FAST CMOS
1-OF-8 DECODER
WITH ENABLE

IDT54/74FCT138T/AT/CT

Integrated Device Technology, Inc.

## FEATURES:

- Std., A and C speed grades
- Low input and output leakage ≤1µA (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
- Product available in Radiation Tolerant and Radiation Enhanced versions
- Military product compliant to MIL-STD-883, Class B and DESC listed (dual marked)
- Available in DIP, SOIC, QSOP, CERPACK and LCC packages

DESCRIPTION:

The IDT54/74FCT138T/AT/CT are 1-of-8 decoders built using an advanced dual metal CMOS technology. The IDT54/74FCT138T/AT/CT accepts three binary weighted inputs (A_0, A_1, A_2) and, when enabled, provides eight mutually exclusive active LOW outputs ($\overline{O}_0$-$\overline{O}_7$). The IDT54/74FCT138T/AT/CT features three enable inputs, two active LOW ($\overline{E}_1$, $\overline{E}_2$) and one active HIGH (E_3). All outputs will be HIGH unless $\overline{E}_1$ and $\overline{E}_2$ 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/AT/CT devices and one inverter.
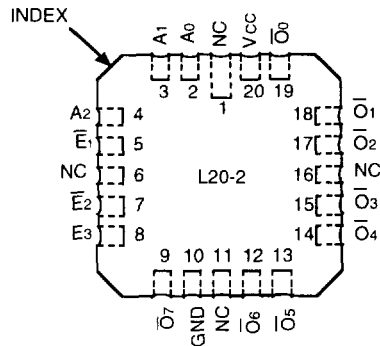
FUNCTIONAL BLOCK DIAGRAM
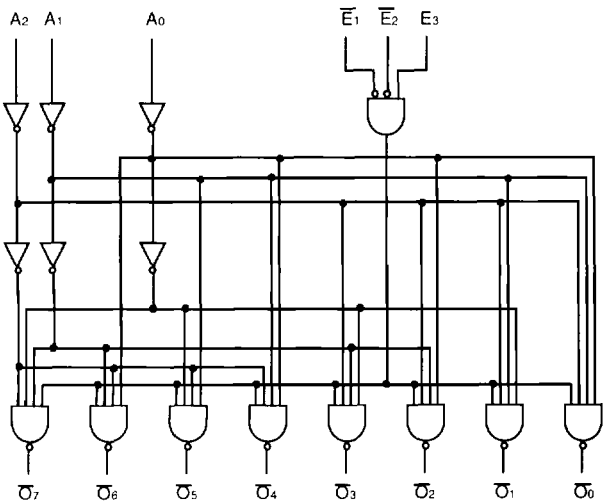
2570 drw 01

PIN CONFIGURATIONS
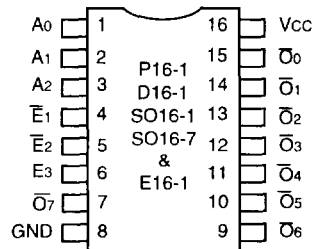
2570 drw 02

DIP/SOIC/QSOP/CERPACK
TOP VIEW

2570 drw 03

LCC
TOP VIEW

MILITARY AND COMMERCIAL TEMPERATURE RANGES **APRIL 1995**

DSC-4213/5

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PIN DESCRIPTION

Pin Names	Description
A_0–A_2	Address Inputs
$\overline{E_1}$, $\overline{E_2}$	Enable Inputs (Active LOW)
E_3	Enable Input (Active HIGH)
$\overline{O_0}$–$\overline{O_7}$	Outputs (Active LOW)

2570 tbl 01

FUNCTION TABLE

Inputs						Outputs							
$\overline{E_1}$	$\overline{E_2}$	E_3	A_0	A_1	A_2	$\overline{O_0}$	$\overline{O_1}$	$\overline{O_2}$	$\overline{O_3}$	$\overline{O_4}$	$\overline{O_5}$	$\overline{O_6}$	$\overline{O_7}$
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

2570 tbl 02

ABSOLUTE MAXIMUM RATINGS[1]

Symbol	Rating	Commercial	Military	Unit
V_{TERM}[2]	Terminal Voltage with Respect to GND	–0.5 to +7.0	–0.5 to +7.0	V
V_{TERM}[3]	Terminal Voltage with Respect to GND	–0.5 to V_{CC} +0.5	–0.5 to V_{CC} +0.5	V
T_A	Operating Temperature	0 to +70	–55 to +125	°C
T_{BIAS}	Temperature Under Bias	–55 to +125	–65 to +135	°C
T_{STG}	Storage Temperature	–55 to +125	–65 to +150	°C
P_T	Power Dissipation	0.5	0.5	W
I_{OUT}	DC Output Current	–60 to +120	–60 to +120	mA

2570 lnk 03

NOTES:
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RAT-INGS 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 Vcc by +0.5V unless otherwise noted.
2. Input and Vcc terminals only.
3. Outputs and I/O terminals only.

CAPACITANCE (T_A = +25°C, f = 1.0MHz)

Symbol	Parameter[1]	Conditions	Typ.	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	6	10	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V	8	12	pF

NOTE:
2570 lnk 04
1. This parameter is measured at characterization but not tested.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Commercial: $T_A = 0°C$ to $+70°C$, $V_{CC} = 5.0V \pm 5\%$; Military: $T_A = -55°C$ to $+125°C$, $V_{CC} = 5.0V \pm 10\%$

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
V_{IH}	Input HIGH Level	Guaranteed Logic HIGH Level		2.0	—	—	V
V_{IL}	Input LOW Level	Guaranteed Logic LOW Level		—	—	0.8	V
I_{IH}	Input HIGH Current[4]	V_{CC} = Max.	V_I = 2.7V	—	—	±1	μA
I_{IL}	Input LOW Current[4]	V_{CC} = Max.	V_I = 0.5V	—	—	±1	μA
I_I	Input HIGH Current[4]	V_{CC} = Max., $V_I = V_{CC}$ (Max.)		—	—	±1	μA
V_{IK}	Clamp Diode Voltage	V_{CC} = Min., $I_N = -18mA$		—	-0.7	-1.2	V
I_{OS}	Short Circuit Current	V_{CC} = Max.[3], V_O = GND		-60	-120	-225	mA
V_{OH}	Output HIGH Voltage	V_{CC} = Min. $V_{IN} = V_{IH}$ or V_{IL}	I_{OH} = -6mA MIL. I_{OH} = -8mA COM'L.	2.4	3.3	—	V
			I_{OH} = -12mA MIL. I_{OH} = -15mA COM'L.	2.0	3.0	—	V
V_{OL}	Output LOW Voltage	V_{CC} = Min. $V_{IN} = V_{IH}$ or V_{IL}	I_{OL} = 32mA MIL. I_{OL} = 48mA COM'L.	—	0.3	0.5	V
V_H	Input Hysteresis	—		—	200	—	mV
I_{CC}	Quiescent Power Supply Current	V_{CC} = Max. V_{IN} = GND or V_{CC}		—	0.01	1	mA

2570 tbl 05

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

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POWER SUPPLY CHARACTERISTICS

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
ΔI_{CC}	Quiescent Power Supply Current TTL Inputs HIGH	V_{CC} = Max. V_{IN} = 3.4V[3]		—	0.5	2.0	mA
I_{CCD}	Dynamic Power Supply Current[4]	V_{CC} = Max. Outputs Open One Bit Toggling 50% Duty Cycle	V_{IN} = V_{CC} V_{IN} = GND	—	0.15	0.3	mA/ MHz
I_C	Total Power Supply Current[6]	V_{CC} = Max. Outputs Open Toggle $\overline{E}_1$, $\overline{E}_2$ or E_3	V_{IN} = V_{CC} V_{IN} = GND	—	1.5	4.0	mA
		50% Duty Cycle f_0 = 10MHz One Input and One Output Toggling	V_{IN} = 3.4V V_{IN} = GND	—	1.8	5.0	

2570 tbl 06

NOTES:
1. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at V_{CC} = 5.0V, +25°C ambient.
3. Per TTL driven input (V_{IN} = 3.4V). All other inputs at V_{CC} or GND.
4. This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
5. Values for these conditions are examples of the I_{CC} formula. These limits are guaranteed but not tested.
6. I_C = $I_{QUIESCENT}$ + I_{INPUTS} + $I_{DYNAMIC}$
   I_C = I_{CC} + ΔI_{CC} $D_H N_T$ + I_{CCD} ($f_0 N_0$)
   I_{CC} = Quiescent Current
   ΔI_{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_0 = Output Frequency
   N_0 = Number of Outputs at f_0
   All currents are in milliamps and all frequencies are in megahertz.

SWITCHING CHARACTERISTICS OVER OPERATING RANGE

|			FCT138T				FCT138AT				FCT138CT				
			Com'l.		Mil.		Com'l.		Mil.		Com'l.		Mil.		
Symbol	Parameter	Condition[1]	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Unit
t_{PLH} t_{PHL}	Propagation Delay A_n to $\overline{O}_n$	C_L = 50pF R_L = 500Ω	1.5	9.0	1.5	12.0	1.5	5.8	1.5	7.8	1.5	5.1	1.5	6.0	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$		1.5	9.0	1.5	12.5	1.5	5.9	1.5	8.0	1.5	5.2	1.5	6.1	ns
t_{PLH} t_{PHL}	Propagation Delay E_3 to $\overline{O}_n$		1.5	9.0	1.5	12.5	1.5	5.9	1.5	8.0	1.5	5.2	1.5	6.1	ns

2570 tbl 07

NOTES:
1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.

TEST CIRCUITS AND WAVEFORMS

TEST CIRCUITS FOR ALL OUTPUTS

V_{CC}

7.0V

500Ω

V_{IN}

Pulse Generator

D.U.T.

V_{OUT}

R_T

50pF

C_L

500Ω
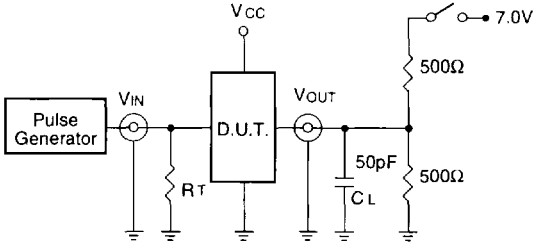
2570 drw 04
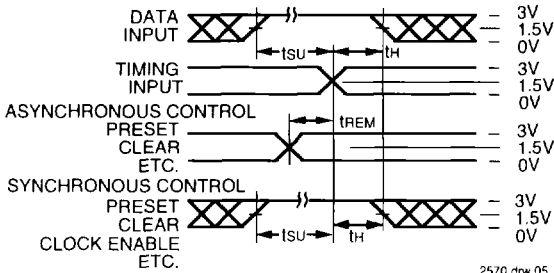
SWITCH POSITION

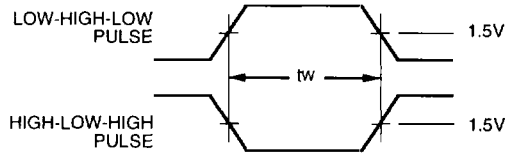| Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

2570 tbl 08

DEFINITIONS:

C_L = Load capacitance: includes jig and probe capacitance.

R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.
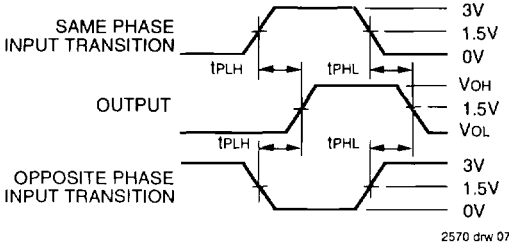
SET-UP, HOLD AND RELEASE TIMES

DATA INPUT — 3V / 1.5V / 0V

t_{SU} t_H

TIMING INPUT — 3V / 1.5V / 0V

ASYNCHRONOUS CONTROL PRESET CLEAR ETC. — 3V / 1.5V / 0V

t_{REM}

SYNCHRONOUS CONTROL PRESET CLEAR CLOCK ENABLE ETC. — 3V / 1.5V / 0V

t_{SU} t_H

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PULSE WIDTH

LOW-HIGH-LOW PULSE — 1.5V

t_W

HIGH-LOW-HIGH PULSE — 1.5V

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PROPAGATION DELAY

SAME PHASE INPUT TRANSITION — 3V / 1.5V / 0V

t_{PLH} t_{PHL}

OUTPUT — V_{OH} / 1.5V / V_{OL}

t_{PLH} t_{PHL}

OPPOSITE PHASE INPUT TRANSITION — 3V / 1.5V / 0V

2570 drw 07

ENABLE AND DISABLE TIMES

ENABLE   DISABLE

CONTROL INPUT — 3V / 1.5V / 0V

t_{PZL} t_{PLZ}

OUTPUT NORMALLY LOW   SWITCH CLOSED — 3.5V / 1.5V / 0.3V V_{OL}

t_{PZH} t_{PHZ}

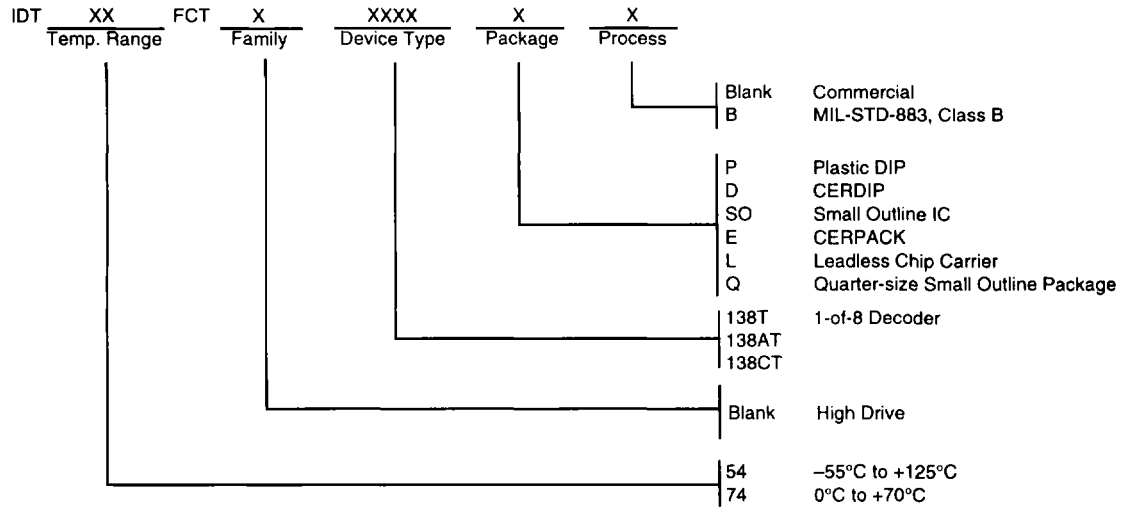OUTPUT NORMALLY HIGH   SWITCH OPEN — 1.5V / 0.3V V_{OH} / 0V
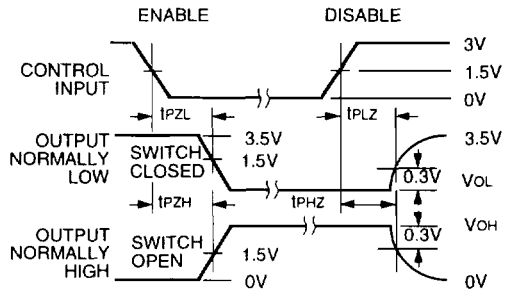
2570 drw 08

NOTES:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH

2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; t_F ≤ 2.5ns; t_R ≤ 2.5ns

ORDERING INFORMATION

```
IDT    XX      FCT    X        XXXX        X        X
    Temp. Range     Family  Device Type  Package  Process
```

Blank	Commercial	
B	MIL-STD-883, Class B	
P	Plastic DIP	
D	CERDIP	
SO	Small Outline IC	
E	CERPACK	
L	Leadless Chip Carrier	
Q	Quarter-size Small Outline Package	
138T	1-of-8 Decoder	
138AT		
138CT		
Blank	High Drive	
54	−55°C to +125°C	
74	0°C to +70°C	

2570 drw 09

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