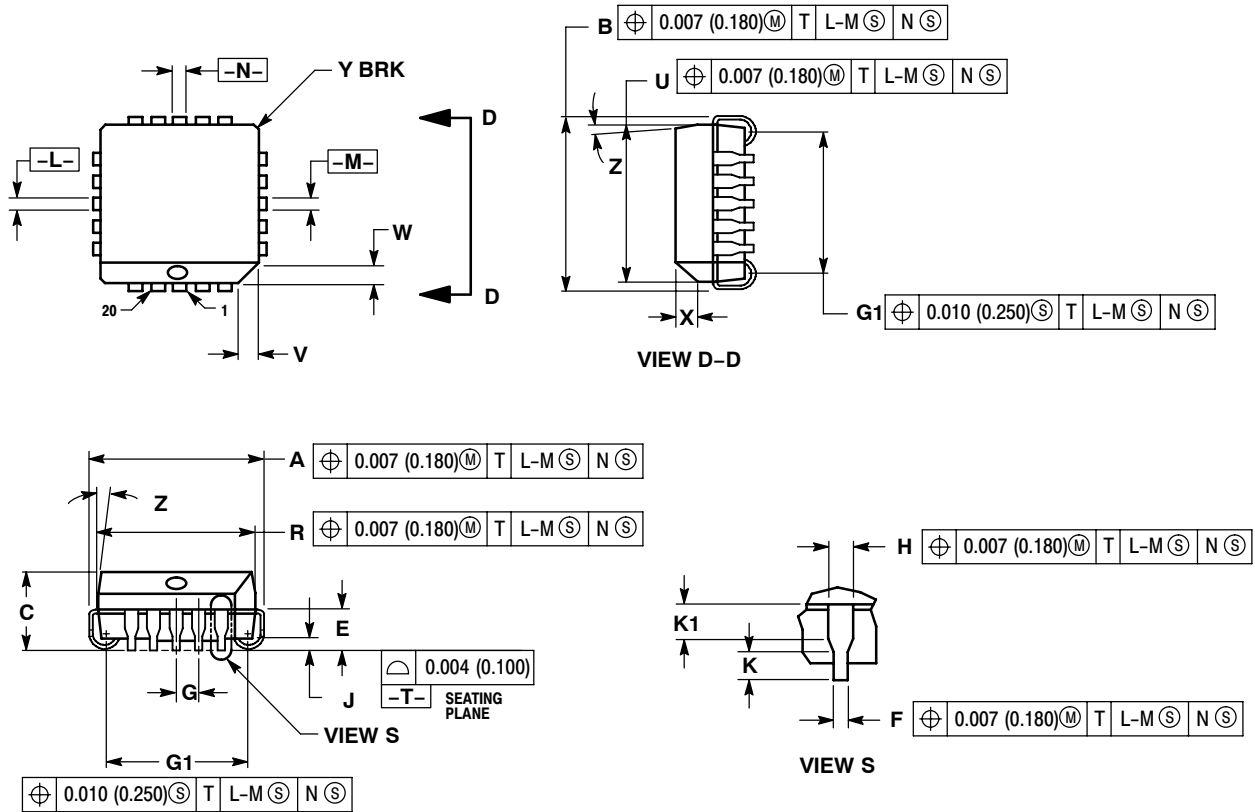
| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.750  | 0.785 | 19.05       | 19.93 |
| B   | 0.240  | 0.295 | 6.10        | 7.49  |
| C   | ---    | 0.200 | ---         | 5.08  |
| D   | 0.015  | 0.020 | 0.39        | 0.50  |
| E   | 0.050  | BSC   | 1.27        | BSC   |
| F   | 0.055  | 0.065 | 1.40        | 1.65  |
| G   | 0.100  | BSC   | 2.54        | BSC   |
| H   | 0.008  | 0.015 | 0.21        | 0.38  |
| K   | 0.125  | 0.170 | 3.18        | 4.31  |
| L   | 0.300  | BSC   | 7.62        | BSC   |
| M   | 0°     | 15°   | 0°          | 15°   |
| N   | 0.020  | 0.040 | 0.51        | 1.01  |



# MC10E1651

## PACKAGE DIMENSIONS

20 LEAD PLLC  
CASE 775-02  
ISSUE E



### NOTES:

1. DIMENSIONS AND TOLERANCING PER ANSI Y14.5M, 1982.
2. DIMENSIONS IN INCHES.
3. DATUMS -L-, -M-, AND -N- DETERMINED WHERE TOP OF LEAD SHOULDER EXITS PLASTIC BODY AT MOLD PARTING LINE.
4. DIMENSION G1, TRUE POSITION TO BE MEASURED AT DATUM -T-, SEATING PLANE.
5. DIMENSIONS R AND U DO NOT INCLUDE MOLD FLASH. ALLOWABLE MOLD FLASH IS 0.010 (0.250) PER SIDE.
6. DIMENSIONS IN THE PACKAGE TOP MAY BE SMALLER THAN THE PACKAGE BOTTOM BY UP TO 0.012 (0.300). DIMENSIONS R AND U ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.
7. DIMENSION H DOES NOT INCLUDE DAMBAR PROTRUSION OR INTRUSION. THE DAMBAR PROTRUSION(S) SHALL NOT CAUSE THE H DIMENSION TO BE GREATER THAN 0.037 (0.940). THE DAMBAR INTRUSION(S) SHALL NOT CAUSE THE H DIMENSION TO BE SMALLER THAN 0.025 (0.635).

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.385     | 0.395 | 9.78        | 10.03 |
| B   | 0.385     | 0.395 | 9.78        | 10.03 |
| C   | 0.165     | 0.180 | 4.20        | 4.57  |
| E   | 0.090     | 0.110 | 2.29        | 2.79  |
| F   | 0.013     | 0.019 | 0.33        | 0.48  |
| G   | 0.050 BSC |       | 1.27 BSC    |       |
| H   | 0.026     | 0.032 | 0.66        | 0.81  |
| J   | 0.020     | ---   | 0.51        | ---   |
| K   | 0.025     | ---   | 0.64        | ---   |
| R   | 0.350     | 0.356 | 8.89        | 9.04  |
| U   | 0.350     | 0.356 | 8.89        | 9.04  |
| V   | 0.042     | 0.048 | 1.07        | 1.21  |
| W   | 0.042     | 0.048 | 1.07        | 1.21  |
| X   | 0.042     | 0.056 | 1.07        | 1.42  |
| Y   | ---       | 0.020 | ---         | 0.50  |
| Z   | 2 °       | 10 °  | 2 °         | 10 °  |
| G1  | 0.310     | 0.330 | 7.88        | 8.38  |
| K1  | 0.040     | ---   | 1.02        | ---   |

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