# MOTOROLA

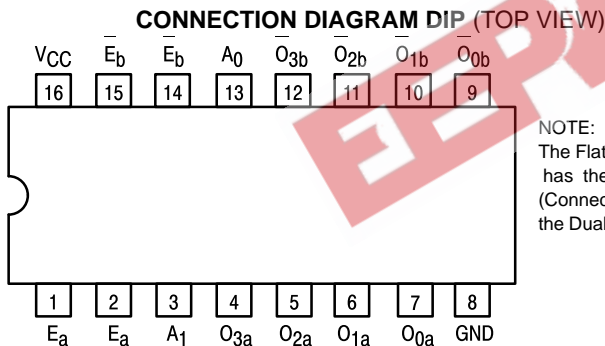# DUAL 1-OF-4 DECODER/DEMULTIPLEXER

The SN54/74LS155 and SN54/74LS156 are high speed Dual 1-of-4 Decoder/Demultiplexers. These devices have two decoders with common 2-bit Address inputs and separate gated Enable inputs. Decoder "a" has an Enable gate with one active HIGH and one active LOW input. Decoder "b" has two active LOW Enable inputs. If the Enable functions are satisfied, one output of each decoder will be LOW as selected by the address inputs. The LS156 has open collector outputs for wired-OR (DOT-AND) decoding and function generator applications.

The LS155 and LS156 are fabricated with the Schottky barrier diode process for high speed and are completely compatible with all Motorola TTL families.

- Schottky Process for High Speed
- Multifunction Capability
- Common Address Inputs
- True or Complement Data Demultiplexing
- Input Clamp Diodes Limit High Speed Termination Effects
- ESD > 3500 Volts

## CONNECTION DIAGRAM DIP (TOP VIEW)

| 16 $V_{CC}$ | 15 $\overline{E}_b$ | 14 $\overline{E}_b$ | 13 $A_0$ | 12 $\overline{O}_{3b}$ | 11 $\overline{O}_{2b}$ | 10 $\overline{O}_{1b}$ | 9 $\overline{O}_{0b}$ |
|---|---|---|---|---|---|---|---|

| 1 $\overline{E}_a$ | 2 $E_a$ | 3 $A_1$ | 4 $\overline{O}_{3a}$ | 5 $\overline{O}_{2a}$ | 6 $\overline{O}_{1a}$ | 7 $\overline{O}_{0a}$ | 8 GND |
|---|---|---|---|---|---|---|---|

NOTE:
The Flatpak version has the same pinouts (Connection Diagram) as the Dual In-Line Package.

## PIN NAMES

| | | LOADING (Note a) | |
|---|---|---|---|
| | | HIGH | LOW |
| $A_0$, $A_1$ | Address Inputs | 0.5 U.L. | 0.25 U.L. |
| $\overline{E}_a$, $\overline{E}_b$ | Enable (Active LOW) Inputs | 0.5 U.L. | 0.25 U.L. |
| $E_a$ | Enable (Active HIGH) Input | 0.5 U.L. | 0.25 U.L. |
| $\overline{O}_0 - \overline{O}_3$ | Active LOW Outputs (Note b) | 10 U.L. | 5 (2.5) U.L. |

NOTES:
a) 1 TTL Unit Load (U.L.) = 40 µA HIGH/1.6 mA LOW.
b) The Output LOW drive factor is 2.5 U.L. for Military (54) and 5 U.L. for Commercial (74) Temperature Ranges. The HIGH level drive for the LS156 must be established by an external resistor.
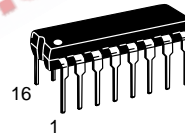
# SN54/74LS155
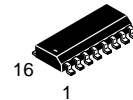# SN54/74LS156

## DUAL 1-OF-4 DECODER/DEMULTIPLEXER

### LS156-OPEN-COLLECTOR LOW POWER SCHOTTKY
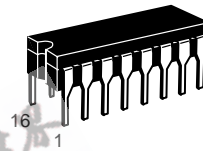


**J SUFFIX**
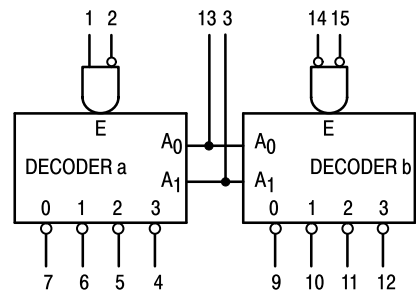CERAMIC
CASE 620-09

**N SUFFIX**
PLASTIC
CASE 648-08

**D SUFFIX**
SOIC
CASE 751B-03

## ORDERING INFORMATION

SN54LSXXXJ  Ceramic
SN74LSXXXN  Plastic
SN74LSXXXD  SOIC

## LOGIC SYMBOL



$V_{CC}$ = PIN 16
GND = PIN 8

# SN54/74LS155 • SN54/74LS156

**LOGIC DIAGRAM**



$V_{CC}$ = PIN 16
GND = PIN 8
◯ = PIN NUMBERS
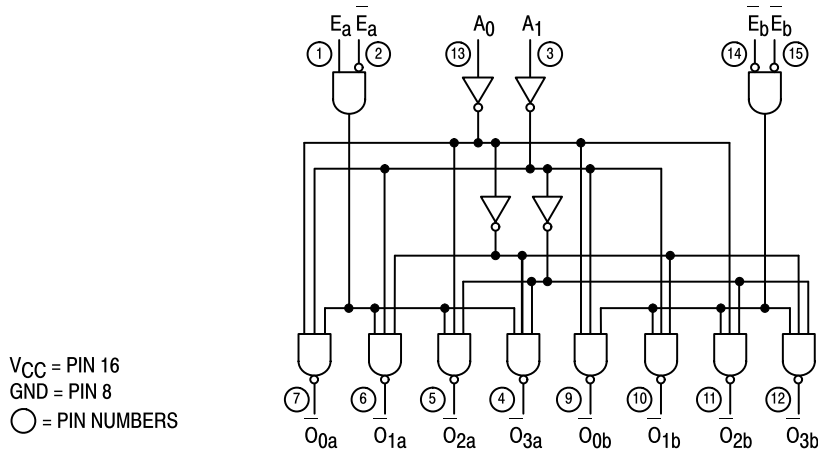
## FUNCTIONAL DESCRIPTION

The LS155 and LS156 are Dual 1-of-4 Decoder/Demultiplexers with common Address inputs and separate gated Enable inputs. When enabled, each decoder section accepts the binary weighted Address inputs ($A_0$, $A_1$) and provides four mutually exclusive active LOW outputs ($O_0 - O_3$). If the Enable requirements of each decoder are not met, all outputs of that decoder are HIGH.

Each decoder section has a 2-input enable gate. The enable gate for Decoder "a" requires one active HIGH input and one active LOW input ($E_a \bullet \overline{E}_a$). In demultiplexing applications, Decoder "a" can accept either true or complemented data by using the $E_a$ or $\overline{E}_a$ inputs respectively. The enable gate for Decoder "b" requires two active LOW inputs ($\overline{E}_b \bullet E_b$). The LS155 or LS156 can be used as a 1-of-8 Decoder/Demultiplexer by tying $E_a$ to $E_b$ and relabeling the common connection as ($A_2$). The other $\overline{E}_b$ and $\overline{E}_a$ are connected together to form the common enable.

The LS155 and LS156 can be used to generate all four minterms of two variables. These four minterms are useful in some applications replacing multiple gate functions as shown in Fig. a. The LS156 has the further advantage of being able to

AND the minterm functions by tying outputs together. Any number of terms can be wired-AND as shown below.

$$f = (E + \overline{A}_0 + \overline{A}_1) \cdot (E + \overline{A}_0 + A_1) \cdot (E + A_0 + \overline{A}_1) \cdot (E + A_0 + A_1)$$

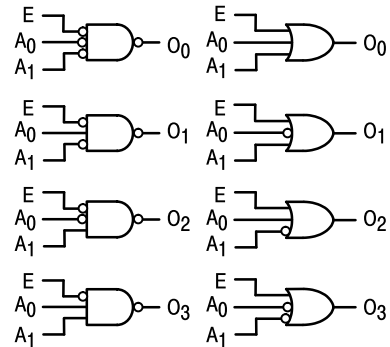where $E = E_a + \overline{E}_a$; $E = \overline{E}_b + E_b$



**Figure a**

## TRUTH TABLE

| ADDRESS | | ENABLE "a" | | OUTPUT "a" | | | | ENABLE "b" | | OUTPUT "b" | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $A_0$ | $A_1$ | $E_a$ | $\overline{E}_a$ | $O_0$ | $O_1$ | $O_2$ | $O_3$ | $\overline{E}_b$ | $E_b$ | $O_0$ | $O_1$ | $O_2$ | $O_3$ |
| X | X | L | X | H | H | H | H | H | X | H | H | H | H |
| X | X | X | H | H | H | H | H | X | H | H | H | H | H |
| L | L | H | L | L | H | H | H | L | L | L | H | H | H |
| H | L | H | L | H | L | H | H | L | L | H | L | H | H |
| L | H | H | L | H | H | L | H | L | L | H | H | L | H |
| H | H | H | L | H | H | H | L | L | L | H | H | H | L |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care

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# SN54/74LS155

**GUARANTEED OPERATING RANGES**

| Symbol | Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 54<br>74 | 4.5<br>4.75 | 5.0<br>5.0 | 5.5<br>5.25 | V |
| $T_A$ | Operating Ambient Temperature Range | 54<br>74 | −55<br>0 | 25<br>25 | 125<br>70 | °C |
| $I_{OH}$ | Output Current — High | 54, 74 | | | −0.4 | mA |
| $I_{OL}$ | Output Current — Low | 54<br>74 | | | 4.0<br>8.0 | mA |

**DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE** (unless otherwise specified)

| Symbol | Parameter | | Min | Typ | Max | Unit | Test Conditions | |
|---|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage | | 2.0 | | | V | Guaranteed Input HIGH Voltage for All Inputs | |
| $V_{IL}$ | Input LOW Voltage | 54 | | | 0.7 | V | Guaranteed Input LOW Voltage for All Inputs | |
| | | 74 | | | 0.8 | | | |
| $V_{IK}$ | Input Clamp Diode Voltage | | | −0.65 | −1.5 | V | $V_{CC}$ = MIN, $I_{IN}$ = −18 mA | |
| $V_{OH}$ | Output HIGH Voltage | 54 | 2.5 | 3.5 | | V | $V_{CC}$ = MIN, $I_{OH}$ = MAX, $V_{IN}$ = $V_{IH}$ or $V_{IL}$ per Truth Table | |
| | | 74 | 2.7 | 3.5 | | V | | |
| $V_{OL}$ | Output LOW Voltage | 54, 74 | | 0.25 | 0.4 | V | $I_{OL}$ = 4.0 mA | $V_{CC}$ = $V_{CC}$ MIN, $V_{IN}$ = $V_{IL}$ or $V_{IH}$ per Truth Table |
| | | 74 | | 0.35 | 0.5 | V | $I_{OL}$ = 8.0 mA | |
| $I_{IH}$ | Input HIGH Current | | | | 20 | µA | $V_{CC}$ = MAX, $V_{IN}$ = 2.7 V | |
| | | | | | 0.1 | mA | $V_{CC}$ = MAX, $V_{IN}$ = 7.0 V | |
| $I_{IL}$ | Input LOW Current | | | | −0.4 | mA | $V_{CC}$ = MAX, $V_{IN}$ = 0.4 V | |
| $I_{OS}$ | Short Circuit Current (Note 1) | | −20 | | −100 | mA | $V_{CC}$ = MAX | |
| $I_{CC}$ | Power Supply Current | | | | 10 | mA | $V_{CC}$ = MAX | |

Note 1: Not more than one output should be shorted at a time, nor for more than 1 second.

**AC CHARACTERISTICS** ($T_A$ = 25°C)

| Symbol | Parameter | Min | Typ | Max | Unit | Test Conditions | |
|---|---|---|---|---|---|---|---|
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>Address, $E_a$ or $E_b$ to Output | | 10<br>19 | 15<br>30 | ns | Figure 1 | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>Address to Output | | 17<br>19 | 26<br>30 | ns | Figure 2 | $V_{CC}$ = 5.0 V<br>$C_L$ = 15 pF |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$E_a$ to Output | | 18<br>18 | 27<br>27 | ns | Figure 1 | |

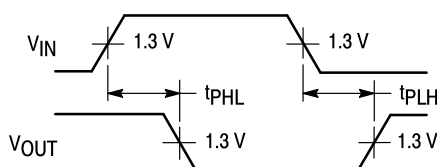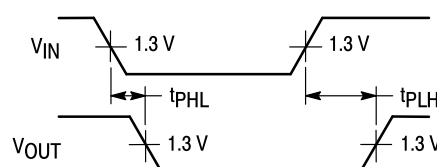## AC WAVEFORMS



**Figure 1**



**Figure 2**

# SN54/74LS156

## GUARANTEED OPERATING RANGES

| Symbol | Parameter | | Min | Typ | Max | Unit |
|--------|-----------|---|-----|-----|-----|------|
| V_CC | Supply Voltage | 54 | 4.5 | 5.0 | 5.5 | V |
| | | 74 | 4.75 | 5.0 | 5.25 | |
| T_A | Operating Ambient Temperature Range | 54 | −55 | 25 | 125 | °C |
| | | 74 | 0 | 25 | 70 | |
| V_OH | Output Voltage — High | 54, 74 | | | 5.5 | V |
| I_OL | Output Current — Low | 54 | | | 4.0 | mA |
| | | 74 | | | 8.0 | |

## DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

| Symbol | Parameter | | Limits | | | Unit | Test Conditions | |
|--------|-----------|---|--------|-----|-----|------|-----------------|---|
| | | | Min | Typ | Max | | | |
| $V_{IH}$ | Input HIGH Voltage | | 2.0 | | | V | Guaranteed Input HIGH Voltage for All Inputs | |
| $V_{IL}$ | Input LOW Voltage | 54 | | | 0.7 | V | Guaranteed Input LOW Voltage for All Inputs | |
| | | 74 | | | 0.8 | | | |
| $V_{IK}$ | Input Clamp Diode Voltage | | | −0.65 | −1.5 | V | $V_{CC}$ = MIN, $I_{IN}$ = −18 mA | |
| $I_{OH}$ | Output HIGH Current | 54, 74 | | | 100 | µA | $V_{CC}$ = MIN, $V_{OH}$ = MAX | |
| $V_{OL}$ | Output LOW Voltage | 54, 74 | | 0.25 | 0.4 | V | $I_{OL}$ = 4.0 mA | $V_{CC}$ = $V_{CC}$ MIN, $V_{IN}$ = $V_{IL}$ or $V_{IH}$ per Truth Table |
| | | 74 | | 0.35 | 0.5 | V | $I_{OL}$ = 8.0 mA | |
| $I_{IH}$ | Input HIGH Current | | | | 20 | µA | $V_{CC}$ = MAX, $V_{IN}$ = 2.7 V | |
| | | | | | 0.1 | mA | $V_{CC}$ = MAX, $V_{IN}$ = 7.0 V | |
| $I_{IL}$ | Input LOW Current | | | | −0.4 | mA | $V_{CC}$ = MAX, $V_{IN}$ = 0.4 V | |
| $I_{CC}$ | Power Supply Current | | | | 10 | mA | $V_{CC}$ = MAX | |

## AC CHARACTERISTICS ($T_A$ = 25°C)

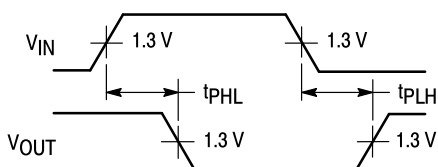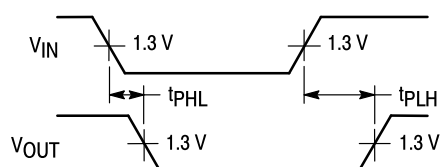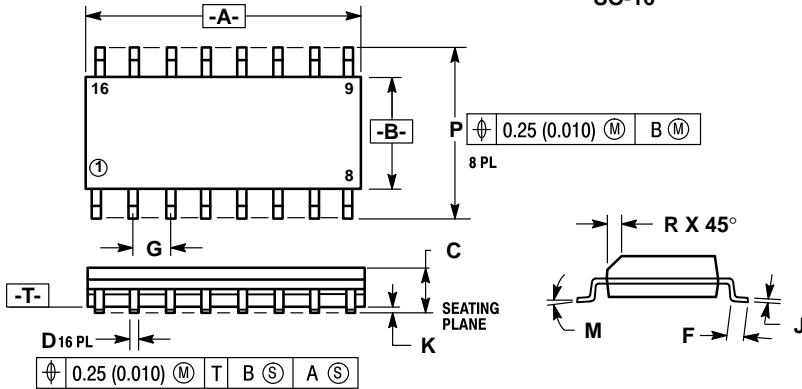| Symbol | Parameter | Limits | | | Unit | Test Conditions | |
|--------|-----------|--------|-----|-----|------|-----------------|---|
| | | Min | Typ | Max | | | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Address, $E_a$ or $E_b$ to Output | | 25 34 | 40 51 | ns | Figure 1 | $V_{CC}$ = 5.0 V $C_L$ = 15 pF $R_L$ = 2.0 kΩ |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Address to Output | | 31 34 | 46 51 | ns | Figure 2 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay $E_a$ to Output | | 32 32 | 48 48 | ns | Figure 1 | |

## AC WAVEFORMS



**Figure 1**



**Figure 2**

**Case 751B-03 D Suffix**
**16-Pin Plastic**
**SO-16**

| DIM | MILLIMETERS | | INCHES | |
| --- | MIN | MAX | MIN | MAX |
| A | 9.80 | 10.00 | 0.386 | 0.393 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.229 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

**Case 648-08 N Suffix**
**16-Pin Plastic**
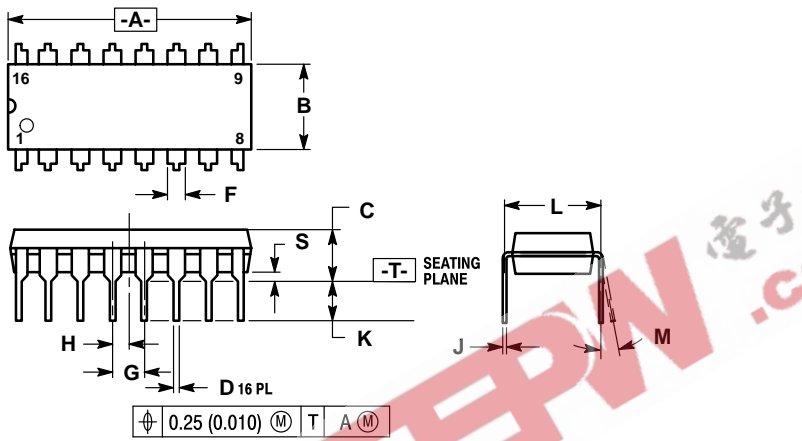
| DIM | MILLIMETERS | | INCHES | |
| --- | MIN | MAX | MIN | MAX |
| A | 18.80 | 19.55 | 0.740 | 0.770 |
| B | 6.35 | 6.85 | 0.250 | 0.270 |
| C | 3.69 | 4.44 | 0.145 | 0.175 |
| D | 0.39 | 0.53 | 0.015 | 0.021 |
| F | 1.02 | 1.77 | 0.040 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| H | 1.27 BSC | | 0.050 BSC | |
| J | 0.21 | 0.38 | 0.008 | 0.015 |
| K | 2.80 | 3.30 | 0.110 | 0.130 |
| L | 7.50 | 7.74 | 0.295 | 0.305 |
| M | 0° | 10° | 0° | 10° |
| S | 0.51 | 1.01 | 0.020 | 0.040 |

**Case 620-09 J Suffix**
**16-Pin Ceramic Dual In-Line**
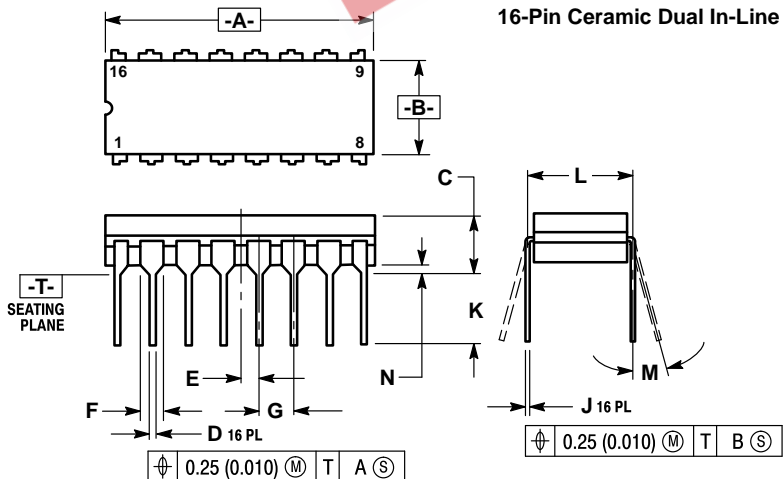
| DIM | MILLIMETERS | | INCHES | |
| --- | MIN | MAX | MIN | MAX |
| A | 19.05 | 19.55 | 0.750 | 0.770 |
| B | 6.10 | 7.36 | 0.240 | 0.290 |
| C | — | 4.19 | — | 0.165 |
| D | 0.39 | 0.53 | 0.015 | 0.021 |
| E | 1.27 BSC | | 0.050 BSC | |
| F | 1.40 | 1.77 | 0.055 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| J | 0.23 | 0.27 | 0.009 | 0.011 |
| K | — | 5.08 | — | 0.200 |
| L | 7.62 BSC | | 0.300 BSC | |
| M | 0° | 15° | 0° | 15° |
| N | 0.39 | 0.88 | 0.015 | 0.035 |

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**MOTOROLA**

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