



# FAST CMOS 1-OF-8 DECODER WITH ENABLE

**IDT54/74FCT138T/AT/CT**

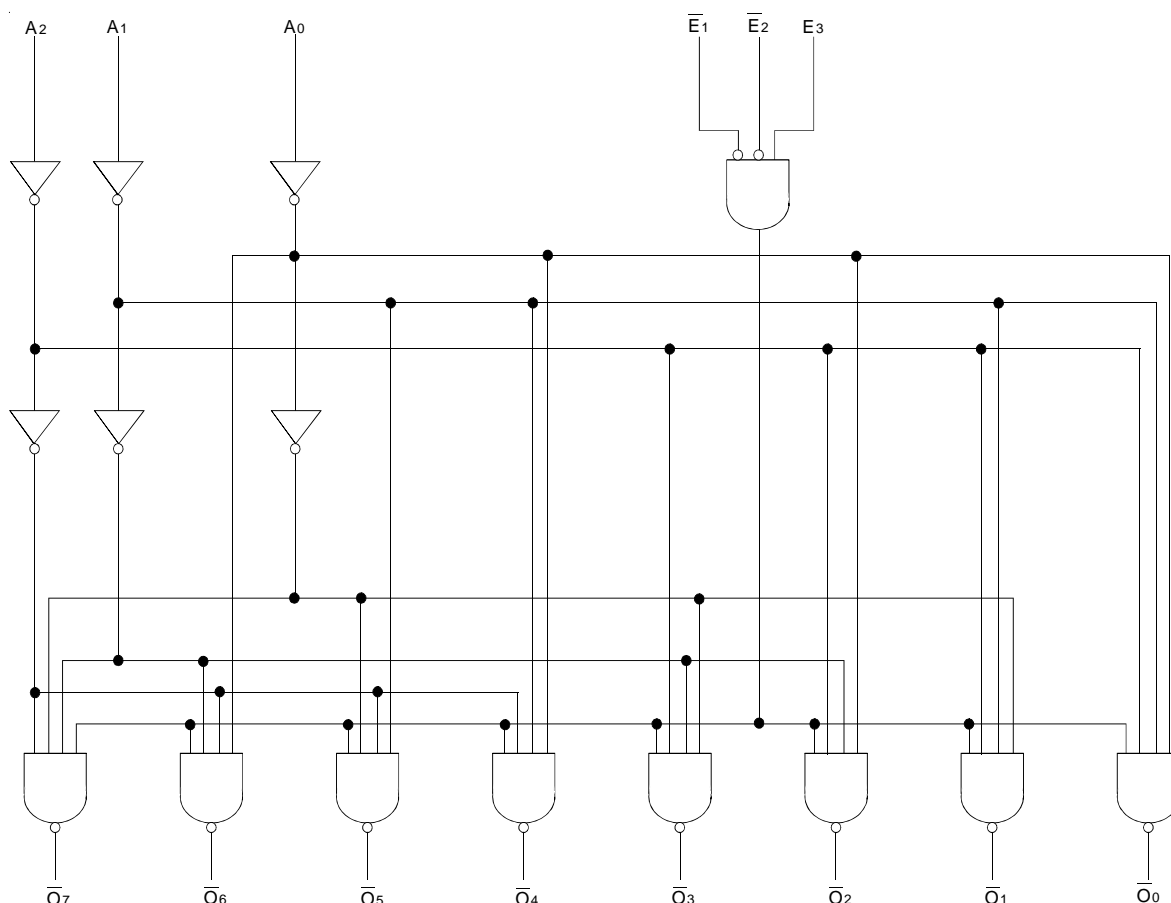
## FEATURES:

- Std., A, and C grades
- Low input and output leakage  $\leq 1\mu\text{A}$  (max.)
- CMOS power levels
- True TTL input and output compatibility:
  - $V_{OH} = 3.3V$  (typ.)
  - $V_{OL} = 0.3V$  (typ.)
- High Drive outputs (-15mA  $I_{OH}$ , 48mA  $I_{OL}$ )
- Meets or exceeds JEDEC standard 18 specifications
- Military product compliant to MIL-STD-883, Class B and DESC listed (dual marked)
- Power off disable outputs permit "live insertion"
- Available in the following packages:
  - Industrial: SOIC, QSOP
  - Military: CERDIP, LCC

## DESCRIPTION:

The IDT54/74FCT138T is a 1-of-8 decoder built using an advanced dual metal CMOS technology. The IDT54/74FCT138T accepts three binary weighted inputs ( $A_0$ ,  $A_1$ ,  $A_2$ ) and, when enabled, provides eight mutually exclusive active low outputs ( $\bar{O}_0 - \bar{O}_7$ ). The IDT54/74FCT138T features three enable inputs, two active low ( $\bar{E}_1$ ,  $\bar{E}_2$ ) and one active high ( $E_3$ ). All outputs will be high unless  $\bar{E}_1$  and  $\bar{E}_2$  are low and  $E_3$  is high. This multiple enable function allows easy parallel expansion of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four IDT54/74FCT138T devices and one inverter.

## FUNCTIONAL BLOCK DIAGRAM

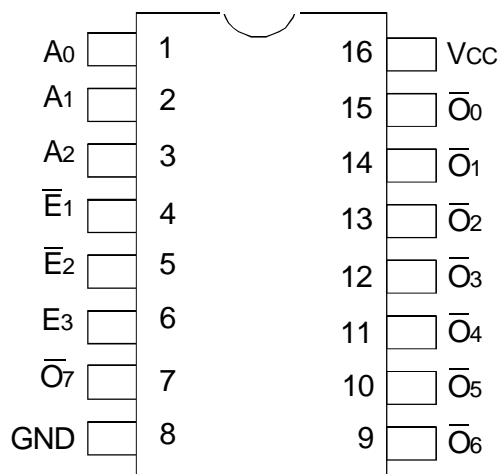


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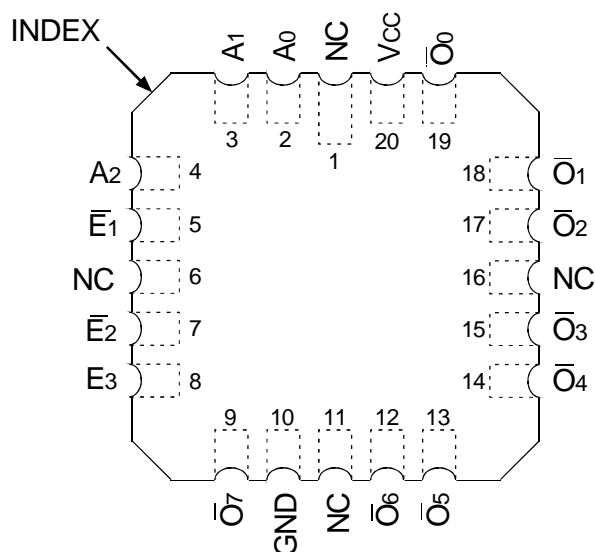
MILITARY AND INDUSTRIAL TEMPERATURE RANGES

JUNE 2002

## PIN CONFIGURATION



CERDIP/ SOIC/ QSOP  
TOP VIEW



LCC  
TOP VIEW

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

| Symbol                           | Description                          | Max                          | Unit |
|----------------------------------|--------------------------------------|------------------------------|------|
| V <sub>TERM</sub> <sup>(2)</sup> | Terminal Voltage with Respect to GND | -0.5 to +7                   | V    |
| V <sub>TERM</sub> <sup>(3)</sup> | Terminal Voltage with Respect to GND | -0.5 to V <sub>CC</sub> +0.5 | V    |
| T <sub>STG</sub>                 | Storage Temperature                  | -65 to +150                  | °C   |
| I <sub>OUT</sub>                 | DC Output Current                    | -60 to +120                  | mA   |

### NOTES:

- Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability. No terminal voltage may exceed V<sub>CC</sub> by -0.5V unless otherwise noted.
- Inputs and V<sub>CC</sub> terminals only.
- Output and I/O terminals only.

## PIN DESCRIPTION

| Pin Names                       | Description                |
|---------------------------------|----------------------------|
| A <sub>0</sub> - A <sub>2</sub> | Address Inputs             |
| $\bar{E}_1, \bar{E}_2$          | Enable Inputs (Active LOW) |
| E <sub>3</sub>                  | Enable Input (Active HIGH) |
| $\bar{O}_0 - \bar{O}_7$         | Outputs (Active LOW)       |

## CAPACITANCE (T<sub>A</sub> = +25°C, F = 1.0MHz)

| Symbol           | Parameter <sup>(1)</sup> | Conditions            | Typ. | Max. | Unit |
|------------------|--------------------------|-----------------------|------|------|------|
| C <sub>IN</sub>  | Input Capacitance        | V <sub>IN</sub> = 0V  | 6    | 10   | pF   |
| C <sub>OUT</sub> | Output Capacitance       | V <sub>OUT</sub> = 0V | 8    | 12   | pF   |

### NOTE:

- This parameter is measured at characterization but not tested.

FUNCTION TABLE<sup>(1)</sup>

| Inputs      |             |       |       |       |       | Outputs     |             |             |             |             |             |             |             |
|-------------|-------------|-------|-------|-------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| $\bar{E}_1$ | $\bar{E}_2$ | $E_3$ | $A_0$ | $A_1$ | $A_2$ | $\bar{O}_0$ | $\bar{O}_1$ | $\bar{O}_2$ | $\bar{O}_3$ | $\bar{O}_4$ | $\bar{O}_5$ | $\bar{O}_6$ | $\bar{O}_7$ |
| H           | X           | X     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
| X           | H           | X     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
| X           | X           | L     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
| L           | L           | H     | L     | L     | L     | L           | H           | H           | H           | H           | H           | H           | H           |
| L           | L           | H     | H     | L     | L     | H           | L           | H           | H           | H           | H           | H           | H           |
| L           | L           | H     | L     | H     | L     | H           | H           | L           | H           | H           | H           | H           | H           |
| L           | L           | H     | H     | H     | L     | H           | H           | H           | L           | H           | H           | H           | H           |
| L           | L           | H     | L     | L     | H     | H           | H           | H           | H           | L           | H           | H           | H           |
| L           | L           | H     | H     | L     | H     | H           | H           | H           | H           | H           | L           | H           | H           |
| L           | L           | H     | L     | H     | H     | H           | H           | H           | H           | H           | H           | L           | H           |
| L           | L           | H     | H     | H     | H     | H           | H           | H           | H           | H           | H           | H           | L           |

NOTE:

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

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Industrial:  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$ ; Military:  $T_A = -55^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$

| Symbol   | Parameter                         | Test Conditions <sup>(1)</sup>                              |  | Min. | Typ. <sup>(2)</sup> | Max.    | Unit          |
|----------|-----------------------------------|---|--|------|---------------------|---------|---------------|
| $V_{IH}$ | Input HIGH Level                  | Guaranteed Logic HIGH Level                                 |  | 2    | —                   | —       | V             |
| $V_{IL}$ | Input LOW Level                   | Guaranteed Logic LOW Level                                  |  | —    | —                   | 0.8     | V             |
| $I_{IH}$ | Input HIGH Current <sup>(4)</sup> | $V_{CC} = \text{Max.}$                                      | $V_I = 2.7\text{V}$  | —    | —                   | $\pm 1$ | $\mu\text{A}$ |
| $I_{IL}$ | Input LOW Current <sup>(4)</sup>  | $V_{CC} = \text{Max.}$                                      | $V_I = 0.5\text{V}$  | —    | —                   | $\pm 1$ | $\mu\text{A}$ |
| $I_I$    | Input HIGH Current <sup>(4)</sup> | $V_{CC} = \text{Max.}, V_I = V_{CC} (\text{Max.})$          |  | —    | —                   | $\pm 1$ | $\mu\text{A}$ |
| $V_{IK}$ | Clamp Diode Voltage               | $V_{CC} = \text{Min.}, I_{IN} = -18\text{mA}$               |  | —    | -0.7                | -1.2    | V             |
| $I_{OS}$ | Short Circuit Current             | $V_{CC} = \text{Max.}, V_O = \text{GND}^{(3)}$              |  | -60  | -120                | -225    | mA            |
| $V_{OH}$ | Output HIGH Voltage               | $V_{CC} = \text{Min.}$<br>$V_{IN} = V_{IH}$ or $V_{IL}$     | $I_{OH} = -6\text{mA MIL}$<br>$I_{OH} = -8\text{mA IND}$   | 2.4  | 3.3                 | —       | V             |
|          |                                   |   | $I_{OH} = -12\text{mA MIL}$<br>$I_{OH} = -15\text{mA IND}$ | 2    | 3                   | —       | V             |
| $V_{OL}$ | Output LOW Voltage                | $V_{CC} = \text{Min.}$<br>$V_{IN} = V_{IH}$ or $V_{IL}$     | $I_{OL} = -32\text{mA MIL}$<br>$I_{OL} = -48\text{mA IND}$ | —    | 0.3                 | 0.5     | V             |
| $V_H$    | Input Hysteresis                  | —   |  | —    | 200                 | —       | mV            |
| $I_{CC}$ | Quiescent Power Supply Current    | $V_{CC} = \text{Max.}$<br>$V_{IN} = \text{GND}$ or $V_{CC}$ |  | —    | 0.01                | 1       | mA            |

NOTES:

- 1. For conditions shown as Min. or Max., use appropriate value specified under Electrical Characteristics for the applicable device type.
- 2. Typical values are at  $V_{CC} = 5.0\text{V}$ ,  $+25^\circ\text{C}$  ambient.
- 3. Not more than one output should be tested at one time. Duration of the test should not exceed one second.
- 4. The test limit for this parameter is  $\pm 5\mu\text{A}$  at  $T_A = -55^\circ\text{C}$ .

## POWER SUPPLY CHARACTERISTICS

| Symbol          | Parameter   | Test Conditions <sup>(1)</sup>   |  | Min. | Typ. <sup>(2)</sup> | Max. | Unit       |
|-----------------|---|--|--|------|---------------------|------|------------|
| $\Delta I_{CC}$ | Quiescent Power Supply Current<br>TTL Inputs HIGH | $V_{CC} = \text{Max.}$<br>$V_{IN} = 3.4V^{(3)}$  |  | —    | 0.5                 | 2    | mA         |
| $I_{CCD}$       | Dynamic Power Supply<br>Current <sup>(4)</sup>    | $V_{CC} = \text{Max.}$<br>Outputs Open<br>One Input Toggling<br>50% Duty Cycle   | $V_{IN} = V_{CC}$<br>$V_{IN} = \text{GND}$ | —    | 0.15                | 0.3  | mA/<br>MHz |
| $I_C$           | Total Power Supply Current <sup>(5)</sup>         | $V_{CC} = \text{Max.}$<br>Outputs Open<br>Toggle $\bar{E}_1, \bar{E}_2$ , or $E_3$<br>50% Duty Cycle<br>$f_o = 10\text{MHz}$<br>One Input and<br>One Output Toggling | $V_{IN} = V_{CC}$<br>$V_{IN} = \text{GND}$ | —    | 1.5                 | 4    | mA         |
|                 |   |  | $V_{IN} = 3.4V$<br>$V_{IN} = \text{GND}$   | —    | 1.8                 | 5    |            |

### NOTES:

- For conditions shown as Min. or Max., use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{CC} = 5.0V$ ,  $+25^\circ\text{C}$  ambient.
- Per TTL driven input; ( $V_{IN} = 3.4V$ ). All other inputs at  $V_{CC}$  or  $\text{GND}$ .
- This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
- $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CC} + \Delta I_{CC} D_{HT} + I_{CCD} (f_o N_o)$   
 $I_{CC}$  = Quiescent Current  
 $\Delta I_{CC}$  = Power Supply Current for a TTL High Input ( $V_{IN} = 3.4V$ )  
 $D_H$  = Duty Cycle for TTL Inputs High  
 $N_T$  = Number of TTL Inputs at  $D_H$   
 $I_{CCD}$  = Dynamic Current caused by an Input Transition Pair (HLH or LHL)  
 $f_o$  = Output Frequency  
 $N_o$  = Number of Outputs at  $f_o$   
 All currents are in milliamps and all frequencies are in megahertz.

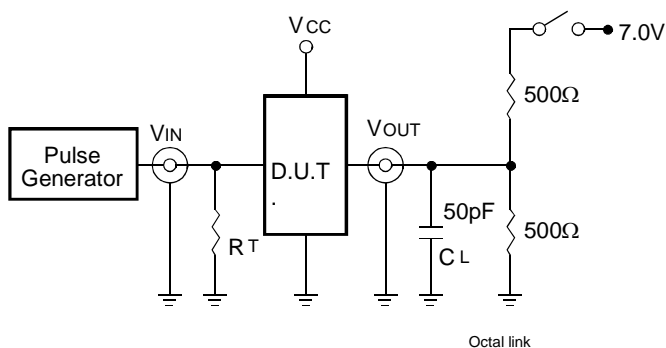
## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

| Symbol                 | Parameter  | Condition <sup>(1)</sup>                 | 54FCT138T           |      | 54/74FCT138AT       |      |                     |      | 54/74FCT138CT       |      |                     |      | Unit |
|------------------------|--|--|---------------------|------|---------------------|------|---------------------|------|---------------------|------|---------------------|------|------|
|                        |  |  | Mil.                |      | Ind.                |      | Mil.                |      | Ind.                |      | Mil.                |      |      |
|                        |  |  | Min. <sup>(2)</sup> | Max. | Min. <sup>(2)</sup> | Max. | Min. <sup>(2)</sup> | Max. | Min. <sup>(2)</sup> | Max. | Min. <sup>(2)</sup> | Max. |      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$A_x$ to $\bar{O}_x$                      | $C_L = 50\text{pF}$<br>$R_L = 500\Omega$ | 1.5                 | 12   | 1.5                 | 5.8  | 1.5                 | 7.8  | 1.5                 | 5.1  | 1.5                 | 6    | ns   |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_x$ |  | 1.5                 | 12.5 | 1.5                 | 5.9  | 1.5                 | 8    | 1.5                 | 5.2  | 1.5                 | 6.1  | ns   |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$E_3$ to $\bar{O}_x$                      |  | 1.5                 | 12.5 | 1.5                 | 5.9  | 1.5                 | 8    | 1.5                 | 5.2  | 1.5                 | 6.1  | ns   |

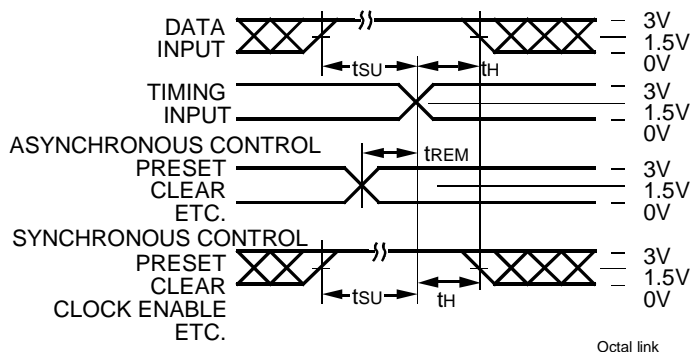
### NOTES:

- See test circuit and waveforms.
- Minimum limits are guaranteed but not tested on Propagation Delays.

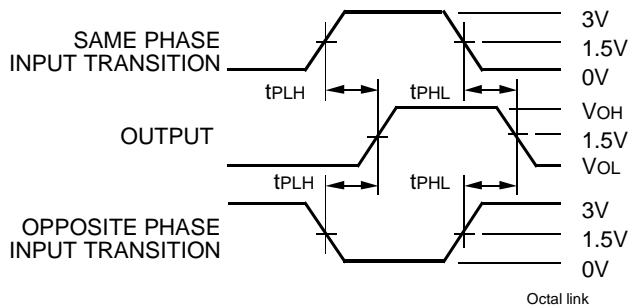
## TEST CIRCUITS AND WAVEFORMS



Test Circuits for All Outputs



Set-Up, Hold, and Release Times



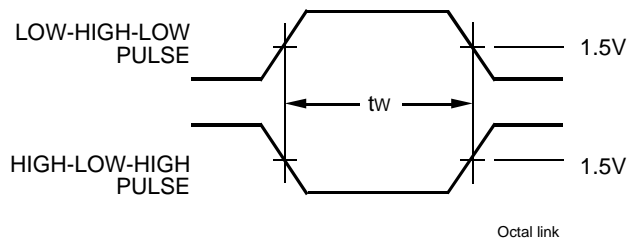
Propagation Delay

## SWITCH POSITION

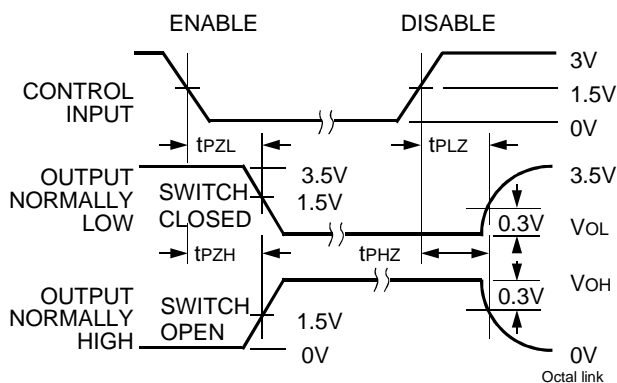
| Test                                    | Switch |
|---|--------|
| Open Drain<br>Disable Low<br>Enable Low | Closed |
| All Other Tests                         | Open   |

### DEFINITIONS:

CL = Load capacitance: includes jig and probe capacitance.  
RT = Termination resistance: should be equal to Zout of the Pulse Generator.



Pulse Width

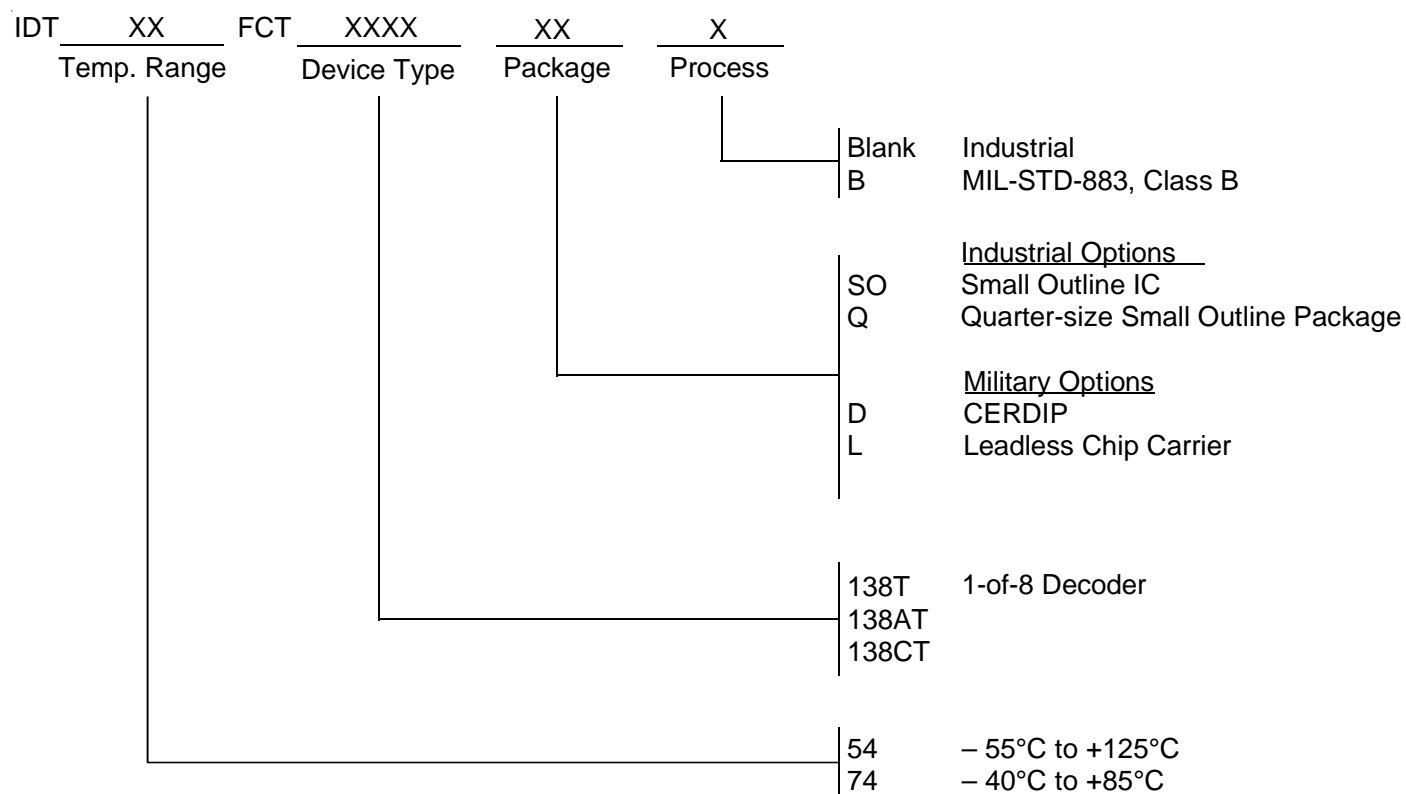


Enable and Disable Times

### NOTES:

- Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.
- Pulse Generator for All Pulses: Rate  $\leq 1.0\text{MHz}$ ;  $t_r \leq 2.5\text{ns}$ ;  $t_f \leq 2.5\text{ns}$ .

## ORDERING INFORMATION



## DATA SHEET DOCUMENT HISTORY

3/25/2002 Removed standard speed grade  
6/20/2002 Updated as per PNC Logic-00-07 and Logic-01-04



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